$3.95

semiconductor data handbook

including solid state lamps and circuit assemblies

LIMA TECHNICAL COLLEGE
OSU LIMA CAMPUS
4240 Campus Drive
LIMA, OHIO 45804

HOW TO USE THIS BOOK

IF THE DEVICE TYPE NUMBER IS KNOWN

Look up the number in the INDEX. Either the exact General Electric type or a suggested replacement type will be shown. The page number of the referenced SPECIFICATION SHEET is also indicated, and going to that page will provide you detailed information. As a convenience, the maximum ratings and major electrical parameters are shown for JEDEC devices.

INDEX 1N

INDEX 2N, 3N

INDEX INDUSTRY TYPES

IF THE GENERAL APPLICATION IS KNOWN

Refer to the SELECTOR GUIDE for an overview of devices available and select one or more types to fit your application. Then refer back to the INDEX to obtain the page number of the detailed SPECIFICATION SHEETS.

Silicon Signal Transistors 104
Silicon Power Transistors 114
Signal Diodes 118
Tunnel Diodes 120
Germanium Transistors 123
Unijunctions, Switches & Triggers 124
Optoelectronics 128
Rectifiers 132
SCRs 138
Triacs 152
Assemblies, Modules & Stacks 158
Selenium Components 164
Special Products
    Voltage Regulating Devices 166
    Differential Amplifiers 168
    Darlington Amplifiers 168
    Diode & Transistor Chips 169
Military & Hi-Rel Types 170
Hardware 171
Technical Publications 173

1N

2N, 3N

INDUSTRY TYPES

USE INDEX FOR EXACT PAGE
SPECIFICATION SHEETS ARE NOT NECESSARILY IN ALPHA NUMERIC ORDER

GE PUBLICATION NUMBER TO PAGE CROSS REFERENCE P103

GE TECHNICAL PUBLICATIONS P173

GENERAL ELECTRIC

The information in this catalog has been carefully checked and is believed to be reliable. However, no responsibility is assumed for inaccuracies. The suggested replacements in this catalog represent what we believe to be the nearest GE equivalents for the products listed and in most instances are exact replacements. However, GE assumes no responsibility and does not guarantee that the replacements are exact, but only that the replacements will meet the terms of its applicable published written product warranties. The pertinent GE product specification sheets should be used as the key tool for actual replacements.

Copyright © 1971 General Electric Company

Semiconductor Products Dept.
Electronics Park
Syracuse, N.Y. 13201
U.S.A.

semiconductor data handbook

including solid state lamps and circuit assemblies

. . . . 175

(USE INDEX FOR EXACT PAGE)

. . . . 201
. . . . 401
. . . . 715
. . . . 801

Type	Silicon Signal Diodes						Silicon Rectifiers					Exact "1N" Type Page	Suggested GE Replacement	
	BV (V)	V_F @ I_F (V)	(MA)	I_R @ V_R (nA)	(V)	t_{rr} (ns)	V_R (V)	I_P (Max.) (A)	V_F @ I_F (Max.) (V)	(A)	I_R (μA)		Type	Page
1N91							100	.15	.22	.15		201		
1N92							200	.10	.19	.10		201		
1N93							300	.075	.18	.075		201		
1N248							50	10	1.5	10	5.0	205		
1N248A							50	20	1.5	20	5.0	205		
1N248C							50	20	1.5	20	5.0	207		
1N249							100	10	1.5	10	5.0	207		
1N249A							100	20	1.5	20	5.0	207		
1N249B							100	20	1.5	20	5.0	207		
1N249C							100	20	1.5	20	5.0	207		
1N250							200	10	1.5	10	5.0	207		
1N250A							200	20	1.5	20	5.0	207		
1N250B							200	20	1.5	20	5.0	207		
1N250C							200	20	1.5	20	5.0	207		
1N251	30	1.0	5	100	10							118		
1N251A	125	1.0	10	1000	100								DA170	1217
1N252	20	1.0	10	100	5							118		
1N254							190	.4	1.5	.4		118	1N5059	312
1N255							380	.4	1.5	.4			1N5060	312
1N256							570	.2	1.5	.2			1N5061	312
1N315													1N5061	312
1N316							50	.2	2.0	.4			A14F	801
1N316A							50	.2	2.0	.4			A14F	801
1N317							100	.2	2.0	.4			A14A	801
1N317A							100	.2	2.0	.4			A14A	801
1N318							200	.2	2.0	.4			1N5059	312
1N318A							200	.2	2.0	.4			1N5059	312
1N319							350	.2	2.0	.4			1N5060	312
1N319A							350	.2	2.0	.4			1N5060	312
1N320							500	.2	2.0	.4			1N5061	312
1N320A							500	.2	2.0	.4			1N5061	312
1N321							850	.25	1.2	.25	1.0		A14P	312
1N321A							850	.25	1.2	.25	1.0		A14P	312
1N322							850	.25	1.2	.25			A14P	312
1N322A							850	.25	1.2	.25			A14P	312
1N323							50	.4	2.0	.4			A14F	801
1N323A							50	.4	2.0	.4			A14F	801
1N324							100	.4	2.0	.4			A14A	801
1N324A							100	.4	2.0	.4			A14A	801
1N325							200	.4	2.0	.4			1N5059	312
1N325A							200	.4	2.0	.4			1N5059	312
1N326							350	.4	2.0	.4			1N5060	312
1N326A							350	.4	2.0	.4			1N5060	312
1N327							500	.4	2.0	.4			1N5061	312
1N327A							500	.4	2.0	.4			1N5061	312
1N328							850	.4	1.2	.4	.06		A14P	312
1N328A							850	.4	1.2	.4	.06		A14P	312
1N329							1000	.4	1.2	.4	.06		A14P	312
1N329A							1000	.4	1.2	.4	.06		A14P	312
1N332							400	.4	2.0	.4	.2		1N5060	312
1N333							400	.2	2.0	.2	.2		1N5060	312
1N334							300	.2	2.0	.4	.2		1N5060	312
1N335							300	.2	2.0	.2	.2		1N5060	312
1N336							200	.4	2.0	.4	.1		1N5059	312
1N337							200	.4	2.0	.2	.1		1N5059	312
1N338							100	1.0	2.0	1.0	.2		A14M	312
1N339							100	.4	2.0	.4	.1		A14A	801
1N340							100	.2	2.0	.2	.1		A14A	801
1N341							400	.4	2.0	.4	.5		1N5060	312
1N342							400	.2	2.0	.2	.5		1N5060	312
1N343							300	.4	2.0	.4	.5		1N5060	312
1N344							300	.2	2.0	.2	.5		1N5060	312
1N345							200	.4	2.0	.4	.5		1N5059	312
1N346							200	.2	2.0	.2	.5		1N5059	312
1N347							100	1.0	2.0	1.0	.5		A14A	801
1N348							100	.4	2.0	.4	.5		A14A	801
1N349							100	.2	2.0	.2	.5		A14A	801
1N359							50	.1	2.0	.1			A14F	801
1N359A							50	.1	2.0	.1			A14F	801

Type	Silicon Signal Diodes						Silicon Rectifiers					Exact "1N" Type Page	Suggested GE Replacement	
	BV (V)	V_F @ I_F (V)	(MA)	I_R @ V_R (nA)	(V)	t_{rr} (ns)	V_R (V)	I_P (Max.) (A)	V_F @ I_F (Max.) (V)	(A)	I_R (µA)		Type	Page
1N360							100	.1	2.0	.1			A14A	801
1N360A							100	.1	2.0	.1			A14A	801
1N361							200	.1	2.0	.1			1N5059	312
1N361A							200	.1	2.0	.1			1N5059	312
1N362							350	.1	2.0	.1			1N5060	312
1N362A							350	.1	2.0	.1			1N5060	312
1N363							500	.1	2.0	.1			1N5061	312
1N363A							500	.1	2.0	.1			1N5061	312
1N364							850	.1	1.2	.1	.06		A14P	312
1N364A							850	.1	1.2	.1	.06		A14P	312
1N365							1000	.1	1.2	.1	.06		A14P	312
1N365A							1000	.1	1.2	.1	.06		A14P	312
1N368							200	.1	.5	.1	.3		1N5059	312
1N440							100	.3	1.5	.3	.3		A14A	801
1N440B							100	.3	1.5	.3	.3		A14A	801
1N441							200	.3	1.5	.3	.75		1N5059	312
1N441B							200	.3	1.5	.3	.75		1N5059	312
1N442							300	.3	1.5	.3	1.0		1N5060	312
1N442B							300	.3	1.5	.3	1.0		1N5060	312
1N443							400	.3	1.5	.3	1.5		1N5060	312
1N443B							400	.3	1.5	.3	1.5		1N5060	312
1N444							500	.3	1.5	.3	1.75		1N5061	312
1N444B							500	.3	1.5	.3	1.75		1N5061	312
1N445							600	.3	1.5	.3	2.0		1N5061	312
1N445B							600	.3	1.5	.3	.002		1N5061	312
1N456	25	1.0	40	25	25							118		
1N457	60	1.0	20	25	60								DA1702	1271
1N458	125	1.0	2	25	125								DA1701	1271
1N459	175	1.0	3	25	175								DT230B	1274
1N461	25	1.0	15	500	25							118		
1N462	60	1.0	5	500	60								DA1702	1271
1N463	175	1.0	1	500	175								DT230H1	1274
1N464	125	1.0	3	500	125								DT230B	1274
1N482	36	1.1	100	250	36								DA1703	1271
1N483	70	1.0	100	250	60								DA1702	1271
1N484	130	1.1	100	250	120								DT230G	1274
1N485	180	1.1	100	250	160								DT230B	1274
1N486	225	1.1	100	250	200								DT23041	1274
1N530							100	.3	2.0	.3	.003		A14A	801
1N531							200	.3	2.0	.3			1N5059	312
1N532							300	.3	2.0	.3	.01		1N5060	312
1N533							400	.3	2.0	.3	.015		1N5060	312
1N534							500	.3	2.0	.3			1N5061	312
1N535							600	.3	2.0	.3	.02		1N5060	312
1N536							50	.25	.5	.25	.5		A14F	801
1N537							100	.25	.4	.25	.5		A14A	801
1N538							200	.25	.3	.25	.5		1N5059	312
1N539							300	.25	.5	.25	.3		1N5060	312
1N540							400	.25	.5	.25	.3		1N5060	312
1N547							600	.25	1.1	.25	.35		1N5061	312
1N548							900	.3	1.1	.3	.35		A14P	312
1N550							100	.5	1.5	.5			A14A	801
1N551							200	.5	1.5	.5	.001		1N5059	312
1N552							300	.5	1.5	.5			1N5060	312
1N553							400	.5	1.5	.5			1N5060	312
1N554							500	.5	1.5	.5			1N5061	312
1N555							600	.5	1.5	.5	.005		1N5061	312
1N560							800	.25	1.75	.25	.015		1N5062	312
1N561							1000	.25	1.75	.25	.02		A14P	312
1N562							800	.4	1.75	.4	.015		1N5062	312
1N563							1000	.4	1.75	.4	.015		A14P	312
1N596							600	.125	3.0	.125	.025		1N5061	312
1N597							800	.125	3.0	.125	.025		1N5062	312
1N598							1000	.125	3.0	.125	.025		A14P	312
1N599							50	.3	1.5	.3	.025		A14F	801
1N599A							50	.3	1.5	.3	.001		A14F	801
1N600							100	.3	1.5	.3	.025		A14A	312
1N600A							100	.3	1.5	.3	.001		A14A	312

Type	Silicon Signal Diodes						Silicon Rectifiers					Exact "1N" Type Page	Suggested GE Replacement	
	BV (V)	V_F @ I_F (V)	(MA)	I_R @ V_R (nA)	(V)	t_{rr} (ns)	V_R (V)	I_P (Max.) (A)	V_F @ I_F (Max.) (V)	(A)	I_R (μA)		Type	Page
1N601							150	.3	1.5	.3	.025		1N5059	312
1N601A							150	.3	1.5	.3	.001		1N5059	312
1N602							200	.3	1.5	.3	.025		1N5059	312
1N602A							200	.3	1.5	.3	.001		1N5059	312
1N603							300	.3	1.5	.3	.025		1N5060	312
1N603A							300	.3	1.5	.3	.001		1N5060	312
1N604							400	.3	1.5	.3	.025		1N5060	312
1N604A							400	.3	1.5	.3	.001		1N5060	312
1N605							500	.3	1.5	.3	.025		1N5061	312
1N605A							500	.3	1.5	.3	.002		1N5061	312
1N606							600	.3	1.5	.3	.025		1N5061	312
1N606A							600	.3	1.5	.3			1N5061	312
1N607							50	.8	1.5	.8	.025		A14F	801
1N607A							50	.8	1.5	.8	.001		A14F	801
1N608							100	.8	1.5	.8	.025		A14A	312
1N608A							100	.8	1.5	.8	.001		A14A	312
1N609							150	.8	1.5	.8	.025		1N5059	312
1N609A							150	.8	1.5	.8	.001		1N5059	312
1N610							200	.8	1.5	.8	.025		1N5059	312
1N610A							200	.8	1.5	.8	.001		1N5059	312
1N611							300	.8	1.5	.8	.025		1N5060	312
1N611A							300	.8	1.5	.8	.001		1N5060	312
1N612							400	.8	1.5	.8	.025		1N5060	312
1N612A							400	.8	1.5	.8	.001		1N5060	312
1N613							500	.8	1.5	.8	.025		1N5061	312
1N613A							500	.8	1.5	.8	.001		1N5061	312
1N614							600	.8	1.5	.8	.025		1N5061	312
1N614A							600	.8	1.5	.8	.001		1N5061	312
1N619	30	1.0	3	20	10								DA1703	1271
1N622	150	1.0	7	160	150								DT230G	1274
1N625		1.5	4	1000	20	1000						118		
1N626		1.5	4	1000	35	1000						118		
1N627		1.5	4	1000	75	1000							DA1701	1271
1N628		1.5	4	1000	125	1000							DT230G	1274
1N629		1.5	4	1000	175	1000							DT230B	1274
1N643	175	1.0	10	1000	100	300							DT230B	1274
1N645							225	.400	1.0	.400	.02		1N5060	312
1N646							300	.400	1.0	.400	.02		1N5060	312
1N647							400	.400	1.0	.400	.02		1N5060	312
1N648							500	.400	1.0	.400	.02		1N5061	312
1N649							600	.400	1.0	.400	.02		1N5061	312
1N659	50	1.0	6	5000	50	300							DA1702	1271
1N660	100	1.0	6	5000	100	300							DA1701	1271
1N661	200	1.0	6	10000	240	300							DT230B	1274
1N662	80	1.0	10	1000	50	500							DA1701	1271
1N663	80	1.0	100	5000	75	500							DA1701	1271
1N673							350	.400	1.0	.250	1.0		1N5060	312
1N676							100	.07	1.0	.07	.2		A14A	801
1N677							100	.15	1.0	.15	.2		A14A	801
1N678							200	.07	1.0	.07	.2		DT230B	1274
1N679							200	.15	1.0	.15	.2		1N5059	312
1N681							300	.07	1.0	.07	.2		1N5060	312
1N682							300	.15	1.0	.15	.2		1N5060	312
1N683							400	.07	1.0	.07	.2		1N5060	312
1N684							400	.15	1.0	.15	.2		1N5060	312
1N685							500	.07	1.0	.07	.2		1N5061	312
1N686							500	.15	1.0	.15	.2		1N5061	312
1N687							600	.07	1.0	.07	.2		1N5061	312
1N689							600	.15	1.0	.15	.2		1N5061	312
1N778	100	1.0	10	500	40	300							DA1701	1271
1N779	175	1.0	10	500	175	300							DT230B	1274
1N789		1.0	10	1000	20	500							DA1703	1271
1N790		1.0	10	5000	20	250							DA1703	1271
1N791		1.0	50	5000	20	500							DA1703	1271
1N792		1.0	100	5000	20	500							DA1703	1271
1N793		1.0	10	1000	50	500							DA1702	1271
1N794		1.0	10	5000	50	250							DA1702	1271
1N795		1.0	50	5000	50	500							DA1702	1271

Type	Silicon Signal Diodes						Silicon Rectifiers					Exact "1N" Type Page	Suggested GE Replacement	
	BV (V)	V_F @ I_F (V)	(MA)	I_R @ V_R (nA)	(V)	t_{rr} (ns)	V_R (V)	I_F (Max.) (A)	V_F @ I_F (Max.) (V)	(A)	I_R (µA)		Type	Page
1N796		1.0	100	5000	50	500							DA1702	1271
1N797		1.0	10	1000	100	500							DT230G	1274
1N799		1.0	50	5000	100	500							DT230G	1274
1N801		1.0	10	1000	125	500							DT230G	1274
1N804		1.0	50	10000	175	500							DT230B	1274
1N806	100	1.0	4	500	100	300							DA1701	1271
1N807	180	1.0	4	500	175	300							DT230B	1274
1N808	100	1.0	100	1000	100	300							DA1701	1271
1N809	200	1.0	100	1000	200	300							DT230G	1274
1N811	20	1.0	1	1000	10	250							DA1704	1271
1N812	30	1.0	1	100	20	250							DA1703	1271
1N813	15	1.0	5	500	10	250							DA1704	1271
1N814	40	1.0	2	100	20	250						118		
1N815	15	1.5	100	500	5	250							DA1704	1271
1N816	6	1.0	100	100									DA1704	1271
1N817	200	1.5	6	20000	175	1000							DT230B	1274
1N818	80	1.5	30	250	60	500							DA1702	1271
1N837		1.0	150	100	75	500							DA1701	1271
1N838		1.0	150	100	125	500							DT230G	1274
1N839		1.0	150	100	175	500							DT230B	1274
1N840		1.0	150	100	40	300							DA1702	1271
1N841		1.0	150	100	120	300							DT230G	1274
1N842		1.0	150	100	160	300							DT230G	1274
1N843		1.0	150	100	200	300							DT230B	1274
1N844		1.0	200	100	80	500							DA1701	1271
1N845		1.0	200	100	160	500							DT230B	1274
1N846							50	.2	.6	.2	.02		A14F	801
1N847							100	.2	.6	.2	.02		A14A	801
1N848							200	.2	.6	.2	.02		1N5059	312
1N849							300	.2	.6	.2	.02		1N5060	312
1N850							400	.2	.6	.2	.02		1N5060	312
1N851							500	.2	.6	.2	.02		1N5061	312
1N852							600	.2	.6	.2	.02		1N5061	312
1N853							700	.2	.6	.2	.02		1N5062	312
1N854							800	.2	.6	.2	.02		1N5062	312
1N855							900	.2	.6	.2	.02		A14P	312
1N856							1000	.2	.6	.2	.02		A14P	312
1N857							50	.15	.6	.15	.02		A14F	312
1N858							100	.15	.6	.15	.02		A14A	801
1N859							200	.15	.6	.15	.02		1N5059	312
1N860							300	.15	.6	.15	.02		1N5060	312
1N861							400	.15	.6	.15	.02		1N5060	312
1N862							500	.15	.6	.15	.02		1N5061	312
1N863							600	.15	.6	.15	.02		1N5061	312
1N864							700	.15	.6	.15	.02		1N5062	312
1N865							800	.15	.6	.15	.02		1N5062	312
1N866							900	.15	.6	.15	.02		A14P	312
1N867							1000	.15	.6	.15	.02		A14P	312
1N868							50	.1	.6	.1	.02		A14F	801
1N869							100	.1	.6	.1	.02		A14A	801
1N870							200	.1	.6	.1	.02		1N5059	312
1N871							300	.1	.6	.1	.02		1N5060	312
1N872							400	.1	.6	.1	.02		1N5060	312
1N873							500	.1	.6	.1	.02		1N5061	312
1N874							600	.1	.6	.1	.02		1N5061	312
1N875							700	.1	.6	.1	.02		1N5062	312
1N876							800	.1	.6	.1	.02		1N5062	312
1N877							900	.1	.6	.1	.02		A14P	312
1N878							1000	.1	.6	.1	.02		A14P	312
1N879							50	.05	.6	.05	.02		A14F	801
1N880							100	.05	.6	.05	.02		A14A	801
1N881							200	.05	.6	.05	.02		1N5059	312
1N882							300	.05	.6	.05	.02		1N5060	312
1N883							400	.05	.6	.05	.02		1N5060	312
1N884							500	.05	.6	.05	.02		1N5061	312
1N885							600	.05	.6	.05	.02		1N5061	312
1N886							700	.05	.6	.05	.02		1N5062	312
1N887							800	.05	.6	.05	.02		1N5062	312
1N888							900	.05	.6	.05	.02		A14P	312

Type	Silicon Signal Diodes						Silicon Rectifiers					Exact "1N" Type Page	Suggested GE Replacement	
	BV (V)	V_F @ I_F (V)	(MA)	I_R @ V_R (nA)	(V)	t_{rr} (ns)	V_R (V)	I_P (Max.) (A)	V_F @ I_F (Max.) (V)	(A)	I_R (μA)		Type	Page
1N889							1000	.05	.6	.05	.02		A14P	312
1N890	60	1.0	20	25	60								DA1702	1271
1N891		1.0	50	100	50	300							DA1702	1271
1N892		1.0	50	100	100	300							DA1701	1271
1N893		1.0	50	100	200	300							DT230I	1274
1N903	40	1.0	10	100	40	4000						118		
1N904	30	1.0	20	100	40	4000						118		
1N905	20	1.0	10	100	20	4000							DA1704	1271
1N906	20	1.0	10	100	20	4000							DA1704	1271
1N907	30	1.0	10	100	30	4000							DA1703	1271
1N908	40	1.0	10	100	40	4000							DA1703	1271
1N914	75	1.0	10	25	20	4000						209		
1N914A	75	1.0	20	25	20	4000						209		
1N914B	75	1.0	100	25	20	4000						209		
1N916	75	1.0	10	25	20	4000						209		
1N916A	75	1.0	20	25	20	4000						209		
1N916B	75	1.0	30	25	20	4000						209		
1N920	36	1.0	500	250	30	300							DA1703	1271
1N921	70	1.0	500	250	60	300							DA1701	1271
1N922	100	1.0	500	250	90	300							DA1701	1271
1N923	130	1.0	500	250	120	300							DT230G	1274
1N925	32	1.0	5	1000	10	150							DA1703	1271
1N926	32	1.0	5	100	10	150							DA1703	1271
1N927	52	1.0	10	100	10	150							DA1702	1271
1N928	96	1.0	10	100	10	150							DT230G	1274
1N929	20	1.0	20	100	20								DA1703	1271
1N930	50	1.0	20	100	50								DA1703	1271
1N931	100	1.0	20	100	100								DT230A	1274
1N934	60	1.0	30	25	60	1000							DA1702	1271
1N947							600	.400	1.0	.400	.002		1N5061	312
1N993	20	1.2	10	1000	4000								DA1704	1271
1N1028							50	.25	1.5	.25			A14F	801
1N1029							100	.25	1.5	.25			A14A	312
1N1030							150	.25	1.5	.25			1N5059	312
1N1031							200	.25	1.5	.25			1N5059	312
1N1032							300	.25	1.5	.25			1N5060	312
1N1033							400	.25	1.5	.25			1N5060	312
1N1034							50	.5	1.5	.5			A14F	801
1N1035							100	.5	1.5	.5			A14A	801
1N1036							150	.5	1.5	.5			1N5059	312
1N3037							200	.5	1.5	.5			1N5059	312
1N3038							300	.5	1.5	.5			1N5060	312
1N3039							400	.5	1.5	.5			1N5060	312
1N1040							50	.5	1.5	.5			A14F	801
1N1041							100	.5	1.5	.5			A14A	801
1N1042							150	.5	1.5	.5			1N5059	312
1N1043							200	.5	1.5	.5			1N5059	312
1N1044							300	.5	1.5	.5			1N5060	312
1N1045							400	.5	1.5	.5			1N5060	312
1N1046							50	.5	1.5	.5			A14F	801
1N1047							100	.5	1.5	.5			A14A	801
1N1048							150	.5	1.5	.5			1N5059	312
1N1049							200	.5	1.5	.5			1N5059	312
1N1050							300	.5	1.5	.5			1N5060	312
1N1051							400	.5	1.5	.5			1N5060	312
1N1052							50	.5	1.5	.5			A15F	805
1N1053							100	.5	1.5	.5			A15A	805
1N1054							150	.5	1.5	.5			1N5624	316
1N1055							200	.5	1.5	.5			1N5624	316
1N1056							300	.5	1.5	.5			1N5625	316
1N1057							400	.5	1.5	.5			1N5625	316
1N1081							100	.25	1.5	.25			A14A	801
1N1081A							100	.25	1.5	.25			A14A	801
1N1082							200	.25	1.5	.25			1N5059	312
1N1082A							200	.25	1.5	.25			1N5059	312
1N1083							300	.25	1.5	.25			1N5060	312
1N1083A							300	.25	1.5	.25			1N5060	312
1N1084							400	.25	1.5	.25			1N5060	312
1N1084A							400	.6	1.5	.6			1N5060	312

Type	Silicon Signal Diodes						Silicon Rectifiers					Exact "1N" Type Page	Suggested GE Replacement	
	BV (V)	V_F @ I_F (V)	(MA)	I_R @ V_R (nA)	(V)	t_{rr} (ns)	V_R (V)	I_F (Max.) (A)	V_F @ I_F (Max.) (V)	(A)	I_R (μA)		Type	Page
1N1085							100	.6	1.5	.6			A15A	805
1N1085A							100	.6	1.5	.6			A15A	805
1N1086							200	.6	1.5	.6			1N5624	316
1N1086A							200	.6	1.5	.6			1N5624	316
1N1087							300	.6	1.5	.6			1N5625	316
1N1087A							300	.6	1.5	.6			1N5625	316
1N1088							400	.6	1.5	.6			1N5625	316
1N1088A							400	.6	1.5	.6			1N5625	316
1N1095							500	.43	.5	.43	.3		1N5061	312
1N1096							600	.4	.5	.4	.3		1N5061	312
1N1100							100	.25	1.2	.25	.2		A14A	801
1N1101							200	.25	1.2	.25	.2		1N5059	312
1N1102							300	.25	1.2	.25	.2		1N5060	312
1N1103							400	.25	1.2	.25	.2		1N5060	312
1N1104							500	.25	1.2	.25	.2		1N5061	312
1N1105							600	.25	1.2	.25	.2		1N5061	312
1N1108							800	.23	3.0	.23			1N5062	312
1N1115							100	1.5	.65	.6	.4		A15A	805
1N1116							200	1.5	.65	.6	.3		1N5624	316
1N1117							300	1.5	.65	.6	.3		1N5625	316
1N1118							400	1.5	.65	.6	.4		1N5625	316
1N1119							500	1.5	.65	.6	.4		1N5626	316
1N1120							600	1.5	.65	.6	.3		1N5061	312
1N1120A							600	1.5	.65	.6	.4		1N5627	316
1N1124							200	3.0	1.1	1.0	.3		1N5624	316
1N1124A							200	3.3	1.1	1.0	.3		1N5625	316
1N1125							300	3.0	1.1	1.0	.3		1N5625	316
1N1125A							300	3.3	1.1	1.0	.3		1N5625	316
1N1126							400	3.0	1.1	1.0	.3		1N5625	316
1N1126A							400	3.3	1.1	1.0	.3		1N5626	316
1N1127							500	3.0	1.1	1.0	.3		1N5626	316
1N1127A							500	3.3	1.1	1.0	.3		1N5626	316
1N1128							600	3.0	1.1	1.0	.3		1N5626	316
1N1128A							600	3.3	1.1	1.0	.3		1N5627	316
1N1169							400	.5	.90	.50	3.5		1N5060	312
1N1169A							400	.5	1.2	.80	005		1N5060	312
1N1183							50	35	1.7	35	10	215		
1N1183A							50	35	1.7	35	10	215		
1N1184							100	35	1.7	35	10	215		
1N1184A							100	35	1.7	35	10	215		
1N1185							150	35	1.7	35	10	215		
1N1185A							150	35	1.7	35	10	215		
1N1186							200	35	1.7	35	10	215		
1N1186A							200	35	1.7	35	10	215		
1N1187							300	35	1.7	35	10	215		
1N1187A							300	35	1.7	35	10	215		
1N1188							400	35	1.7	35	10	215		
1N1188A							400	35	1.7	35	10	215		
1N1189							500	35	1.7	35	10	215		
1N1189A							500	40	1.2	40	2	215		
1N1190							600	35	1.7	35	10	215		
1N1190A							600	40	1.2	40	1.8	215		
1N1195							300	18	2.35	18	5	207		
1N1195A							300	20	.6	20	3.2	207		
1N1196							400	18	2.35	18	5.0	207		
1N1196A							400	20	.6	20	2.5	207		
1N1197							500	18	2.35	18	5.0	207		
1N1197A							500	20	.6	20	2.2	207		
1N1198							600	18	2.35	18	5.0	207		
1N1198A							600	20	.6	20	1.5	207		
1N1199							50	12			10	219		
1N1199A							50	12	1.35	12	3.0	219		
1N1200							100	12			10	219		
1N1200A							100	50	1.35	50	2.5	219		
1N1201							150	12			10	219		
1N1201A							150	50	1.35	50	2.3	219		
1N1202							200	12			10	219		
1N1202A							200	50	1.35	50	2.0	219		

Type	Silicon Signal Diodes						Silicon Rectifiers					Exact "1N" Type Page	Suggested GE Replacement	
	BV (V)	V_F @ I_F (V)	(MA)	I_R @ V_R (nA)	(V)	t_{rr} (ns)	V_R (V)	I_P (Max.) (A)	V_F @ I_F (Max.) (V)	(A)	I_R (μA)		Type	Page
1N1203							300	12			10	219		
1N1203A							300	50	1.35	50	1.75	219		
1N1204							400	12			10	219		
1N1204A							400	50	1.35	50	1.5	219		
1N1205							500	12			10	219		
1N1205A							500	50	1.35	50	1.2	219		
1N1206							600	12			10	219		
1N1206A							600	50	1.35	50	1.0	219		
1N1217							50	1.6	1.0	1.6	1.5		A15F	805
1N1217A							50	1.6	1.5	1.6	.05		A15F	805
1N1217B							50	1.35	1.7	1.0	.3		A15F	805
1N1218							100	1.6	1.0	1.6	1.5		A15A	805
1N1218A							100	1.6	1.5	1.6	.05		A15A	805
1N1218B							100	1.35	1.7	1.35	.3		A15A	805
1N1219							150	1.6	1.0	1.6	1.5		1N5624	316
1N1219A							150	1.6	1.5	1.6	.05		1N5624	316
1N1219B							150	1.35	1.7	1.35	.3		1N5624	316
1N1220							200	1.6	1.0	1.6	1.5		1N5624	316
1N1220A							200	1.6	1.5	1.5	.05		1N5624	316
1N1220B							200	1.35	1.7	1.35	.3		1N5624	316
1N1221							300	1.6	1.0	1.6	1.5		1N5625	316
1N1221A							300	1.6	1.5	1.6	.05		1N5625	316
1N1221B							300	1.35	1.7	1.35	.3		1N5625	316
1N1222							400	1.6	1.0	1.6	1.5		1N5625	316
1N1222A							400	1.6	1.5	1.6	.05		1N5625	316
1N1222B							400	1.35	1.7	1.35	.3		1N5625	316
1N1223							500	1.6	1.0	1.6	1.5		1N5626	316
1N1223A							500	1.6	1.5	1.6	.05		1N5626	316
1N1223B							500	1.35	1.7	1.35	.3		1N5626	316
1N1224							600	1.6	1.0	1.6	1.5		1N5626	316
1N1224A							600	1.6	1.5	1.6	.05		1N5626	316
1N1224B							600	1.35	1.7	1.35	.3		1N5626	316
1N1225							700	1.6	1.0	1.6	1.5		1N5627	316
1N1225A							700	1.1	1.55	1.1	.05		1N5627	316
1N1225B							700	1.62	1.25	1.62	.3		1N5627	316
1N1226							800	1.6	1.0	1.6	1.5		1N5627	316
1N1226A							800	1.1	1.5	1.1	.5		1N5627	316
1N1226B							800	1.15	1.58	1.15	.3		1N5627	316
1N1227							50	1.6	1.0	1.6	1.5		A15F	805
1N1227A							50	1.6	1.5	1.6	.05		A15F	805
1N1228							100	1.6	1.0	1.6	1.5		A15A	805
1N1228A							100	1.6	1.5	1.6	.05		A15A	805
1N1229							150	1.6	1.0	1.6	1.5		1N5624	316
1N1229A							150	1.6	1.5	1.6	.05		1N5624	316
1N1230							200	1.6	1.0	1.6	1.5		1N5624	316
1N1230A							200	1.6	1.5	1.6	1.5		1N5624	316
1N1231							300	1.6	1.0	1.6	1.5		1N5625	316
1N1231A							300	1.6	1.5	1.6	.05		1N5625	316
1N1232							400	1.6	1.0	1.6	1.5		1N5625	316
1N1232A							400	1.6	1.5	1.6	.05		1N5625	316
1N1233							500	1.6	1.0	1.6	1.5		1N5626	316
1N1233A							500	1.6	1.5	1.6	.05		1N5626	316
1N1234							600	1.6	1.0	1.6	1.5		1N5626	316
1N1234A							600	1.6	1.5	1.6	.05		1N5626	316
1N1235							700	1.6	1.0	1.6	1.5		1N5626	316
1N1235A							700	1.6	1.5	1.6	.05		1N5626	316
1N1236							800	1.6	1.0	1.6	1.5		1N5627	316
1N1236A							800	1.6	1.0	1.6	1.5		1N5627	316
1N1251							50	.25	1.0	.25	.5		A14F	801
1N1252							100	.25	1.0	.25	.5		A14A	801
1N1253							200	.25	1.0	.25	.5		1N5059	312
1N1254							300	.2	1.0	.2	.5		1N5060	312
1N1255							400	.15	1.0	.15	.5		1N5060	312
1N1255A							400	.2	1.0	.2	.5		1N5060	312
1N1256							500	.13	1.0	.13	.4		1N5061	312
1N1257							600	.11	1.0	.11	.3		1N5061	312
1N1258							700	.1	1.0	.1	.2		1N5062	312
1N1259							800	.08	1.0	.08	.1		1N5062	312
1N1260							900	.065	1.0	.065	.1		A14P	801

Type	Silicon Signal Diodes						Silicon Rectifiers					Exact "1N" Type Page	Suggested GE Replacement	
	BV (V)	V_F @ I_F (V)	(MA)	I_R @ V_R (nA)	(V)	t_{rr} (ns)	V_R (V)	I_P (Max.) (A)	V_F @ I_F (Max.) (V)	(A)	I_R (μA)		Type	Page
1N1261							1000	.05	1.0	.05	.1		A14P	801
1N1341A							50	6.0	1.4	6.0	3.0	223		
1N1341R							50	6.0	1.4	6.0	3.0	223		
1N1341RA							50	6.0	1.4	6.0	3.0	223		
1N1342A							100	6.0	1.4	6.0	2.5	223		
1N1342R							100	6.0	1.4	6.0	2.5	223		
1N1342RA							100	6.0	1.4	6.0	2.5	223		
1N1343A							150	6.0	1.4	6.0	2.25	223		
1N1343R							150	6.0	1.4	6.0	2.25	223		
1N1343RA							150	6.0	1.4	6.0	2.25	223		
1N1344A							200	6.0	1.4	6.0	2.0	223		
1N1344R							200	6.0	1.4	6.0	2.0	223		
1N1344RA							200	6.0	1.4	6.0	2.0	223		
1N1345A							300	6.0	1.4	6.0	1.75	223		
1N1345R							300	6.0	1.4	6.0	1.75	223		
1N1345RA							300	6.0	1.4	6.0	1.75	223		
1N1346A							400	6.0	1.4	6.0	1.5	223		
1N1346R							400	6.0	1.4	6.0	1.5	223		
1N1346RA							400	6.0	1.4	6.0	1.5	223		
1N1347A							500	6.0	1.4	6.0	1.25	223		
1N1347R							500	6.0	1.4	6.0	1.25	223		
1N1347RA							500	6.0	1.4	6.0	1.25	223		
1N1348A							600	6.0	1.4	6.0	1.0	223		
1N1348R							600	6.0	1.4	6.0	1.0	223		
1N1348RA							600	6.0	1.4	6.0	1.0	223		
1N1406							600	.1	5.0	.1	.1		1N5061	312
1N1407							800	1.0	5.0	1.0	.1		1N5062	312
1N1408							1000	1.0	5.0	1.0	.1		A14P	801
1N1415		1.1	1	1000	300								1N5060	312
1N1440							200	.75	1.2	.75	.5		1N5059	312
1N1441							300	.75	1.2	.75	.5		1N5060	312
1N1442							400	.75	1.2	.75	.5		1N5060	312
1N1443							1000	1.6	1.0	1.6	1.5		A14P	312
1N1443A							1000	1.1	1.45	1.1	.5		A14P	312
1N1446							100		2.0		2.0		A15A	805
1N1447							200		2.0		2.0		1N5624	316
1N1448							300		2.0		2.0		1N5625	316
1N1449							400		2.0		2.0		1N5625	316
1N1450							100		1.4		5.0		A15A	805
1N1451							200		1.4				1N5624	316
1N1452							300		1.4				1N5625	316
1N1453							400		1.4				1N5625	316
1N1454							100	25	1.5				1N5060	312
1N1486							500	.5			3.5		1N5061	312
1N1487							100	.25	.55	.25	.4		A14A	801
1N1488							200	.25	.55	.25	.3		1N5059	312
1N1489							300	.25	.55	.25	.3		1N5060	312
1N1490							400	.25	.55	.25	.3		1N5060	312
1N1491							500		.55		.3		1N5061	312
1N1492							600		.55		.3		1N5061	312
1N1537							50	1.6	1.5	1.6	.05		A15F	805
1N1538							100	1.6	1.5	1.6	.05		A15A	805
1N1539							150	1.6	1.5	1.6	.05		1N5624	316
1N1540							200	1.6	1.5	1.6	.05		1N5624	316
1N1541							300	1.6	1.5	1.6	.05		1N5625	316
1N1542							400	1.6	1.5	1.6	.05		1N5625	316
1N1543							500	1.6	1.5	1.6	.05		1N5626	316
1N1544							600	1.6	1.5	1.6	.05		1N5626	316
1N1553							300		1.4		1.0		1N5060	312
1N1554							400		1.4		1.0		1N5060	312
1N1555							500		1.4		1.0		1N5061	312
1N1556							100		1.4		1.0		A14A	801
1N1557							200		1.4		1.0		1N5059	312
1N1558							300		1.4		1.0		1N5060	312
1N1559							400		1.4		1.0		1N5060	312
1N1560							500		1.4		1.0		1N5061	312
1N1563							100	1.0	1.5	1.0	.003		A14A	801
1N1563A							100	1.5	1.5	1.5	.003		A15A	805
1N1564							200	1.0	1.5	1.0	.003		1N5059	312

Type	Silicon Signal Diodes						Silicon Rectifiers					Exact "1N" Type Page	Suggested GE Replacement	
	BV (V)	V_F (V)	@ I_F (MA)	I_R (nA)	@ V_R (V)	t_{rr} (ns)	V_R (V)	I_P (Max.) (A)	V_F (V)	@ I_F (Max.) (A)	I_R (μA)		Type	Page
1N1564A							200	1.5	1.5	1.5	.003		1N5624	316
1N1565							300	1.0	1.5	1.0	.003		1N5060	312
1N1565A							300	1.5	1.5	1.5	.003		1N5625	316
1N1566							400	1.0	1.5	1.0	.003		1N5060	312
1N1566A							400	1.5	1.5	1.5	.003		1N5625	316
1N1567							500	1.0	1.2	1.0	.005		1N5060	312
1N1567A							500	1.5	1.5	1.5	.003		1N5627	316
1N1568							600	1.0	1.2	1.0	.005		1N5061	312
1N1568A							600	1.5	1.5	1.5	.003		1N5626	316
1N1581							50	3.0	1.5	3.0	5		1N5626	316
1N1581R							50	3.0	1.5	3.0	5			
1N1582							100	3.0	1.5	3.0	5			
1N1582R							100	3.0	1.5	3.0	5			
1N1583							200	3.0	1.5	3.0	5			
1N1583R							200	3.0	1.5	3.0	5			
1N1584							300	3.0	1.5	3.0	5			
1N1584R							300	3.0	1.5	3.0	5			
1N1585							400	3.0	1.5	3.0	5			
1N1585R							400	3.0	1.5	3.0	5			
1N1586							500	3.0	1.5	3.0	5			
1N1586R							500	3.0	1.5	3.0	5			
1N1587							600	3.0	1.5	3.0	5			
1N1587R							600	3.0	1.5	3.0	5			
1N1612							50	5	1.5	5	1.0	227		
1N1612R							50	5	1.5	5	1.0	227		
1N1613							100	5	1.5	5	1.0	227		
1N1613R							100	5	1.5	5	1.0	227		
1N1614							200	5	1.5	5	1.0	227		
1N1614R							200	5	1.5	5	1.0	227		
1N1615							400	5	1.5	5	1.0	227		
1N1615R							400	5	1.5	5	1.0	227		
1N1616							600	5	1.5	5	1.0	227		
1N1616R							600	5	1.5	5	1.0	227		
1N1617							100	1.5	1.2	1.5			A15A	805
1N1618							200	1.5	1.2	1.5			1N5624	316
1N1619							300	1.5	1.2	1.5			1N5625	316
1N1620							400	1.5	1.2	1.5			1N5625	316
1N1644							50	.25	.5	.25	.4		A14F	801
1N1645							100	.25	.5	.25	.4		A14A	801
1N1646							150	.25	.5	.25	.3		1N5059	312
1N1647							200	.25	.5	.25	.3		1N5059	312
1N1648							250	.25	.5	.25	.3		1N5060	312
1N1649							300	.25	.5	.25	.3		1N5060	312
1N1650							350	.25	.5	.25	.3		1N5060	312
1N1651							400	.25	.5	.25	.3		1N5060	312
1N1652							500	.25	.5	.25	.3		1N5061	312
1N1653							600	.25	.5	.25	.3		1N5061	312
1N1692							100	.25	.6	.25	.5		A14A	801
1N1693							200	.25	.6	.25	.5		1N5059	312
1N1694							300	.25	.6	.25	.5		1N5060	312
1N1695							400	.25	.6	.25	.5		1N5060	312
1N1696							500		.6		.5		1N5061	312
1N1697							600		.6		.5		1N5061	312
1N1701							50	.3	1.3	.3	.2		A14F	801
1N1702							100	.3	1.3	.3	.2		A14A	801
1N1703							200	.3	1.3	.3	.2		1N5059	312
1N1704							300	.3	1.3	.3	.2		1N5060	312
1N1705							400	.3	1.3	.3	.2		1N5060	312
1N1706							500	.3	1.3	.3	.2		1N5061	312
1N1707							50	.5	1.15	.5	.2		A14F	801
1N1708							100	.5	1.15	.5	.2		A14A	801
1N1709							200	.5	1.15	.5	.2		1N5059	312
1N1710							300	.5	1.15	.5	.2		1N5060	312
1N1711							400	.5	1.15	.5	.2		1N5060	312
1N1712							500	.5	1.15	.5	.2		1N5061	312
1N1730							1000		5		.1	233		
1N1731							1500		5		.1	233		
1N1732							2000		9		.1	233		
1N1733							3000		12		.1	233		

Type	Silicon Signal Diodes						Silicon Rectifiers					Exact "1N" Type Page	Suggested GE Replacement	
	BV (V)	VF @ IF (V)	(MA)	IR @ VR (nA)	(V)	trr (ns)	VR (V)	IP (Max.) (A)	VF @ IF (Max.) (V)	(A)	IR (µA)		Type	Page
1N1734							5000		18		.1	233		
1N1765				1 Watt Zener Diode 5.6 Volts Nominal ± 10%								167		
1N1765A				1 Watt Zener Diode 5.6 Volts Nominal ± 5%								167		
1N1766				1 Watt Zener Diode 6.2 Volts Nominal ± 10%								167		
1N1766A				1 Watt Zener Diode 6.2 Volts Nominal ± 5%								167		
1N1767				1 Watt Zener Diode 6.8 Volts Nominal ± 10%								167		
1N1767A				1 Watt Zener Diode 6.8 Volts Nominal ± 5%								167		
1N1768				1 Watt Zener Diode 7.5 Volts Nominal ± 10%								167		
1N1768A				1 Watt Zener Diode 7.5 Volts Nominal ± 5%								167		
1N1769				1 Watt Zener Diode 8.2 Volts Nominal ± 10%								167		
1N1769A				1 Watt Zener Diode 8.2 Volts Nominal ± 5%								167		
1N1770				1 Watt Zener Diode 9.1 Volts Nominal ± 10%								167		
1N1770A				1 Watt Zener Diode 9.1 Volts Nominal ± 5%								167		
1N1771				1 Watt Zener Diode 10.0 Volts Nominal ± 10%								167		
1N1771A				1 Watt Zener Diode 10.0 Volts Nominal ± 5%								167		
1N1772				1 Watt Zener Diode 11.0 Volts Nominal ± 10%								167		
1N1772A				1 Watt Zener Diode 11.0 Volts Nominal ± 5%								167		
1N1773				1 Watt Zener Diode 12.0 Volts Nominal ± 10%								167		
1N1773A				1 Watt Zener Diode 12.0 Volts Nominal ± 5%								167		
1N1774				1 Watt Zener Diode 13.0 Volts Nominal ± 10%								167		
1N1774A				1 Watt Zener Diode 13.0 Volts Nominal ± 5%								167		
1N1775				1 Watt Zener Diode 15.0 Volts Nominal ± 10%								167		
1N1775A				1 Watt Zener Diode 15.0 Volts Nominal ± 5%								167		
1N1776				1 Watt Zener Diode 16.0 Volts Nominal ± 10%								167		
1N1776A				1 Watt Zener Diode 16.0 Volts Nominal ± 5%								167		
1N1907							50	1.5	1.0	1.5	.01		A14F	801
1N1908							100	1.5	1.0	1.5	.01		A14A	801
1N1909							200	1.5	1.0	1.5	.01		1N5059	312
1N1910							300	1.5	1.0	1.5	.01		1N5625	316
1N1911							400	1.5	1.0	1.5	.01		1N5060	312
1N1912							500	1.5	1.0	1.5	.01		1N5061	312
1N1913							500	1.5	1.0	1.5	.01		1N5061	312
1N1914							500	1.5	1.0	1.5	.01		1N5062	312
1N1915							600	1.5	1.0	1.5	.01		1N5062	312
1N1916							900	1.5	1.0	1.5	.01		A14P	312
1N2013							50	.25	1.2	.25	.25		A14F	801
1N2014							100	.25	1.2	.25	.25		A14A	801
1N2015							150	.25	1.2	.25	.25		1N5059	312
1N2016							200	.25	1.2	.25	.25		1N5059	312
1N2017							250	.25	1.2	.25	.25		1N5060	312
1N2018							300	.25	1.2	.25	.25		1N5060	312
1N2019							350	.25	1.2	.25	.25		1N5060	312
1N2020							400	.25	1.2	.25	.25		1N5060	312
1N2054							50	250	1.6	250	55		1N3735	263
1N2054R							50	250	1.6	250	55		1N3735R	263
1N2055							100	250	1.6	250	55		1N3735	263
1N2055R							100	250	1.6	250	55		1N3735R	263
1N2056							150	250	1.6	250	55		1N3736	263
1N2056R							150	250	1.6	250	55		1N3736R	263
1N2057							200	250	1.6	250	55		1N3736	263
1N2057R							200	250	1.6	250	55		1N3736R	263
1N2058							250	250	1.6	250	55		1N3737	263
1N2058R							250	250	1.6	250	55		1N3737R	263
1N2059							300	250	1.6	250	55		1N3737	263
1N2059R							300	250	1.6	250	55		1N3737R	263
1N2060							350	250	1.6	250	55		1N3738	263
1N2060R							350	250	1.6	250	55		1N3738R	263
1N2061							400	250	1.6	250	55		1N3738	263
1N2061R							400	250	1.6	250	55		1N3738R	263
1N2062							450	250	1.6	250	55		1N3739	263
1N2062R							450	250	1.6	250	55		1N3739R	263
1N2063							500	250	1.6	250	55		1N3739	263
1N2063R							500	250	1.6	250	55		1N3739R	263
1N2064							600	250	1.6	250	55		1N3740	263
1N2064R							600	250	1.6	250	55		1N3740R	263
1N2065							700	250	1.6	250	55		1N3741	263
1N2065R							700	250	1.6	250	55		1N3741R	263
1N2066							800	250	1.6	250	55		1N3741	263

Type	Silicon Signal Diodes						Silicon Rectifiers					Exact "1N" Type Page	Suggested GE Replacement	
	BV (V)	V_F @ I_F (V)	(MA)	I_R @ V_R (nA)	(V)	t_{rr} (ns)	V_R (V)	I_P (Max.) (A)	V_F @ I_F (Max.) (V)	(A)	I_R (μA)		Type	Page
1N2066R							800	250	1.6	250	55		1N3741R	263
1N2067							900	250	1.6	250	55		1N3742	263
1N2067R							900	250	1.6	250	55		1N3742R	263
1N2068							1000	250	1.6	250	55		1N3742	263
1N2068R							1000	250	1.6	250	55		1N3742R	263
1N2069							200	.75	.6	.75	.2		1N5059	312
1N2069A							200	.75	.5	.75	.05		1N5059	312
1N2070							400	.75	.6	.75	.2		1N5060	312
1N2070A							400	.75	.5	.75	.05		1N5060	312
1N2071							600	.75	.6	.75	.2		1N5061	312
1N2071A							600	.75	.6	.75	.05		1N5061	312
1N2072							50	.625	1.1	.625	.25		A14F	801
1N2073							100	.625	1.1	.625	.25		A14A	801
1N2074							150	.625	1.1	.625	.25		1N5059	312
1N2075							200	.625	1.1	.625	.25		1N5059	312
1N2076							250	.625	1.1	.625	.25		1N5060	312
1N2077							300	.625	1.1	.625	.25		1N5060	312
1N2078							400	.625	1.1	.625	.25		1N5060	312
1N2079							500	.625	1.1	.625	.25		1N5061	312
1N2080							50	.5	.75	.5	.35		A14F	801
1N2081							100	.5	.75	.5	.35		A14A	801
1N2082							200	.5	.75	.5	.35		1N5059	312
1N2083							300	.5	.75	.5	.35		1N5060	312
1N2084							400	.5	.75	.5	.35		1N5060	312
1N2085							500	.5	.75	.5	.35		1N5061	312
1N2086							600	.5	.75	.5	.35		1N5061	312
1N2090							50	.5	.5	.5	.25		A14F	801
1N2091							100	.5	.5	.5	.25		A14A	801
1N2092							200	.5	.5	.5	.25		1N5059	312
1N2093							300	.5	.5	.5	.25		1N5062	312
1N2094							400	.5	.5	.5	.25		1N5062	312
1N2095							500	.5	.5	.5	.25		1N5061	312
1N2096							600	.5	.5	.5	.25		1N5061	312
1N2103							50	.75	1.2	.75	.3		A14F	801
1N2104							100	.75	1.2	.75	.3		A14A	801
1N2105							200	.75	1.2	.75	.3		1N5059	312
1N2106							300	.75	1.2	.75	.3		1N5060	312
1N2107							400	.75	1.2	.75	.3		1N5060	312
1N2108							500	.75	1.2	.75	.3		1N5061	312
1N2109							50	2.0	1.2	.75	.3		A15F	805
1N2115							365	.2	.8	.2	.25		1N5060	312
1N2116							400	.5	1.4	.5	.4		1N5060	312
1N2117							720	.75	1.3	.75	.01		1N5062	312
1N2128							50	60	2.0	60	10		1N1183A	215
1N2129							100	60	2.0	60	10		1N1184A	215
1N2130							150	60	2.0	60	10		1N1185A	215
1N2131							200	60	2.0	60	10		1N1186A	215
1N2132							250	60	2.0	60	10		1N1187A	215
1N2133							300	60	2.0	60	10		1N1187A	215
1N2134							350	60	2.0	60	10		1N1188A	215
1N2135							400	60	2.0	60	10		1N1188A	215
1N2136							450	60	2.0	60	10		1N1189A	215
1N2137							500	60	2.0	60	10		1N1190A	215
1N2154							50	25	.6	25	5.0	237		
1N2154R							50	25	.6	25	5.0	237		
1N2155							100	25	.6	25	5.0	237		
1N2155R							100	25	.6	25	5.0	237		
1N2156							200	25	.6	25	5.0	237		
1N2156R							200	25	.6	25	5.0	237		
1N2157							300	25	.6	25	5.0	237		
1N2157R							300	25	.6	25	5.0	237		
1N2158							400	25	.6	25	5.0	237		
1N2158R							400	25	.6	25	5.0	237		
1N2159							500	25	.6	25	5.0	237		
1N2159R							500	25	.6	25	5.0	237		
1N2160							600	25	.6	25	5.0	237		
1N2160R							600	25	.6	25	5.0	237		
1N2181							400	3.0	1.1	3.0	.3		1N5625	316
1N2216							50	1.5	.6	1.5			A14F	801

Type	Silicon Signal Diodes						Silicon Rectifiers					Exact "1N" Type Page	Suggested GE Replacement	
	BV (V)	V_F @ I_F (V)	(MA)	I_R @ V_R (nA)	(V)	t_{rr} (ns)	V_R (V)	I_P (Max.) (A)	V_F @ I_F (Max.) (V)	(A)	I_R (μA)		Type	Page
1N2217							50	1.5	.6	1.5			A14F	801
1N2218							500	1.5	.6	1.5	.003		1N5061	312
1N2218A							500	1.5	.6	1.5	.003		1N5626	316
1N2219							500	1.5	.6	1.5	.003		1N5626	316
1N2219A							500	1.5			.003		1N5626	316
1N2120							600	.4	1.2	.4	.003		1N5061	312
1N2120A							600	.4	1.2	.4	.003		1N5626	316
1N2121							600	1.5			.003		1N5061	312
1N2121A							600	1.5			.003		1N5626	316
1N2122							800	.3	1.2	.3	.003		1N5062	312
1N2122A							800	.3	1.2	.3	.003		1N5062	312
1N2123							800	1.0			.003		1N5062	312
1N2123A							800	.3			.003		1N5062	312
1N2124							1000	.3	1.2	.3	.003		A14P	312
1N2124A							1000	.3	1.2	.3	.003		A14P	312
1N2125							1000	1.0			.003		A14P	312
1N2125A							1000	1.0			.003		A14P	312
1N2266							50	.3	1.2	.3	.003		A14F	801
1N2267							50	1.0			.003		A14F	801
1N2268							500	.3	1.2	.3	.003		1N5061	312
1N2269							500	1.0			.003		1N5061	312
1N2270							600	.3	1.2	.3	.003		1N5061	312
1N2271							600	1.0			.003		1N5061	312
1N2289							100	1.5			.003		A14A	801
1N2289A							100	1.5			.003		A14A	801
1N2290							100	5.0			.003		A14A	801
1N2290A							100	5.0			.003		1N5059	312
1N2291							200	1.5			.003		1N5624	316
1N2291A							200	1.5			.003		1N5624	316
1N2292							300	1.5			.003		1N5060	312
1N2292A							300	1.5			.003		1N5625	316
1N2293							400	1.5			.003		1N5060	312
1N2293A							400	1.5			.003		1N5625	316
1N2348							50	3.0	1.1	3.0	.3		A15F	805
1N2349							100	3.0	1.1	3.0	.3		A15A	805
1N2350							150	3.0	1.1	3.0	.3		1N5624	316
1N2372							1000	.2	2.0	.2	.5		A14P	312
1N2373							600	.1	3.0	.1	.25		1N5061	312
1N2374							1000	.1	3.0	.1	.25		A14P	312
1N2382							4000	.15	18	.15	.2	233		
1N2383							6000	.1	27	.1	.2	233		
1N2384							8000	.07	27	.07	.2	233		
1N2385							10000	.07	39	.07	.2	233		
1N2390							50	1.5	1.2	1.5	.3		A14F	801
1N2390A							50	1.5	1.2	1.5	.3		A15F	805
1N2391							100	1.5	1.2	1.5	.3		A14A	801
1N2391A							100	1.5	1.2	1.5	.3		A15A	805
1N2392							200	1.5	1.2	1.5	.3		1N5059	312
1N2392A							200	1.5	1.2	1.5	.3		1N5624	316
1N2393							300	1.5	1.2	1.5	.3		1N5060	312
1N2393A							300	1.5	1.2	1.5	.3		1N5625	316
1N2394							400	1.5	1.2	1.5	.3		1N5060	312
1N2394A							400	1.5	1.2	1.5	.3		1N5625	316
1N2395							500	1.5	1.2	1.5	.3		1N5061	312
1N2395A							500	1.5	1.2	1.5	.3		1N5626	316
1N2396							600	1.5	1.2	1.2	.3		1N5061	312
1N2396A							600	1.5	1.2	1.2	.3		1N5626	316
1N2397							700	1.5	1.2	1.2	.3		1N5062	312
1N2397A							700	1.5	1.2	1.2	.3		1N5627	316
1N2398							800	1.5	1.2	1.2	.3		1N5062	312
1N2398A							800	1.5	1.2	1.2	.3		1N5627	316
1N2399							50	1.5	1.2	1.2	.3		A14F	801
1N2399A							50	1.5	1.2	1.2	.3		A15F	805
1N2400							100	1.5	1.2	1.2	.3		A14A	801
1N2400A							100	1.5	1.2	1.2	.3		A15A	805
1N2401							200	1.5	1.2	1.2	.3		1N5059	312
1N2401A							200	1.5	1.2	1.2	.3		1N5624	316
1N2402							300	1.5	1.2	1.2	.3		1N5060	312

Type	Silicon Signal Diodes						Silicon Rectifiers					Exact "1N" Type Page	Suggested GE Replacement	
	BV (V)	V_F @ I_F (V)	(MA)	I_R @ V_R (nA)	(V)	t_{rr} (ns)	V_R (V)	I_F (Max.) (A)	V_F @ I_F (Max.) (V)	(A)	I_R (μA)		Type	Page
1N2402A							300	1.5	1.2	1.2	.3		1N5625	316
1N2403							400	1.5	1.2	1.2	.3		1N5060	312
1N2403A							400	1.5	1.2	1.2	.3		1N5625	316
1N2404							500	1.5	1.2	1.2	.3		1N5061	312
1N2404A							500	1.5	1.2	1.2	.3		1N5626	316
1N2405							600	1.5	1.2	1.2	.3		1N5061	312
1N2405A							600	1.5	1.2	1.2	.3		1N5626	316
1N2406							700	1.5	1.2	1.2	.3		1N5062	312
1N2406A							700	1.5	1.2	1.2	.3		1N5627	316
1N2407							800	1.5	1.2	1.2	.3		1N5062	312
1N2407A							800	1.5	1.2	1.2	.3		1N5627	316
1N2408							50	1.5	1.2	1.2	.3		A14F	801
1N2408A							50	1.5	1.2	1.2	.3		A15F	805
1N2409							100	1.5	1.2	1.2	.3		A14A	801
1N2409A							100	1.5	1.2	1.2	.3		A15A	805
1N2410							200	1.5	1.2	1.5	.3		1N5059	312
1N2410A							200	1.5	1.2	1.5	.3		1N5624	316
1N2411							300	1.5	1.2	1.5	.3		1N5060	312
1N2411A							300	1.5	1.2	1.5	.3		1N5625	316
1N2412							400	1.5	1.2	1.5	.3		1N5060	312
1N2412A							400	1.5	1.2	1.5	.3		1N5625	316
1N2413							500	1.5	1.2	1.5	.3		1N5061	312
1N2413A							500	1.5	1.2	1.5	.3		1N5626	316
1N2414							600	1.5	1.2	1.5	.3		1N5061	312
1N2414A							600	1.5	1.2	1.5	.3		1N5061	312
1N2415							700	1.5	1.2	1.5	.3		1N5062	312
1N2415A							700	1.5	1.2	1.5	.3		1N5627	316
1N2416							800	1.5	1.2	1.5	.3		1N5062	312
1N2416A							800	1.5	1.2	1.5	.3		1N5627	316
1N2417							50	1.5	1.2	1.5	.3		A14F	801
1N2417A							50	1.5	1.2	1.5	.3		A15F	805
1N2418							100	1.5	1.2	1.5	.3		A14A	801
1N2418A							100	1.5	1.2	1.5	.3		A15A	805
1N2419							200	1.5	1.2	1.5	.3		1N5059	312
1N2419A							200	1.5	1.2	1.5	.3		1N5624	316
1N2420							300	1.5	1.2	1.5	.3		1N5060	312
1N2420A							300	1.5	1.2	1.5	.3		1N5625	316
1N2421							400	1.5	1.2	1.5	.3		1N5060	312
1N2421A							400	1.5	1.2	1.5	.3		1N5625	316
1N2422							500	1.5	1.2	1.5	.3		1N5061	312
1N2422A							500	1.5	1.2	1.5	.3		1N5626	316
1N2423							600	1.5	1.2	1.5	.3		1N5061	312
1N2423A							600	1.5	1.2	1.5	.3		1N5626	316
1N2424							700	1.5	1.2	1.5	.3		1N5062	312
1N2424A							700	1.5	1.2	1.5	.3		1N5627	316
1N2425							800	1.5	1.2	1.5	.3		1N5062	312
1N2425A							800	1.5	1.2	1.5	.3		1N5627	316
1N2482							200	.75	1.2	.75	.5		1N5059	312
1N2483							400	.75	1.2	.75	.5		1N5060	312
1N2484							500	.75	1.2	.75	.5		1N5061	312
1N2485							200	.75	1.2	.75	.5		1N5059	312
1N2486							300	.75	1.2	.75	.5		1N5060	312
1N2487							400	.75	1.2	.75	.5		1N5060	312
1N2488							500	.75	1.2	.75	.5		1N5061	312
1N2489							600	.75	1.2	.75	.5		1N5061	312
1N2501							800	.15	1.7	.15	.2		1N5062	312
1N2502							1000	.15	1.7	.15	.2		A14P	312
1N2505							800	.3	1.7	.3	.2		1N5062	312
1N2506							1000	.3	1.7	.3	.2		A14P	312
1N2524							50	2.5	1.2	2.5	.5		A15F	805
1N2525							100	2.5	1.2	2.5	.5		A15A	805
1N2526							200	2.5	1.2	2.5	.5		1N5624	316
1N2527							300	2.5	1.2	2.5	.5		1N5625	316
1N2528							400	2.5	1.2	2.5	.5		1N5625	316
1N2529							500	2.5	1.2	2.5	.5		1N5626	316
1N2530							600	2.5	1.2	2.5	.5		1N5626	316
1N2531							700	2.5	1.2	2.5	.5		1N5627	316
1N2532							800	2.5	1.2	2.5	.5		1N5627	316
1N2535							50	2.5	1.0	1.0	.1		A15F	805

Type	Silicon Signal Diodes						Silicon Rectifiers					Exact "1N" Type Page	Suggested GE Replacement	
	BV (V)	V_F @ I_F (V)	(MA)	I_R @ V_R (nA)	(V)	t_{rr} (ns)	V_R (V)	I_P (Max.) (A)	V_F @ I_F (Max.) (V)	(A)	I_R (μA)		Type	Page
1N2536							100	2.5	1.0	1.0	.1		A15A	805
1N2537							200	2.5	1.0	1.0	.1		1N5624	316
1N2538							300	2.5	1.0	1.0	.1		1N5625	316
1N2539							400	2.5	1.0	1.0	.1		1N5625	316
1N2540							500	2.5	1.0	1.0	.1		1N5626	316
1N2541							600	2.5	1.0	1.0	.1		1N5626	316
1N2542							700	2.5	1.0	1.0	.1		1N5627	316
1N2543							800	2.5	1.0	1.0	.1		1N5627	316
1N2546							50	2.5	1.5	2.5	1.0		A15F	805
1N2547							100	2.5	1.5	2.5	1.0		A15A	805
1N2548							200	2.5	1.5	2.5	1.0		1N5624	316
1N2549							300	2.5	1.5	2.5	1.0		1N5625	316
1N2550							400	2.5	1.5	2.5	1.0		1N5625	316
1N2551							500	2.5	1.5	2.5	1.0		1N5626	316
1N2552							600	2.5	1.5	2.5	1.0		1N5626	316
1N2553							700	2.5	1.5	2.5	1.0		1N5627	316
1N2554							800	2.5	1.5	2.5	1.0		1N5627	316
1N2609							50	.75	1.1	.75	.3		A14F	801
1N2610							100	.75	1.1	.75	.3		A14A	801
1N2611							200	.75	1.1	.75	.3		1N5059	312
1N2612							300	.75	1.1	.75	.3		1N5060	312
1N2613							400	.75	1.1	.75	.3		1N5060	312
1N2614							500	.75	1.1	.75	.3		1N5061	312
1N2615							600	.75	1.1	.75	.3		1N5061	312
1N2616							800	.75	1.1	.75	.3		1N5062	312
1N2617							1000	.75	1.1	.75	.3		A14P	312
1N2638							100	1.5	1.3	1.5	.3		A14A	801
1N2641							200	1.5	1.3	1.5	.3		1N5059	312
1N2644							300	1.5	1.3	1.5	.3		1N5624	316
1N2644A							300	1.5	1.3	1.5	.3		1N5624	316
1N2647							400	1.5	1.3	1.5	.3		1N5625	316
1N2647A							400	1.5	1.3	1.5	.3		1N5625	316
1N2650							600	1.5	2.6	1.5	.3		1N5626	316
1N2650A							600	1.5	2.6	1.5	.3		1N5626	316
1N2653							800	1.5	2.6	1.5	.3		1N5627	316
1N2653A							800	1.5	2.6	1.5	.3		1N5627	316
1N2669							100	3.6	1.3	3.6	.3		A15A	805
1N2673							200	3.6	1.3	3.6	.3		1N5624	316
1N2677							300	3.6	1.3	3.6	.3		1N5625	316
1N2681							400	3.6	1.3	3.6	.3		1N5625	316
1N2685							600	3.6	2.6	3.6	.3		1N5626	316
1N2687							800	3.6	2.6	3.6	.3		1N5627	316
1N2702							100	3.0	1.3	3.0	.2		A15A	805
1N2705							200	3.0	1.3	3.0	.2		1N5624	316
1N2708							300	3.0	1.3	3.0	.2		1N5625	316
1N2711							400	3.0	1.3	3.0	.2		1N5625	316
1N2714							600	3.0	2.6	3.0	.2		1N5626	316
1N2717							800	3.0	2.6	3.0	.2		1N5627	316
1N2725							100	3.0	1.3	3.0	.3		A15A	805
1N2728							200	3.0	1.3	3.0	.3		1N5624	316
1N2731							300	3.0	1.3	3.0	.3		1N5625	316
1N2734							400	3.0	1.3	3.0	.3		1N5625	316
1N2737							600	3.0	2.6	3.0	.3		1N5626	316
1N2738							800	3.0	2.6	3.0	.3		1N5627	316
1N2740							100	3.6	1.3	3.6	.3		A15A	805
1N2742							200	3.6	1.3	3.6	.4		1N5624	316
1N2744							300	3.6	1.3	3.6	.3		1N5625	316
1N2746							400	3.6	1.3	3.6	.3		1N5625	316
1N2748							600	3.6	2.6	3.6	.3		1N5626	316
1N2749							800	3.6	2.6	3.6	.3		1N5627	316
1N2750							100	3.0	1.3	3.0	.3		A15A	805
1N2753							200	3.0	1.3	3.0	.3		1N5624	316
1N2756							300	3.0	1.3	3.0	.3		1N5625	316
1N2759							400	3.0	1.3	3.0	.3		1N5625	316
1N2762							600	3.0	2.6	3.0	.3		1N5626	316
1N2763							800	3.0	2.6	3.0	.3		1N5627	316
1N2772							700	.5	1.8				1N5062	312
1N2773							800	.5	1.8				1N5062	312
1N2774							900	.5	1.8				A14P	312

Type	Silicon Signal Diodes						Silicon Rectifiers					Exact "1N" Type Page	Suggested GE Replacement	
	BV (V)	V_F @ I_F (V)	(MA)	I_R @ V_R (nA)	(V)	t_{rr} (ns)	V_R (V)	I_F (Max.) (A)	V_F @ I_F (Max.) (V)	(A)	I_R (μA)		Type	Page
1N2775							1000	.5	1.8				A14P	312
1N2847							100	1.5	2.0	1.5	.3		A15A	805
1N2848							200	1.5	2.0	1.5	.3		1N5624	316
1N2849							300	1.5	2.0	1.5	.3		1N5625	316
1N2850							400	1.5	2.0	1.5	.3		1N5625	316
1N2850A							400	1.5	2.0	1.5	.3		1N5625	316
1N2851							500	1.5	2.0	1.5	.3		1N5626	316
1N2851A							500	1.5	2.0	1.5	.3		1N5626	316
1N2852							600	1.5	2.0	1.5	.3		1N5626	316
1N2852A							600	1.5	2.0	1.5	.3		1N5626	316
1N2858							50	.75	1.2	.75	.3		A14F	801
1N2858A							50	1.0	1.2	1.0	.3		A14F	801
1N2859							100	.75	1.2	.75	.3		A14A	801
1N2859A							100	1.0	1.2	1.0	.3		A14A	801
1N2860							200	.75	1.2	.75	.3		1N5059	312
1N2860A							200	1.0	1.2	1.0	.3		1N5059	312
1N2861							300	.75	1.2	.75	.3		1N5060	312
1N2861A							300	1.0	1.2	1.0	.3		1N5060	312
1N2862							400	.75	1.2	.75	.3		1N5060	312
1N2862A							400	1.0	1.2	1.0	.3		1N5060	312
1N2863							500	.75	1.2	.75	.3		1N5061	312
1N2863A							500	1.0	1.2	1.0	.3		1N5061	312
1N2864							600	.75	1.2	.75	.3		1N5061	312
1N2864A							600	1.0	1.2	1.0	.3		1N5061	312
1N2865							1000	.7	2.5	.7	.1		A14P	312
1N2878							700	.25	2.0	.25	.5		1N5062	312
1N2879							700	.25	2.0	.25	.3		1N5062	312
1N2880							1000	.25	2.0	.25	.5		A14P	312
1N2881							1000	.25	2.0	.25	.3		A14P	312
1N2882							500	.25	3.0	.25	.5		1N5061	312
1N2883							500	.25	3.0	.25	.3		1N5061	312
1N3062	75	1.0	20	100	50	2						118		
1N3063	75	.85	10	100	50	2						241		
1N3064	75	1.0	10	100	50	4						242		
1N3065	75	1.0	20	100	50	2						242		
1N3066	75	1.0	10	100	50	2						242		
1N3067	30	1.0	5	100	20	2						119		
1N3068	30	1.0	5	100	20	50						119		
1N3069	65	1.0	50	100	50	50							DA1702	1271
1N3070	200	1.0	100	100	145	50						118		
1N3071	200	1.0	100	100	150	50						118		
1N3072							50	.2	1.5	.2	.5		A14F	801
1N3073							100	.2	1.5	.2	.5		A14A	801
1N3074							150	.2	1.5	.2	.5		1N5059	312
1N3075							200	.2	1.5	.2	.5		1N5059	312
1N3076							250	.2	1.5	.2	.5		1N5060	312
1N3077							300	.2	1.5	.2	.5		1N5060	312
1N3078							350	.2	1.5	.2	.5		1N5060	312
1N3079							400	.2	1.5	.2	.5		1N5060	312
1N3080							500	.2	1.5	.2	.5		1N5061	312
1N3081							600	.2	1.5	.2	.5		1N5061	312
1N3082							200	.5	1.25	.5	.2		1N5059	312
1N3083							400	.5	1.25	.5	.2		1N5060	312
1N3084							600	.5	1.25	.5	.2		1N5061	312
1N3106							800	.75	1.6	.75	.3		1N5061	312
1N3123	40	1.5	10	100	40	4							DA1703	1271
1N3124	40	1.0	20	100	40	4							DA1703	1271
1N3161							50	240	1.3	240	16		A90F	263
1N3161R							50	240	1.3	240	16		A91F	263
1N3162							100	240	1.3	240	16		A90A	263
1N3162R							100	240	1.3	240	16		A91A	263
1N3163							150	240	1.3	240	16		A90G	263
1N3163R							150	240	1.3	240	16		A91G	263
1N3164							200	240	1.3	240	16		A90B	263
1N3164R							200	240	1.3	240	16		A91B	263
1N3165							250	240	1.3	240	16		A90H	263
1N3165R							250	240	1.3	240	16		A91H	263
1N3166							300	240	1.3	240	16		A90C	263
1N3166R							300	240	1.3	240	16		A91C	263

Type	Silicon Signal Diodes						Silicon Rectifiers					Exact "1N" Type Page	Suggested GE Replacement	
	BV (V)	V_F (V)	@ I_F (MA)	I_R (nA)	@ V_R (V)	t_{rr} (ns)	V_R (V)	I_P (Max.) (A)	V_F (V)	@ I_F (Max.) (A)	I_R (µA)		Type	Page
1N3167							350	240	1.3	240	16		A90J	263
1N3167R							350	240	1.3	240	16		A91J	263
1N3168							400	240	1.3	240	16		A90D	263
1N3168R							400	240	1.3	240	16		A91D	263
1N3169							500	240	1.3	240	16		A90E	263
1N3169R							500	240	1.3	240	16		A91E	263
1N3170							600	240	1.3	240	16		A90M	263
1N3170R							600	240	1.3	240	16		A91M	263
1N3171							700	240	1.3	240	16		A90S	263
1N3171A							700	240	1.3	240	16		A90S	263
1N3171R							700	240	1.3	240	16		A91S	263
1N3171AR							700	240	1.3	240	16		A91S	263
1N3172							800	240	1.3	240	16		A90N	263
1N3172A							800	240	1.3	240	16		A90N	263
1N3172R							800	240	1.3	240	16		A91N	263
1N3172AR							800	240	1.3	240	16		A91N	263
1N3173							900	240	1.3	240	16		A90T	263
1N3173A							900	240	1.3	240	16		A90T	263
1N3173R							900	240	1.3	240	16		A91T	263
1N3173AR							900	240	1.3	240	16		A91T	263
1N3174								240	1.3	240	16		A90P	263
1N3174A								240	1.3	240	16		A90P	263
1N3174R								240	1.3	240	16		A91P	263
1N3174RA								240	1.3	240	16		A91P	263
1N3183							350	.5	1.0	.5			1N5060	312
1N3184							500	.5	1.0	.5			1N5061	312
1N3185							700	.5	2.0	.5			1N5062	312
1N3186							1000	.5	2.0	.5			A14P	312
1N3189							200	1.0	1.1	1.0	.2		1N5059	312
1N3190							400	1.0	1.1	1.0	.2		1N5060	312
1N3191							600	1.0	1.1	1.0	.2		1N5061	312
1N3193							200	.75	1.2	.75	.2		1N5059	312
1N3194							400	.75	1.2	.75	.2		1N5060	312
1N3195							600	.75	1.2	.75	.2		1N5061	312
1N3196							800	.75	1.2	.75	.2		1N5062	312
1N3208							50	15	1.5	15	10	247		
1N3208R							50	15	1.5	15	10	247		
1N3209							100	15	1.5	15	10	247		
1N3209R							100	15	1.5	15	10	247		
1N3210							200	15	1.5	15	10	247		
1N3210R							200	15	1.5	15	10	247		
1N3211							300	15	1.5	15	10	247		
1N3211R							300	15	1.5	15	10	247		
1N3212							400	15	1.5	15	10	247		
1N3212R							400	15	1.5	15	10	247		
1N3213							500	15	1.5	15	10	247		
1N3213R							500	15	1.5	15	10	247		
1N3214							600	15	1.5	15	10	247		
1N3214R							600	15	1.5	15	10	247		
1N3227							100	.5	3.3	.5	.25		A14A	801
1N3228							200	.5	3.3	.5	.25		1N5059	312
1N3229							400	.5	3.3	.5	.25		1N5060	312
1N3230							600	.5	3.3	.5	.25		1N5061	312
1N3231							800	.5	3.3	.5	.25		1N5062	312
1N3232							1000	.5	3.3	.5	.25		A14P	312
1N3237							50	.75	2.2	.75	.25		A14F	801
1N3238							100	.75	2.2	.75	.25		A14A	801
1N3239							200	.75	2.2	.75	.25		1N5059	312
1N3240							400	.75	2.2	.75	.25		1N5060	312
1N3241							600	.75	2.2	.75	.25		1N5061	312
1N3242							800	.75	2.2	.75	.25		1N5062	312
1N3243							1000	.75	2.2	.75	.25		A14P	312
1N3247							100	1.0	1.1	1.0	.25		A14A	801
1N3248							200	1.0	1.1	1.0	.25		1N5059	312
1N3249							400	1.0	1.1	1.0	.25		1N5060	312
1N3250							600	1.0	1.1	1.0	.25		1N5061	312
1N3251							800	1.0	1.1	1.0	.25		1N5062	312
1N3252							1000	1.0	1.1	1.0	.25		A14P	312
1N3253							200	.75	1.2	.75	.2		1N5059	312

Type	Silicon Signal Diodes						Silicon Rectifiers					Exact "1N" Type Page	Suggested GE Replacement	
	BV (V)	V_F @ I_F (V)	(MA)	I_R @ V_R (nA)	(V)	t_{rr} (ns)	V_R (V)	I_P (Max.) (A)	V_F @ I_F (Max.) (V)	(A)	I_R (μA)		Type	Page
1N3254							400	.75	1.2	.75	.2		1N5060	312
1N3255							600	.75	1.2	.75	.2		1N5061	312
1N3256							800	.75	1.2	.75	.2		1N5062	312
1N3258							1000	.75	1.2	.75	.2		A14P	312
1N3260							50	160	1.6	160	12	249		
1N3260R							50	160	1.6	160	12	249		
1N3261							100	160	1.6	160	12	249		
1N3261R							100	160	1.6	160	12	249		
1N3262							150	160	1.6	160	12	249		
1N3262R							150	160	1.6	160	12	249		
1N3263							200	160	1.6	160	12	249		
1N3263R							200	160	1.6	160	12	249		
1N3264							250	160	1.6	160	12	249		
1N3264R							250	160	1.6	160	12	249		
1N3265							300	160	1.6	160	12	249		
1N3265R							300	160	1.6	160	12	249		
1N3266							350	160	1.6	160	12	249		
1N3266R							350	160	1.6	160	12	249		
1N3267							400	160	1.6	160	12	249		
1N3267R							400	160	1.6	160	12	249		
1N3268							500	160	1.6	160	12	249		
1N3268R							500	160	1.6	160	12	249		
1N3269							600	160	1.6	160	12	249		
1N3269R							600	160	1.6	160	12	249		
1N3270							700	160	1.6	160	12	249		
1N3270R							700	160	1.6	160	12	249		
1N3271							800	160	1.6	160	12	249		
1N3271R							800	160	1.6	160	12	249		
1N3272							900	160	1.6	160	12	249		
1N3272R							900	160	1.6	160	12	249		
1N3273							1000	160	1.6	160	12	249		
1N3273R							1000	160	1.6	160	12	249		
1N3277							200	.75	1.3	.75			1N5059	312
1N3278							400	.75	1.3	.75			1N5060	312
1N3279							600	.75	1.3	.75			1N5061	312
1N3280							800	.75	1.3	.75			1N5062	312
1N3281							1000	.75	1.3	.75			A14P	312
1N3282							1000	.1	3.7	.1			A14P	312
1N3288							100	100	1.5	100	200	251		
1N3288R							100	100	1.5	100	200	251		
1N3289							200	100	1.5	100	200	251		
1N3289R							200	100	1.5	100	200	251		
1N3290							300	100	1.5	100	200	251		
1N3290R							300	100	1.5	100	200	251		
1N3291							400	100	1.5	100	200	251		
1N3291R							400	100	1.5	100	200	251		
1N3292							500	100	1.5	100	200	251		
1N3292R							500	100	1.5	100	200	251		
1N3293							600	100	1.5	100	200	251		
1N3293R							600	100	1.5	100	200	251		
1N3294							800	100	1.5	100	200	251		
1N3294R							800	100	1.5	100	200	251		
1N3295							1000	100	1.5	100	200	251		
1N3295R							1000	100	1.5	100	200	251		
1N3296							1200	100	1.5	100	200	251		
1N3296R							1200	100	1.5	100	200	251		
1N3486							1000	.4	2.0	.4	.05		A14P	312
1N3544							100	.6	1.5	.6	.2		A14A	801
1N3245							200	.6	1.5	.6	.2		1N5059	312
1N3246							300	.6	1.5	.6	.2		1N5060	312
1N3247							400	.6	1.5	.6	.2		1N5060	312
1N3248							500	.6	1.5	.6	.2		1N5061	312
1N3249							600	.6	1.5	.6	.2		1N5061	312
1N3563							1000	.4	1.2	.4	.2		A14P	312
1N3569							100	3.5	1.3	3.5	.4		A15A	805
1N3570							200	3.5	1.3	3.5	.4		1N5624	316
1N3271							300	3.5	1.3	3.5	.4		1N5625	316
1N3272							400	3.5	1.3	3.5	.4		1N5625	316
1N3273							500	3.5	1.3	3.5	.4		1N5626	316

Type	Silicon Signal Diodes						Silicon Rectifiers					Exact "1N" Type Page	Suggested GE Replacement	
	BV (V)	V_F @ I_F (V)	(MA)	I_R @ V_R (nA)	(V)	t_{rr} (ns)	V_R (V)	I_P (Max.) (A)	V_F @ I_F (Max.) (V)	(A)	I_R (μA)		Type	Page
1N3274							600	3.5	1.3	3.5	.4		1N5626	316
1N3569-74												255		
1N3595	125	1.0	200	1000	125	3000							DT230G	1274
1N3596	20	1.0	30	100	20	4000							DA1701	1271
1N3597	150	1.2	400	100	150	300							DT230G	1274
1N3600	50	1.0	200	100	50	6							1N4150	280
1N3602	50	1.0	20	100	50	5							DA1702	1271
1N3603	30	1.0	30	100	50	5							DA1703	1271
1N3604	75	1.0	50	50	50	2						242		
1N3605	40	.55	.1	50	30	2						242		
1N3606	75	.55	.1	50	30	2						242		
1N3611							200	.75	1.0	.75	.01		1N5059	312
1N3612							400	.75	1.0	.75	.01		1N5060	312
1N3613							600	.75	1.0	.75	.01		1N5061	312
1N3614							800	.75	1.0	.75	.01		1N5062	312
1N3615							50	16	1.2	16	3		1N1199A	219
1N3616							100	16	1.2	16	2.5		1N1200A	219
1N3617							150	16	1.2	16	2.25		1N1201A	219
1N3618							200	16	1.2	16	2.0		1N1202A	219
1N3619							300	16	1.2	16	1.75		1N1203A	219
1N3620							400	16	1.2	16	1.5		1N1204A	219
1N3621							500	16	1.2	16	1.25		1N1205A	219
1N3622							600	16	1.2	16	1.0		1N1206A	219
1N3623							800	16	1.2	16	.75		1N3671A	219
1N3624							1000	16	1.2	16	.6		1N3673A	219
1N3639							200	.75	1.2	.75	.2		1N5059	312
1N3640							400	.75	1.2	.75	.2		1N5060	312
1N3641							600	.75	1.2	.75	.2		1N5061	312
1N3642							800	.75	1.2	.75	.2		1N5062	312
1N3649							800	1.0	1.1	1.0	.005		1N5062	312
1N3656							200	.5	1.2	.5	.01		1N5059	312
1N3657							400	.5	1.2	.5	.01		1N5060	312
1N3658							600	.5	1.2	.5	.01		1N5061	312
1N3670							700	12	2.05	12	3	219		
1N3670A							700	12	1.5	12	.19	219		
1N3670R							700	12	2.05	12	3	219		
1N3670RA							700	12	1.5	12	.9	219		
1N3671							800	12	2.05	12	2	219		
1N3671A							800	12	1.3	12	.8	219		
1N3671R							800	12	2.05	12	2	219		
1N3671RA							800	12	1.3	12	.8	219		
1N3672							900	12	2.05	12	2	219		
1N3672A							900	12	1.15	12	.7	219		
1N3672R							900	12	2.05	12	2	219		
1N3672RA							900	12	1.15	12	.7	219		
1N3673							1000	12	2.05	12	1.0	219		
1N3673A							1000	12	1.0	12	.6	219		
1N3673R							1000	12	2.05	12	1.0	219		
1N3673RA							1000	12	1.0	12	.6	219		
1N3712			Tunnel Diodes See Pages 120-122									259		
1N3713												259		
1N3714												259		
1N3715												259		
1N3716												259		
1N3717												259		
1N3718												259		
1N3719												259		
1N3720												259		
1N3721												259		
1N3723							1000	.75	2.2	.75	.005		A14P	312
1N3735							100	250	1.3	250	16	263		
1N3735R							100	250	1.3	250	16	263		
1N3736							200	250	1.3	250	16	263		
1N3736R							200	250	1.3	250	16	263		
1N3737							300	250	1.3	250	16	263		
1N3737R							300	250	1.3	250	16	263		
1N3738							400	250	1.3	250	16	263		
1N3738R							400	250	1.3	250	16	263		
1N3739							500	250	1.3	250	13	263		
1N3739R							500	250	1.3	250	13	263		

Type	Silicon Signal Diodes						Silicon Rectifiers					Exact "1N" Type Page	Suggested GE Replacement	
	BV (V)	V_F @ I_F (V)	(MA)	I_R @ V_R (nA)	(V)	t_{rr} (ns)	V_R (V)	I_P (Max.) (A)	V_F @ I_F (Max.) (V)	(A)	I_R (μA)		Type	Page
1N3740							600	250	1.3	250	12	263		
1N3740R							600	250	1.3	250	12	263		
1N3741							800	250	1.3	250	9	263		
1N3741R							800	250	1.3	250	9	263		
1N3742							1000	250	1.3	250	7	263		
1N3742R							1000	250	1.3	250	7	263		
1N3743							1200	250	1.3	250	7	263		
1N3743R							1200	250	1.3	250	7	263		
1N3748							200	.5	1.5				1N5059	312
1N3749							400	.5	1.5				1N5060	312
1N3750							600	.5	1.5				1N5061	312
1N3751							800	.5	1.5				1N5062	312
1N3752							1000	.5	1.5				A14P	312
1N3754							100	.15	1.2	.15	.3		A14A	801
1N3755							200	.15	1.2	.15	.3		1N5059	312
1N3756							400	.15	1.2	.15	.3		1N5060	312
1N3757							200	1.0	1.0	1.0			1N5059	312
1N3758							400	1.0	1.0	1.0			1N5060	312
1N3759							600	1.0	1.0	1.0			1N5061	312
1N3760							800	1.0	1.0	1.0			1N5062	312
1N3761							1000	1.0	1.0	1.0			A14P	312
1N3765							700	35	1.8	35	5	215		
1N3765R							700	35	1.8	35	5	215		
1N3766							800	35	1.8	35	4	215		
1N3766R							800	35	1.8	35	4	215		
1N3767							900	35	1.8	35	3	215		
1N3767R							900	35	1.8	35	3	215		
1N3768							1000	35	1.8	35	2	215		
1N3768R							1000	35	1.8	35	2	215		
1N3866							200	1.0	1.5	1.0	.05		1N5059	312
1N3867							400	1.0	1.5	1.0	.05		1N5060	312
1N3768							600	1.0	1.5	1.0	.05		1N5061	312
1N3769							1000	.5	3.0	.5	.05		A14P	312
1N3872	90	1.0	150	100	90	15000							DA1701	1271
1N3873	50	1.14	200	100	50	4000						118		
1N3879							50	6.0	1.5	6.0	3	269		
1N3879R							50	6.0	1.5	6.0	3	269		
1N3880							150	6.0	1.5	6.0	3	269		
1N3880R							150	6.0	1.5	6.0	3	269		
1N3881							200	6.0	1.5	6.0	3	269		
1N3881R							200	6.0	1.5	6.0	3	269		
1N3882							300	6.0	1.5	6.0	3	269		
1N3882R							300	6.0	1.5	6.0	3	269		
1N3883							400	6.0	1.5	6.0	3	269		
1N3883R							400	6.0	1.5	6.0	3	269		
1N3889							50	12	1.5	12	3	271		
1N3889R							50	12	1.5	12	3	271		
1N3890							100	12	1.5	12	3	271		
1N3890R							100	12	1.5	12	3	271		
1N3891							200	12	1.5	12	3	271		
1N3891R							200	12	1.5	12	3	271		
1N3892							300	12	1.5	12	3	271		
1N3892R							300	12	1.5	12	3	271		
1N3893							400	12	1.5	12	3	271		
1N3893R							400	12	1.5	12	3	271		
1N3899							50	20	1.5	20	6	273		
1N3899R							50	20	1.5	20	6	273		
1N3900							100	20	1.5	20	6	273		
1N3900R							100	20	1.5	20	6	273		
1N3901							200	20	1.5	20	6	273		
1N3901R							200	20	1.5	20	6	273		
1N3902							300	20	1.5	20	6	273		
1N3902R							300	20	1.5	20	6	273		
1N3903							400	20	1.5	20	6	273		
1N3903R							400	20	1.5	20	6	273		

Type	Silicon Signal Diodes						Silicon Rectifiers					Exact "1N" Type Page	Suggested GE Replacement	
	BV (V)	V_F @ I_F (V)	(MA)	I_R @ V_R (nA)	(V)	t_{rr} (ns)	V_R (V)	I_P (Max.) (A)	V_F @ I_F (Max.) (V)	(A)	I_R (μA)		Type	Page
1N3909							50	30	1.5	30	10	275		
1N3909R							50	30	1.5	30	10	275		
1N3910							100	30	1.5	30	10	275		
1N3910R							100	30	1.5	30	10	275		
1N3911							200	30	1.5	30	10	275		
1N3911R							200	30	1.5	30	10	275		
1N3912							300	30	1.5	30	10	275		
1N3912R							300	30	1.5	30	10	275		
1N3913							400	30	1.5	30	10	275		
1N3913R							400	30	1.5	30	10	275		
1N3938							200	2.0	1.1	2.0	.4		1N5624	316
1N3939							400	2.0	1.1	2.0	.4		1N5625	316
1N3940							600	2.0	1.1	2.0	.4		1N5626	316
1N3941							800	2.0	1.1	2.0	.4		1N5627	316
1N3952	130	.74	10	25	100								1N5059	312
1N3957							1000	.4	1.0	.4	.01		A14P	312
1N3981							200	.9	1.0	.9	.01		1N5059	312
1N3982							400	.9	1.0	.9	.01		1N5060	312
1N3983							600	.9	1.0	.9	.01		1N5061	312
1N3987							700	6.0	1.4	6.0	.9		C.F.	
1N3987R							700	6.0	1.4	6.0	.9		C.F.	
1N3988							800	6.0	1.4	6.0	.8		C.F.	
1N3988R							800	6.0	1.4	6.0	.8		C.F.	
1N3989							900	6.0	1.4	6.0	.7		C.F.	
1N3989R							900	6.0	1.4	6.0	.7		C.F.	
1N3990							1000	6.0	1.4	6.0	.6		C.F.	
1N3990R							1000	6.0	1.4	6.0	.6		C.F.	
1N4001							50	1.0	1.6	1.0	.03		A14F	801
1N4002							100	1.0	1.6	1.0	.03		A14A	801
1N4003							200	1.0	1.6	1.0	.03		1N5059	312
1N4004							400	1.0	1.6	1.0	.03		1N5060	312
1N4005							600	1.0	1.6	1.0	.03		1N5061	312
1N4006							800	1.0	1.6	1.0	.03		1N5062	312
1N4007							1000	1.0	1.6	1.0	.03		A14P	312
1N4009	25	1.0	30	100	20	4						209		
1N4011							1000	.5	1.1	.5	.2		A14P	312
1N4044							50	275	1.35	275	15	277		
1N4044R							50	275	1.35	275	15	277		
1N4045							100	275	1.35	275	15	277		
1N4045R							100	275	1.35	275	15	277		
1N4046							150	275	1.35	275	15	277		
1N4046R							150	275	1.35	275	15	277		
1N4047							200	275	1.35	275	15	277		
1N4047R							200	275	1.35	275	15	277		
1N4048							250	275	1.35	275	15	277		
1N4048R							250	275	1.35	275	15	277		
1N4049							300	275	1.35	275	15	277		
1N4049R							300	275	1.35	275	15	277		
1N4050							400	275	1.35	275	15	277		
1N4050R							400	275	1.35	275	15	277		
1N4051							500	275	1.35	275	15	277		
1N4051R							500	275	1.35	275	15	277		
1N4052							600	275	1.35	275	15	277		
1N4052R							600	275	1.35	275	15	277		
1N4053							700	275	1.35	275	15	277		
1N4053R							700	275	1.35	275	15	277		
1N4054							800	275	1.35	275	15	277		
1N4054R							800	275	1.35	275	15	277		
1N4055							900	275	1.35	275	15	277		
1N4055R							900	275	1.35	275	15	277		
1N4056							1000	275	1.35	275	15	277		
1N4056R							1000	275	1.35	275	15	277		
1N4087	50	.975	30	90	50	2.5						118		
1N4089							400	.4	1.2	.4	.2		1N5060	312
1N4090		Tunnel Diode - See Pages 120-122										279		

C.F. = Contact Factory

Type	Silicon Signal Diodes						Silicon Rectifiers					Exact "1N" Type Page	Suggested GE Replacement	
	BV (V)	V_F @ I_F (V)	(MA)	I_R @ V_R (nA)	(V)	t_{rr} (ns)	V_R (V)	I_F (Max.) (A)	V_F @ I_F (Max.) (V)	(A)	I_R (μA)		Type	Page
1N4136							200	70	1.6	70	16		1N1186A	215
1N4137							400	70	1.6	70	12		1N1188A	215
1N4138							600	70	1.6	70	8		1N1190A	215
1N4139							50	3.0	1.0	3.0	.1		A15F	805
1N4140							100	3.0	1.0	3.0	.1		A15A	805
1N4141							200	3.0	1.0	3.0	.1		1N5624	316
1N4142							400	3.0	1.0	3.0	.1		1N5625	316
1N4143							600	3.0	1.0	3.0	.1		1N5626	316
1N4144							800	3.0	1.0	3.0	.1		1N5627	316
1N4145							1000	3.0	1.0	3.0	.1		A15P	805
1N4148	75	1.0	10	25	20	4						209		
1N4149	75	1.0	10	25	20	4						209		
1N4150	50	1.0	200	100	50	6						280		
1N4151	50	1.0	50	50	50	2						242		
1N4152	30	.88	20	50	30	2						242		
1N4153	50	.88	20	50	50	2						242		
1N4154	25	1.0	30	100	25	4						209		
1N4156	20	1.84	100	50	20							284		
1N4157	20	2.66	100	50	20							284		
1N4245							200	1.0	1.64	1.0	.05	288		
1N4246							400	1.0	1.64	1.0	.05	288		
1N4247							600	1.0	1.64	1.0	.05	288		
1N4248							800	1.0	1.64	1.0	.05	288		
1N4249							1000	1.0	1.64	1.0	.05	288		
1N4250							800	.5			.05		1N5062	312
1N4251							1000	.5			.05		A14P	312
1N4305	75	.575	25	100	50	2						241		
1N4306	50	1.0	50	50	50	2						290		
1N4307	50	1.0	50	50	50	2						290		
1N4322	50	1.0	200	100	50	6							1N4150	280
1N4361							900	.5	1.3	.5	.5		A14P	312
1N4363	120	1.0	200	100	120	40							1N4150	280
1N4364							100	.75	1.5	.75	.1		A14A	801
1N4365							200	.75	1.5	.75	.1		1N5059	312
1N4366							300	.75	1.5	.75	.1		1N5060	312
1N4367							400	.75	1.5	.75	.1		1N5060	312
1N4368							500	.75	1.5	.75	.1		1N5061	312
1N4369							600	.75	1.5	.75	.1		1N5061	312
1N4376	10	1.1	50	100	10	750							DA1704	1271
1N4383							200	1.0	1.3	1.0	.27		1N5059	312
1N4384							400	1.0	1.3	1.0	.25		1N5060	312
1N4385							600	1.0	1.3	1.0	.22		1N5061	312
1N4444	50	1.0	100	50	50	7						292		
1N4446	75	1.0	20	25	20	4						209		
1N4447	75	1.0	20	25	20	4						209		
1N4448	75	.72	5	25	20	4						209		
1N4449	75	.73	5	25	20	4						209		
1N4450	30	.92	100	50	30	4						280		
1N4451	30	.875	100	50	30	10						294		
1N4453	20	.92	100	50	20							284		
1N4454	75	1.0	10	100	50	2						242		
1N4458							800	5.0	1.5	5.0	.5		1N3671	219
1N4459							1000	5.0	1.5	5.0	.5		1N3673	219
1N4506							200	12	1.4	12	2.5	298		
1N4507							400	12	1.4	12	2.5	298		
1N4508							600	12	1.4	12	2.5	298		
1N4509							800	12	1.4	12	2.0	298		
1N4510							1000	12	1.4	12	1.75	298		
1N4510R							1000	12	1.4	12	1.75	298		
1N4511							1200	12	1.4	12	1.5	298		
1N4511R							1200	12	1.4	12	1.5	298		
1N4514							800	1.1	1.0	1.1	.1		1N5062	312
1N4517							200	2.0	1.2	2.0	.1		1N5624	316
1N4525-30								35	1.4	35	2.5	302		
1N4529R							1000	35	1.4	35	2.5	302		
1N4530							1200	35	1.4	35	2.5	302		
1N4530R							1200	35	1.4	35	2.5	302		
1N4531	75	1.0	10	25	20	4						209		

Type	Silicon Signal Diodes						Silicon Rectifiers					Exact "1N" Type Page	Suggested GE Replacement	
	BV (V)	V_F @ I_F (V)	(MA)	I_R @ V_R (nA)	(V)	t_{rr} (ns)	V_R (V)	I_F (Max.) (A)	V_F @ I_F (Max.) (V)	(A)	I_R (μA)		Type	Page
1N4532	75	1.0	10	100	30	2						242		
1N4533	40	.88	20	50	30	2						242		
1N4534	50	.88	20	50	50	2						242		
1N4536	25	1.0	30	100	25	2						209		
1N4585							800	1.0	1.3	1.0	.2		1N5061	312
1N4586							1000	1.0	1.3	1.0	.2		A14P	312
1N4606	70	1.0	200	100	25	6						280		
1N4607	70	.95	250	100	25	10						294		
1N4608	70	.96	350	100	50	10						294		
1N4610	55	1.1	300	100	55	2							1N4606	306
1N4719							50	3.0	1.0	3.0	1.5		A15F	805
1N4720							100	3.0	1.0	3.0	1.5		A15A	805
1N4721							200	3.0	1.0	3.0	1.5		1N5624	316
1N4722							400	3.0	1.0	3.0	1.5		1N5625	316
1N4723							600	3.0	1.0	3.0	1.5		1N5626	316
1N4724							800	3.0	1.0	3.0	1.5		1N5627	316
1N4725							1000	3.0	1.0	3.0	1.5		A15P	805
1N4726	20	.85	10	100	20							307		
1N4727	20	.85	10	100	20							307		
1N4816							50	1.5	1.3	1.5	.25		A14F	801
1N4817							100	1.5	1.3	1.5	.25		A14A	801
1N4818							200	1.5	1.3	1.5	.25		1N5059	312
1N4818A							200	1.5	1.3	1.5	.25		1N5059	312
1N4819							300	1.5	1.3	1.5	.25		1N5060	312
1N4819A							300	1.5	1.3	1.5	.25		1N5060	312
1N4820							400	1.5	1.3	1.5	.25		1N5060	312
1N4820A							400	1.5	1.3	1.5	.25		1N5060	312
1N4821							500	1.5	1.3	1.5	.25		1N5061	312
1N4821A							500	1.5	1.3	1.5	.25		1N5061	312
1N4822							600	1.5	1.3	1.5	.25		1N5061	312
1N4822A							600	1.5	1.3	1.5	.25		1N5061	312
1N4828	20	1.1	100	100	20							119		
1N4829	20	1.87	100	100	20							284		
1N4830	20	2.69	100	100	20							284		
1N4863	50	1.2	100	50	50	7						309		
1N4864	80	1.1	100	100	80	9						309		
1N4933							50	1.0	1.2	1.0	.3		A114F	819
1N4934							100	1.0	1.2	1.0	.3		A114A	819
1N4935							200	1.0	1.2	1.0	.3		A114B	821
1N4936							400	1.0	1.2	1.0	.3		A114D	821
1N4937							600	1.0	1.2	1.0	.3		A114M	821
1N4938							200	.1	1.0	.1			DT230B	1274
1N4942							200	2.0	2.5	2.0	50		A114B	821
1N4943							300	2.0	2.5	2.0	50		A114C	821
1N4944							400	2.0	2.5	2.0	50		A114D	821
1N4945							500	2.0	2.5	2.0	50		A114E	821
1N4946							600	2.0	2.5	2.0	50		A114M	821
1N4950	25	.53	1.0	100	25								DA1704	1271
1N4951	20	.85	1.0	100	20							311		
1N4952	50	.85	1.0	100	50							311		
1N4997							50	3.0	1.0	3.0	2.0		A15F	805
1N4998							100	3.0	1.0	3.0	2.0		A15A	805
1N4999							200	3.0	1.0	3.0	2.0		1N5624	316
1N5000							400	3.0	1.0	3.0	2.0		1N5625	316
1N5001							600	3.0	1.0	3.0	2.0		1N5626	316
1N5002							800	3.0	1.0	3.0	2.0		1N5627	316
1N5004							100	1.0	1.3	1.0	1.0		A14A	801
1N5005							200	1.0	1.3	1.0	1.0		1N5059	312
1N5006							400	1.0	1.3	1.0	1.0		1N5060	312
1N5007							600	1.0	1.3	1.0	1.0		1N5061	312
1N5052							700	1.5	1.3	1.5	.5		1N5062	312
1N5052A							700	1.5	1.3	1.5	.5		1N5062	312
1N5053							800	1.5	1.3	1.5	.5		1N5062	312
1N5053A							800	1.5	1.3	1.5	.5		1N5062	312
1N5054							1000	1.5	1.3	1.5	.5		A14P	312
1N5054A							1000	1.5	1.3	1.5	.5		A14P	312
1N5055							100	1.0	1.4	1.0	.25		A14A	801
1N5056							200	1.0	1.4	1.0	.25		1N5059	312
1N5057							300	.8	1.4	.8	.25		1N5060	312

Type	Silicon Signal Diodes						Silicon Rectifiers					Exact "1N" Type Page	Suggested GE Replacement	
	BV (V)	V_F @ (V)	I_F (MA)	I_R @ (nA)	V_R (V)	t_{rr} (ns)	V_R (V)	I_P (Max.) (A)	V_F @ (V)	I_F (Max.) (A)	I_R (μA)		Type	Page
1N5058							400	.8	1.4	.8	.25		1N5060	312
1N5059							200	1.5	1.0	1.5	.3	312		
1N5060							400	1.5	1.0	1.5	.3	312		
1N5061							600	1.5	1.0	1.5	.2	312		
1N5062							800	1.25	1.0	1.25	.2	312		
1N5171							50	2.0	1.2	2.0	.03		A15F	805
1N5172							100	2.0	1.2	2.0	.03		A15A	805
1N5173							300	2.0	1.2	2.0	.03		1N5625	316
1N5174							400	2.0	1.2	2.0	.03		1N5625	316
1N5175							500	2.0	1.2	2.0	.03		1N5626	316
1N5176							600	2.0	1.2	2.0	.03		1N5626	316
1N5177							800	2.0	1.2	2.0	.03		1N5627	316
1N5179		2.8	1.0	50	20	200						284		
1N5197							50	2.0			.1		A15F	805
1N5198							100	2.0			.1		A15A	805
1N5199							200	2.0			.1		1N5624	316
1N5200							400	2.0			.1		1N5625	316
1N5201							600	2.0			.1		1N5626	316
1N5206							400	2.0	1.1	2.0	.003		1N5625	316
1N5207							400	4.0	1.25	4.0	.005		1N5625	316
1N5211							200	1.0	1.2	1.0	.2		1N5059	312
1N5212							400	1.0	1.2	1.0	.2		1N5060	312
1N5213							600	1.0	1.2	1.0	.2		1N5061	312
1N5214							800	.75	1.2	.75	.2		1N5062	312
1N5215							200	1.0	1.2	1.0	.2		1N5059	312
1N5216							400	1.0	1.2	1.0	.2		1N5060	312
1N5217							600	1.0	1.2	1.0	.2		1N5061	312
1N5218							800	.75	1.2	.75	.2		1N5062	312
1N5219	30	1.0	50	50	30	2							DA1703	1271
1N5220	30	1.0	50	50	30	2							DA1703	1271
1N5282	55	1.3	500	100	55	4							1N4606	306
1N5282A	55	1.3	500	100	55	4							1N4606	306
1N5315	75	.49	.1	50	50	4							1N4606	306
1N5316	75	.49	.1	50	55	4							DA1701	1271
1N5317	55	1.17	500	100	55	4							1N4606	306
1N5318	50	.87	200	100	50	4							1N4151	242
1N5319	25	1.0	100	100	25	4							1N4450	280
1N5319A	25	1.0	100	100	25	4							1N4450	280
1N5331							1200	12	1.35	12		219		
1N5331A							1200	12	1.35	12		219		
1N5332							1200	35	1.7	35		215		
1N5332R							1200	35	1.7	35		215		
1N5391							50	1.5	1.4	1.5			A15F	805
1N5391A							50	1.5	1.4	1.5			A14F	801
1N5392							100	1.5	1.4	1.5			A15A	805
1N5392A							100	1.5	1.4	1.5			A14A	801
1N5393							200	1.5	1.4	1.5			1N5059	312
1N5394							300	1.5	1.4	1.5			1N5060	312
1N5395							400	1.5	1.4	1.5			1N5060	312
1N5396							500	1.5	1.4	1.5			1N5061	312
1N5397							600	1.5	1.4	1.5			1N5061	312
1N5398							800	1.5	1.4	1.5			1N5062	312
1N5399							1000	1.5	1.4	1.5			A14P	312
1N5412	30	.5	100	25	20	2							1N4450	280
1N5413	55	.5	100	25	20	2							1N4606	306
1N5414	75	.5	100	25	20	2							1N4606	306
1N5433							600	2.0	1.2	2.0	50		A114M	821
1N5434							600	2.0	1.1	2.0	50		A114M	821
1N5624							200	3.0	.95	3.0	.3	316		
1N5625							400	3.0	.95	3.0	.3	316		
1N5626							600	3.0	.95	3.0	.3	316		
1N5627							800	3.0	.95	3.0	.3	316		

Type	Germanium	Silicon	PNP	NPN	Maximum Ratings					Electrical Characteristics							Exact "2N" Type Page	Suggested GE Replacement	
					P_D @ 25°C (mw)	PT.	T_J °C	V_{CB} (V)	V_{CEO} (V)	h_{FE} Max.	h_{FE} Min.	@ I_C (mA)	$V_{CE(SAT)}$ (V)	@ I_C	h_{fe}	f_T Typical (MHz)		Type	Page
2N34	x		x		50	A		25										2N322	123
2N34A	x		x		50	A		25										2N322	123
2N36	x		x		50	A	50	20										2N323	123
2N37	x		x		50	A	20								30			2N322	123
2N38	x		x		50	A									15			2N319	123
2N38A	x		x		50	A	20	20										2N319	123
2N41	x		x		50	A		25										2N322	123
2N43	x		x		240	A	85	45	30	34		20			30	500	123		
2N43A	x		x		240	A	85	45	30	34	65	20			30	500	123		
2N44	x		x		240	A	85	45	30	18	43	20				500	123		
2N44A	x		x		240	A	85	45	30	18	43	20				500	123		
2N46	x		x		50	A		25										2N1414	442
2N47	x		x		50			35										2N1414	442
2N48	x		x		50			35										2N1414	442
2N49	x		x		50			35										2N1414	442
2N54	x		x		.2W	A	60	45										2N1415	442
2N55	x		x		.2W	A	60	45										2N1414	442
2N56	x		x		.2W	A		60	45									2N320	123
2N59	x		x		180	A	85	25	25									2N1415	442
2N59A	x		x		180	A	85	40	40									2N1415	442
2N60	x		x		180	A	85	25	25									2N1415	442
2N60A	x		x		180	A	85	40	40									2N1415	442
2N60B	x		x		180	A	85	50	50									2N1925	458
2N60C	x		x		180	A	85	50	60									2N1926	458
2N61	x		x		180	A	85	25	25									2N1415	442
2N61A	x		x		180	A	85	40	40									2N1415	442
2N61B	x		x		180	A	85	50	50									2N1924	458
2N61C	x		x		180	A	85	60	60									2N1924	458
2N63	x		x		102	A	85	44	44									2N1924	458
2N64	x		x		102	A	85	30	30									2N1415	442
2N65	x		x			A	85	24	24									2N324	123
2N73	x		x		.2W	A			50									2N524	417
2N74	x		x		.2W	A			50									2N524	417
2N75	x		x		.2W	A			20									2N524	417
2N76	x		x		5W	J	60	20								500		2N322	123
2N77	x		x		35	A		25										2N324	123
2N78,A	x		x		65	A	85	20	15	45	135	1					123		
2N79	x		x		35	A		35										2N321	123
2N80	x		x		50	A		25										2N508	413
2N81	x		x		50	A	100		20						20			2N1415	442
2N82	x		x		35	A	71	20		20	60	1.0						2N1415	442
2N96	x		x		50	A		30								500		2N1414	442
2N104	x		x		150	A	70	30										2N1415	442
2N105	x		x		35	A	50	35										2N1415	442
2N106	x		x		102	A	85	6.0										2N1414	442
2N108	x		x		50	A												2N322	123
2N109	x		x		165	A	71	35	25	65	115	50	0.15	50	50			2N1175	434
2N111	x		x		150	A	85	30	15	15		1.0						2N396	123
2N111A	x		x		150	A	85	30	15	15		1.0						2N396	123
2N112	x		x		150	A	85	30	15	15		1.0						2N396	123
2N113	x		x		96	A	85	10										2N396	123
2N114	x		x		96	A	85	10										2N396	123
2N122		x		x	8.7W	C	150	120		3.0		100						D44R1	1261
2N130	x		x		85	A	85	44										2N1413	442
2N130A	x		x		100	A	85	45	40						14			2N1413	442
2N131	x		x		85	A	30											2N1413	442
2N131A	x		x		100	A	85	45	30						27			2N1413	442
2N132	x		x		85	A	85	24										2N1175	434
2N132A	x		x		100	A	85	35	20									2N1413	442
2N133	x		x		85	A	85	30										2N1414	442
2N133A	x		x		100	A	85	35	20									2N1414	442
2N135	x		x		100	A	85	20	12						20	4.5		2N396	123
2N136	x		x		100	A	85	20	12						40	6.5		2N396	123
2N137	x		x		100	A	85	10	6.0						60	10		2N396	123
2N138	x		x		50	A	50	24										2N508	413
2N138A	x		x		150	A	85	45	30	10		50						2N1415	442
2N139	x		x		80	A	70	16										2N396	123
2N140	x		x		80	A	70	16										2N396	123
2N167,A	x		x		75	A	85	30	30	17	90	8					123		
2N169,A	x		x		65	A	85	25	25						30		123		

Type	Germanium	Silicon	PNP	NPN	Maximum Ratings					Electrical Characteristics							Exact "2N" Type Page	Suggested GE Replacement	
					P_D @ 25°C (mw)	PT.	T_J °C	V_{CB} (V)	V_{CEO} (V)	h_{FE} Max.	h_{FE} Min.	@ I_C (mA)	$V_{CE(SAT)}$ (V)	@ I_C	h_{fe}	f_T Typical (MHz)		Type	Page
N175	x		x		50	A	71	10										2N1175A	434
N180	x		x		.15W	A	75	30										2N1415	442
N181	x		x		.25W	A	75	30										2N526	417
N185	x		x		150	A	50	20										2N323	123
N188A	x		x		200	A	85	25	25							1.2	123		
N206	x		x		75	A		30										2N1414	442
N207	x		x		50	A	65	12	12						35			2N1415	442
N207A	x		x		50	A	65	12	12						35			2N1415	442
N207B	x		x		50	A	65	12	12						35			2N1415	442
N217	x		x		150	A	71	35	25	65	115	50	0.15	50				2N321	123
N218	x		x		80	A	70	16										2N396	123
N219	x		x		80	A	70	16										2N396	123
N220	x		x		50	A	71	10										2N323	123
N223	x		x		100	A	65		18						39			2N323	123
N224	x		x		250	A	75	25		60	120	100	0.25	100				2N321	123
N225	x		x		250	A	75	25		60	120	100	0.25	100				2N321	123
N226	x		x		250	A	75	30		35	105	100	0.25	100				2N321	123
N227	x		x		250	A	75	30		35	105	100	0.25	100				2N321	123
N237	x		x		150	A	55	45							0.98	500		2N525	417
N238	x		x		50	A	60	20										2N323	123
N265	x		x		75	A	85		25							1.5		2N508	413
N269	x		x		120	A	85	25	24									2N404	401
N270	x		x		150	A	50	25										2N321	123
N271	x		x		150	A	85	30	10									2N396	123
N271A	x		x		150	A	85	30	10									2N396	123
N272	x		x		150	A	85	30	10						60			2N324	123
N273	x		x		150	A	85	45	25	30		50						2N1415	442
N281	x		x		167	C	75	16	45	120						0.35		2N1415	442
N291	x		x		180	A	50	25							30			2N320	123
N315	x		x		100	A	85	20	15	15	30	100	0.15	100				2N396	123
N315A	x		x		150	A	100	30	20	20	50	100	0.15	100				2N396	123
N316	x		x		100	A	85	20	10	20	50	200	0.18	200				2N397	123
N316A	x		x		150	A	100	30	15	20	50	200	0.18	200				2N397	123
N319	x		x		225	A	85		20								123		
N320	x		x		225	A	85		20								123		
N321	x		x		225	A	85		20								123		
N322	x		x		140	A	60	18	18	34	65	20				1.0	123		
N323	x		x		140	A	60	18	18	53	125	20				1.5	123		
N324	x		x		140	A	60	18	18	72	198	20				2.0	123		
N331	x		x		200	A	71	30										2N1415	442
N343A		x		x	1.0	C	150	60	60						.966			D40D7	1233
N359	x		x		170	A	85	25	18	100	300	50						2N508	413
N360	x		x		170	A	85	32	30	50	150	50						2N1415	442
N361	x		x		170	A	85	32	30	25	75	50						2N1413	442
N362	x		x		170	A	85	25	18						50			2N324	123
N363	x		x		170	A	85	32	28						25			2N1414	442
N367	x		x		100	A	75	30							9.0	300		2N1413	442
N368	x		x		100	A	75	75	30						19	400		2N1413	442
N369	x		x		100	A	75	30							49	500		2N1415	442
N381	x		x		200	A	100	50	25	35	65	20			35			2N320	123
N382	x		x		200	A	100	50	25	60	95	20			70			2N321	123
N383	x		x		200	A	100	50	25	75	120	20			90			2N321	123
N396	x		x		200	A	100	30	20	30	150	10	0.2	50		5.0	123		
N396A	x		x		200	A	100	30	20	30	150	10	0.2	50		5.0	123		
N397	x		x		200	A	100	30	15	40	150	10	0.2	50		10	123		
398	x		x		50	A	55	105	105	20		5.0							
398A	x		x		150	A	100	105	105	20		5.0	0.35	5.0	20			2N524	417
402	x		x		180	A	85	25	20									2N320	123
403	x		x		180	A	85	25	20									2N319	123
404A	x		x		150	A	100	40	35	30		12	0.15	12		4.0	401		
405	x		x		150	A	71	20										2N322	123
406	x		x		150	A	71	20										2N322	123
407	x		x		150	A	71	20										2N323	123
408	x		x		150	A	71	20										2N323	123
409	x		x		80	A	71	13										2N396	123
410	x		x		80	A	71	13										2N396	123
411	x		x		80	A	71	13										2N397	123
412	x		x		80	A	71	13										2N397	123
413	x		x		150	A	85	30	18								123		
413A	x		x		150	A	85	30	15								123		

Type	Germanium	Silicon	PNP	NPN	Maximum Ratings					Electrical Characteristics							Exact "2N" Type Page	Suggested GE Replacement	
					P_D @ 25°C (mw)	PT.	T_J °C	V_{CB} (V)	V_{CEO} (V)	h_{FE} Max.	h_{FE} Min.	@ I_C (mA)	$V_{CE(SAT)}$ @ I_C (V)		h_{fe}	f_T Typical (MHz)		Type	Page
2N414	x		x		150	A	85	30	15								123		
2N414A	x		x		150	A	85	30	15									2N396	123
2N415	x		x		150	A	85	30	10									2N396	123
2N415A	x		x		150	A	85	30	10									2N396	123
2N416	x		x		150	A	85	30	12									2N396	123
2N417	x		x		150	A	85	30	10									2N396	123
2N422	x		x		150	A	85	35	20									2N320	123
2N425	x		x		175	A	85	30	20	20	40		0.32	100		2.5		2N396	123
2N426	x		x		175	A	85	30	10	30	60		0.32	100		3.0		2N396	123
2N427	x		x		175	A	85	30	15	40	80		0.32	150		5.0		2N396	123
2N428	x		x		175	A	85	30	12	60			0.32	200		10		2N397	123
2N460	x		x		.2W	A	100	45		16	32							2N524	417
2N461	x		x		.2W	A	100	45		32	100						123		
2N462	x		x		150	A	75	40		20		200				500		2N524	417
2N464	x		x		150	A	85	45	40									2N524	417
2N465	x		x		150	A	85	45	30									2N1414	442
2N466	x		x		150	A	85	35	20									2N321	123
2N467	x		x		150	A	85	35	15									2N508	413
2N481	x		x		150	A	85	12	12									2N396	123
2N482	x		x		150	A	85	12	12									2N396	123
2N483	x		x		150	A	85	12	12									2N396	123
2N484	x		x		150	A	85	12	12									2N396	123
2N485	x		x		150	A	85	12	12									2N396	123
2N486	x		x		150	A	85	12	12									2N396	123
2N489					UNIJUNCTIONS - FOR OTHER TYPES SEE SELECTOR GUIDE P 124												405		
2N489A																	405		
2N489B																	405		
2N490																	405		
2N490A																	405		
2N490B																	405		
2N490C																	411		
2N491																	405		
2N491A																	405		
2N491B																	405		
2N492																	405		
2N492A																	405		
2N492B																	405		
2N492C																	411		
2N493																	405		
2N493A																	405		
2N493B																	405		
2N493C																	411		
2N494																	405		
2N494A																	405		
2N494B																	405		
2N494C																	411		
2N497		x		x	4W	C	200	60	60	12	36	200						D40D7	1233
2N497A		x		x	5W	C	200	60	60	12	36	200						D40D7	1233
2N498		x		x	4W	C	200	100	100	12	36	200						D40N1	1237
2N505	x		x															2N396	123
2N506	x		x		50	A	85	40		25	50	50	0.6	50		500		2N320	123
2N508	x		x		200	A	100	18	18	99	198	20				2.5	413		
2N508A	x		x		200	A	100	30	30	100	200	20			75	2.5	413		
2N519	x		x		100	A	85	15	15						15	0.5		2N396	123
2N519A	x		x		150	A	100	25	18	20	50				15	0.5		2N396	123
2N520	x		x		100	A	85	15	12						20	3.0		2N396	123
2N520A	x		x		150	A	100	25	15	40	170	20			40	2.0		2N396	123
2N521	x		x		100	A	85	15	10						35	8.0		2N397	123
2N521A	x		x		150	A	100	25	12	60	250	20			70	8.0		2N397	123
2N524	x		x		225	A	100	45	30	25	42	20	0.13	20	16	800	417		
2N525	x		x		225	A	100	45	30	34	65	20	0.13	20	30	1.0	417		
2N526	x		x		225	A	100	45	30	53	90	20	0.13	20	44	1.3	417		
2N527	x		x		225	A	100	45	30	72	121	20	0.13	20	60	1.5	417		
2N530	x		x		100	A	85	15	15									2N396	123
2N531	x		x		100	A	85	15	15									2N396	123
2N532	x		x		100	A	85	15	15									2N396	123
2N534	x		x		25	A	65	50	50						35			2N525	417
2N535	x		x		50	A	85	20	20						35			2N1415	442
2N535A	x		x		50	A	85	20	20						35			2N1415	442
2N535B	x		x		50	A	85	20	20						35			2N508	413

Type	Germanium	Silicon	PNP	NPN	Maximum Ratings					Electrical Characteristics							Exact "2N" Type Page	Suggested GE Replacement	
					P_D @ 25°C (mw)	PT.	T_J °C	V_{CB} (V)	V_{CEO} (V)	h_{FE} Max.	h_{FE} Min.	@ I_C (mA)	$V_{CE(SAT)}$ (V)	@ I_C	h_{fe}	f_T Typical (MHz)		Type	Page
2N536	x		x		50	A	85	20	20	100		30	0.13	10		1.0		2N508	413
2N563	x		x		150	A	85	30	25	10	30							2N44A	123
2N564	x		x		120	A	85	30	25	10	30							2N524	417
2N565	x		x		150	A	85	30	25	30	50							2N43A	123
2N566	x		x		120	A	85	30	25	30	50							2N525	417
2N567	x		x		150	A	85	30	25	50	70							2N526	417
2N568	x		x		120	A	85	30	25	50	70							2N526	417
2N569	x		x		150	A	85	30	20	70	100							2N241A	123
2N570	x		x		120	A	85	30	20	70	100							2N527	417
2N571	x		x		150	A	85	30	10	100								2N508	413
2N572	x		x		120	A	85	30	10	100								2N508	413
2N578	x		x		120	A	71	20		10		400	0.3	400		3.0		2N396	123
2N579	x		x		120	A	71	20		20		400	0.3	400		5.0		2N396	123
2N580	x		x		120	A	71	20		30		400	0.3	400		10		2N397	123
2N581	x		x		80	A	71	18		20		20		20		4.0		2N396	123
2N582	x		x		120	A	71	25		40		20	0.3	100		14		2N397	123
2N583	x		x		80	A	71	18		20		20		20		4.0		2N396	123
2N584	x		x		120	A	71	25		40		20	0.3	100		14		2N397	123
2N586	x		x		250	A	85	45		35		250	0.5	250				2N525	417
2N591	x		x		50	A	71	32	32									2N324	123
2N592	x		x		125	A	85	20	20	20								2N1414	442
2N593	x		x		125	A	85	40	30	30								2N1414	442
2N597	x		x		250	A	100	45	40	40		100	0.2	10		3.0		2N526	417
2N599	x		x		250	A	100	30	20	100		100	0.2	10		10		2N508	413
N602	x		x		120	A	85	20	20	20	80		0.25	10		10		2N396	123
N603	x		x		120	A	85	30	20	30	100		0.25	15		30		2N396	123
N604	x		x		120	A	85	30	20	40	140		0.25	20		50		2N397	123
N605	x		x		.12W	A	85	15	15									2N396	123
N606	x		x		.12W	A	85	15	15									2N396	123
N607	x		x		.12W	A	85	15	15									2N396	123
N608	x		x		.12W	A	85	15	15									2N396	123
N609	x		x		180	A	85	25	15									2N321	123
N610	x		x		180	A	85	25	15									2N320	123
N611	x		x		180	A	85	25	15									2N320	123
N612	x		x		180	A	85	25	15									2N319	123
N613	x		x		180	A	85	25	15									2N320	123
N614	x		x		180	A	85	20	15									2N396	123
N615	x		x		180	A	85	20	15									2N396	123
N616	x		x		180	A	85	15	12									2N396	123
N617	x		x		180	A	85	15	12									2N396	123
N631	x		x		167	A	85	25	20									2N508	413
N632	x		x		167	A	85	36	20									2N324	123
N633	x		x		167	A	85	35	30									2N323	123
N650	x		x		200	A	100	45	30	30		10	0.25	50	30	0.75		2N1924	458
N650A	x		x		200	A	100	45	30	33		10	0.25	50	30	0.75		2N1924	458
N651	x		x		200	A	100	45	30	45		10	0.25	50	50	1.0		2N1925	458
N652	x		x		200	A	100	45	30	80		10	0.25	50	100			2N1925	458
N652A	x		x		200	A	100	45	30	80		10	0.25	50	100			2N1926	458
N653	x		x		200	A	100	30	25	20		10			30			2N1926	458
N654	x		x		200	A	100	30	25	40		10			50			2N1414	442
N655	x		x		200	A	100	30	25	70		10			100			2N1175	434
N656		x		x	4W	C	200	60	60	30	90	200						D40D7	1233
N656A		x		x	5W	C	200	60	60	30	90	200						D40D7	1233
N657		x		x	4W	C	200	100	100	30	90	200						D40N1	1237
N658	x		x		167	A	85	25	16	25	80		3.45	150		2.5		2N396	123
N659	x		x		167	A	85	25	14	40	110		3.5	250		5.0		2N396	123
N660	x		x		167	A	85	25	11	60	150		3.5	400		10		2N397	123
N662	x		x		167	A	85	25	11	30			3.4	180		4.0		2N396	123
N380	x		x		150	A	75	20	20	18	165	50	0.75	50	15		420	2N1413	442
N681					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157												420		
N682																	420		
N683																	420		
N684																	420		
N685																	420		
N686																	420		
N687																	420		
N688																	420		
N689																	420		
N690																	420		
N691																	420		
N692																			

Type	Germanium	Silicon	PNP	NPN	Maximum Ratings					Electrical Characteristics							Exact "2N" Type Page	Suggested GE Replacement	
					P_D @ 25°C (mw)	PT.	T_J °C	V_{CB} (V)	V_{CEO} (V)	h_{FE} Max.	h_{FE} Min.	@ I_C (mA)	$V_{CE(SAT)}$ (V)	@ I_C	h_{fe}	f_T Typical (MHz)		Type	Page
2N696A		x		x	800	A	300	60	35	20	60	150	1.5	150	15	40		D40D4	1233
2N697		x		x	600	A	175	60	40	40	120	150	1.5	150	15	40		GET2221	1296
2N697A		x		x	800	A	300	60	35	40	120	150	1.5	150	25	50		D40D4	1233
2N698		x		x	800	A	200	120	80	20	60	150	1.2	50	15	40		D40D7	1233
2N699		x		x	600	A	175	120	80	40	120	150	5.0	150	35	50		2N6014	694
2N702		x		x	300	A	175	25	25	20	60	10	0.5	10		70		GET2221	1364
2N703		x		x	300	A	175	25	25	40	100	10	0.5	10		70		GET2221	1364
2N705	x		x		300	C	100	15	15	25		10	0.3	10				2N6001	674
2N706		x		x	300	A	175	25	20	20		10	0.6	10		200		GET706	1288
2N706A		x		x	300	A	175	25	20	20	60	10	0.6	10		200		GET706	1288
2N706B		x		x	300	A	175	25	15	20	60	10	0.4	10		200		GET706	1288
2N708		x		x	360	A	200	40	20	30	120	10	0.4	10		300		GET708	1288
2N718		x		x	400	A	175	60	40	40	120	150	1.5	150		50		GET2221	1296
2N718A		x		x	500	A	200	75	50	40	120	150	1.5	150	30	60		GET2221	1296
2N728		x		x	4W	A	175	15	15	20	200	10	0.7	10		100		2N6000	670
2N729		x		x	4W	A	175	30	30	20	200	10	0.7	10		100		2N6000	670
2N753		x		x	300	A	175		20	40	120	10	0.6	10		200		GET914	1288
2N759		x		x	500	A	200	45	45				1.0	10	36	50		2N6004	678
2N760		x		x	500	A	200	45	45				1.0	10	76	50		2N6004	678
2N869		x		x	360	A	200	25	18	20	120	10	1.0	10		100		2N6000	670
2N877-81					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157												425		
2N885-89																	425		
2N890																	425		
2N891																	425		
2N911		x		x	500	A	200	100	80	35		10	0.4	10	36	50		2N6000	670
2N912		x		x	500	A	200	100	80	15		10	0.4	10	18	40		2N6000	670
2N914		x		x	360	A	200	40	20	30	120	10	0.7	200		300		GET914	1288
2N915		x		x	360	A	200	70	50	50	200	10	1.0	10	50	250		2N6004	678
2N916		x		x	360	A	200	45	25	50	200	10	0.5	10	50	300		2N6000	670
2N929		x		x	600	C	175	45	45	40	120	.01	1.0	10	150	1.0		GET929	1292
2N930		x		x	600	C	175	45	45	100	300	.01	1.0	10	150	1.0		GET930	1292
2N956		x		x	500	A	200	75	50	100	300	150	1.5	150	50	70		GET2221	1296
2N995		x	x		360	A	200	20	15	35	140	20	0.2	20		100		2N6001	674
2N997		x		x	360	A	175	20	40	35		.10	1.6	100			432		
2N998		x		x	360	A	200	100	60				1.2	50	1000		433		
2N999		x		x	360	A	200	60	60				1.6	100			432		
2N1008	x		x		300	C	85	20	15				.25	100				2N1415	442
2N1008A	x		x		300	C	85	40	35				.25	100	40			2N526	417
2N1008B	x		x		300	C	85	60	55				.25	100	40			2N1925	458
2N1009	x		x		400	C	85	35	35				.25	100	40	7.5		2N396	123
2N1015		x		x	150	C	150	30	30	10		2.0	1.5	2A				GET2221	1296
2N1015A		x		x	150	C	150	60	60	10		2.0	1.5	2A				2N6015	698
2N1047		x		x	40W	C	200	80		12	36	500	7.5					D44C7	1255
2N1049		x		x	40W	C	200	80		30	90	500	7.5	500				D44C8	1255
2N1050		x		x	40W	C	200	120		30	90	500	7.5	500				D44R1	1261
2N1056	x		x		240	A	100	70	50	18	43	20	0.13	20		500		2N1924	458
2N1057	x		x		240	A	100	45	45	34	90	20	0.13	20		500		2N1924	458
2N1058	x			x	50		75	20	20						10	4.0		2N5825	657
2N1059	x			x	180		75	40	15			10				10		2N5826	657
2N1067		x		x	5W	C	175	60	30	15	75	200	2.0	200		0.75		D40D1	1233
2N1068		x		x	10W	C	175	60	30	15	75	750	2.0	200		0.75		D40D1	1233
2N1069		x		x	50W	C	175	60	45	20	50	1.5	1.33	0.5		0.5		D44C6	1255
2N1070		x		x	50W	C	175	60	45	20	50	1.5	0.5	1.5		0.5		D44C8	1255
2N1084																		D43C5	1251
2N1085																		D40D5	1233
2N1090	x			x	120	A	85	25		30		20	0.2	20		5.0		GET708	1288
2N1091	x			x	120	A	85	25		40		20	0.3	200		10		GET914	1288
2N1092		x		x	2W	A	175	60	30	15	75	200	2.0	200		0.75		D42C1	1247
2N1093	x		x		150	A	95	30	15	50	150	20	0.2	20	40	5.0		2N1307	436
2N1097	x		x		200	A	100	18	18	34	90	20				1.0		2N1414	442
2N1098	x		x		200	A	100	18	18	25	90	20				1.0		2N1415	442
2N1102	x			x	180		75	40	25	25	50	35	0.5	100		10		GET914	1288
2N1107	x		x		30	C		16								40		2N6001	674
2N1108	x		x		30	C		16								35		2N6001	674
2N1109	x		x		30	C		16								35		2N6001	674
2N1110	x		x		30	C		16								35		2N6001	674
2N1115	x		x		150	A	85	20	15				0.35	60		5.0		2N396	123
2N1128	x		x		150	A	85	25	18						70			2N324	123
2N1129	x		x		150	A	85	25	25	100	200	100	0.25	100				2N508	413
2N1130	x		x		150	A	85	30		50	165	100	0.25	100				2N1926	458

Type	Germanium	Silicon	PNP	NPN	Maximum Ratings					Electrical Characteristics							Exact "2N" Type Page	Suggested GE Replacement	
					P_D @ 25°C (mw)	PT.	T_J °C	V_{CB} (V)	V_{CEO} (V)	h_{FE} Max.	h_{FE} Min.	@ I_C (mA)	$V_{CE(SAT)}$ @ I_C (V)		h_{fe}	f_T Typical (MHz)		Type	Page
N1144	x		x		175	A	85	16	16	34	90	20				1.0		2N1414	442
N1145	x		x		175	A	85	16	16	25	90	20				1.0		2N1415	442
N1149		x		x	150	A	175	45		9.0	20	25			0.9	4.0		2N5824	657
N1150		x		x	150	A	175	45		18	40	25			.948	5.0		2N5827	662
N1151		x		x	150	A	175	45		18	90	25			.948	8.0		2N5827	662
N1153		x		x	150	A	175	45		76	333	25			.987	7.0		2N5827	662
N1155		x		x	750	C	150	80		9.0		50			0.9			2N6014	694
N1171	x		x		170	A	85	30	12	30		30				10		2N397	123
N1175	x		x		200	A	85	35	25	70	140	20				1.5	434		
N1175A	x		x		200	A	85	35	25	70	140	20				1.5	434		
N1177	x		x		80	A	71	30										2N6001	674
N1186	x		x		200	A	100	60	45			10			30	0.75		2N1924	458
N1187	x		x		200	A	100	60	45	45		10			50	1.0		2N1926	458
N1188	x		x		200	A	100	60	45	80		10			100	1.2		2N1926	458
N1191	x		x		200	A	100	40	25	20	80	10			30			2N1414	442
N1192	x		x		200	A	100	40	25	40	135	10			50			2N1175	434
N1193	x		x		200	A	100	40	25	70	300	10			100			2N508	413
N1206		x		x	3W	A	200	60	60	20	80				25	10		D40D7	1233
N1265	x		x		50	A	85	12	10				0.5	100	25	600		2N1414	442
N1266	x		x		80	A	85	10							10			2N1415	442
N1273	x		x		250	A	100	15	15	27	165	50	1.0	100	20			2N1414	442
N1274	x		x		250	A	100	25	25	27	165	50	1.0	100	20			2N1414	442
N1280	x		x		200	A	85	16	16	40		20				5.0		2N396	123
N1281	x		x		200	A	85	16	12	60		20				7.0		2N396	123
N1282	x		x		200	A	85	16	6.0	70		20				10		2N397	123
N1284	x		x		150	A	85	20	15	30	150	10	0.2	10		5.0		2N396	123
N1287	x		x		300	C	85	25	25				0.5	20	40			2N526	417
N1287A	x		x		300	C	85	25	25				0.5	20	60			2N527	417
N1303	x		x		150	A	85	30		20		10	0.2	10		3.0	436		
N1305	x		x		150	A	85	30		40	200	10	0.2	10		5.0	436		
N1307	x		x		150	A	85	30		60	300	10	0.2	10		10	436		
N1313	x		x		180	A	100	30	15	40	125		0.28	0.3		6.0		2N396	123
N1316	x		x		200	A	85	30	15	50	200					10		2N397	123
N1317	x		x		200	A	85	20	12	45	180					10		2N397	123
N1318	x		x		200	A	85	10	6.0	40	150					10		2N396	123
N1335		x		x	800	A	175	120	45	10	150	30				70		D44R1	1261
N1336		x		x	800	A	175	120	45	10	150	30				70		D44R1	1261
N1337		x		x	800	A	175	120	45	10	150	30				70		D44R1	1261
N1338		x		x	800	A	175	80	25	10	150	30				70		D44R1	1261
N1339		x		x	800	A	175	120	50	10	150	30				70		D44R1	1261
N1340		x		x	800	A	175	120	50	10	150	30				70		D44R1	1261
N1341		x		x	800	A	175	120	50	10	150	30				70		D44R1	1261
N1342		x		x	800	A	175	150	65	10	150	30				70		D44R1	1261
N1344	x		x		150	A	85	15	10	60		20				7.0		2N397	123
N1345	x		x		150	A	85	10	8.0	30	100	.4W				10		2N397	123
N1346	x		x		150	A	85	12	10	40	250	.35	.13	12		10		2N397	123
N1347	x		x		150	A	85	20	12	30		10	0.2	10		5.0		2N396	123
N1348																		2N1305	436
N1352	x		x		150	A	85	30	20	40	100							2N526	417
N1353	x		x		200	A	85	15	10	25	150	10	0.2	50		1.5		2N396	123
N1354	x		x		200	A	85	30	15	25	150	10	0.2	50		3.0		2N396	123
N1355	x		x		200	A	85	30	20	30	150	10	0.2	50		5.0		2N396	123
N1356	x		x		200	A	100	30	20	40	140	10	0.2	50		5.0		2N397	123
N1357	x		x		200	A	85	30	15	40	150	10	0.2	50		10		2N397	123
N1366	x			x	100	A	85	18	18	20		1.0			10	5.0		2N397	123
N1382	x		x		250	A	100	25	25	45	165	50	1.0	100	40			2N1415	442
N1383	x		x		250	A	100	25	25	27	165	50	1.0	100	20			2N1414	442
N1404	x		x		150	A	85	25					.15	12		4.0		2N404	401
N1408	x		x		150	A	100	50	50	10					10			2N1924	458
N1409		x		x	800	A	200	30	25	15	45	150				200		D40D1	1233
N1410A		x		x	800	A	200	30	30	30	90	150				130		D40D1	1233
N1413	x		x		200	A	85	35	25	25	42	20			20	800	442		
N1414	x		x		200	A	85	35	25	34	65	20			30	1.0	442		
N1415	x		x		200	A	85	35	25	53	90	20			44	1.3	442		
N1420A		x		x	800	A	200	60	40	100	300	150	1.5	150		60		2N6014	694
N1445		x		x	4W	C	200	120	120	20	80	200	4.0	200		75		D44R1	1261
N1446	x		x		200	A	85	45	25	16	45	20			16	0.8		2N524	417
N1447	x		x		200	A	85	45	25	35	65	20			30	1.5		2N525	417
N1448	x		x		200	A	85	45	25	50	90	20			45	2.0		2N526	417
N1449	x		x		200	A	85	45	25	70	125	20			60	2.5		2N527	417

Type	Germanium	Silicon	PNP	NPN	Maximum Ratings P					Electrical Characteristics							Exact "2N" Type Page	Suggested GE Replacement	
					P_D @ 25°C (mw)	PT.	T_J °C	V_{CB} (V)	V_{CEO} (V)	h_{FE} Max.	h_{FE} Min.	@ I_C (mA)	$V_{CE(SAT)}$ (V)	@ I_C	h_{fe}	f_T Typical (MHz)		Type	Page
2N1451	x		x		200	A	85	45	20	20	65	20						2N1413	442
2N1452	x		x		200	A	85	45	20	30	90	20						2N1414	442
2N1470		x		x	55W	C	200	60	60	15		1.0	3.0	1.0				D44C8	1255
2N1471	x		x		200	A	85	12	15						100	3.0		2N508	413
2N1478	x		x		250	A	100	30	20	40		100	0.2	10		3.0		2N396	123
2N1479		x		x	5W	C	200	60	60	20	60	200	1.4	200				D40D4	1233
2N1480		x		x	5W	C	200	100	100	20	60	200	1.4	200				D40D4	1233
2N1481		x		x	5W	C	200	60	60	35	100	200	1.4	200				D40D4	1233
2N1482		x		x	5W	C	200	100	100	35	100	200	1.4	200				D40D7	1233
2N1483		x		x	25W	C	200	60	60	25	60	750	2.0	750				D44C5	1255
2N1484		x		x	25W	C	200	100	100	20	60	750	2.0	750				D44C8	1255
2N1485		x		x	25W	C	200	60	60	35	100	750	.75	750				D44C5	1255
2N1486		x		x	25W	C	200	100	100	35	100	750	.75	750				D44C8	1255
2N1505		x		x	800	A	175	50	20	7.0	100	0.1	2.0	.15		70		D40D3	1233
2N1506		x		x	800	A	175	60	20	10	100	0.1	1.5	.15		140		D40D3	1233
2N1506A		x		x	800	A	200	80	50	10	100	0.1	0.6	.15		140		D40D7	1233
2N1524	x		x		80	A	85	24							17			2N1924	458
2N1525	x		x		80	A	85	24							17			2N1925	458
2N1595					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157												446		
2N1595A																	446		
2N1596																	446		
2N1596A																	446		
2N1597																	446		
2N1597A																	446		
2N1598																	446		
2N1598A																	446		
2N1599																	446		
2N1599A																	446		
2N1613		x		x	800	A	200	75	50	40	120	150	1.5	150	30	60		2N6014	694
2N1613A		x		x	1W	A	200	75	50	40	120	150	1.0	150	30	60		D40D7	1233
2N1613B		x		x	1W	A	200	120	55	40	120	150	0.2	150	30	60		D40D7	1233
2N1671					UNIJUNCTIONS - FOR OTHER TYPES SEE SELECTOR GUIDE P 124												450		
2N1671A																	450		
2N1671B																	450		
2N1671C																	450		
2N1684	x		x		100	A	100	25	25				.15	12		4.0		2N397	123
2N1691		x		x	40	C	200	120	120	20	60	500	7.5			90		D44R1	1261
2N1700		x		x	5W	C	200	60	60	20	80	100	12.5	2.5		0.4		D40D4	1233
2N1701		x		x	25W	C	200	60	60	20	80	300	20	5.0		0.35		D44C4	1255
2N1705	x		x		200	A	100	18	12						70			2N527	417
2N1706	x		x		200	A	100	25	18	60	120	20			50			2N527	417
2N1707	x		x		200	A	100	30	25	30	150	10			40			2N527	417
2N1708		x		x	1W	C	175	25	12	20		10	.22	10		200			
2N1709		x		x	15W	C	175	75	30	7.5	75	.35	5.0	1.0		175		D42C7	1247
2N1710		x		x	15W	C	175	60	30	4.0	100	.35	5.0	1.0		140		D42C4	1247
2N1711		x		x	800	A	200	75	50	100	300	150	1.5	150	50	70		D40D5	1233
2N1711A		x		x	1W	A	200	75	50	100	300	150	1.0	150	50	70		D40D7	1233
2N1711B		x		x	1W	A	200	120	55	100	300	150	0.2	150	50	70		D40D7	1233
2N1714		x		x	20W	C	175	90	60	20	60	200	2.0	200		16		D40D7	1233
2N1715		x		x	20W	C	175	150	100	20	60	200	2.0	200		16		D44R1	1261
2N1716		x		x	20W	C	175	90	60	40	120	200	2.0	200		16		D40D7	1233
2N1717		x		x	20W	C	175	150	100	40	120	200	2.0	200		16		D44R1	1261
2N1718		x		x	20W	C	175	90	60	20	60	200	2.0	200		16		D44C7	1255
2N1720		x		x	20W	C	175	90	60	40	120	200	2.0	200		16		D44C8	1255
2N1768		x		x	40W	C	200	60	40	35	100	750	.75	750		600		D44C6	1255
2N1769		x		x	40W	C	200	100	55	35	100	750	.75	750		600		D44C8	1255
2N1770					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157												894		
2N1770A																	890		
2N1771																	894		
2N1771A																	890		
2N1772																	894		
2N1772A																	890		
2N1773																	894		
2N1773A																	890		
2N1774																	894		
2N1774A																	890		
2N1775																	894		
2N1775A																	890		
2N1776																	894		
2N1776A																	890		
2N1777																			

Type	Germanium	Silicon	PNP	NPN	Maximum Ratings P_D @ 25°C (mw)	PT.	T_J °C	V_{CB} (V)	V_{CEO} (V)	Electrical Characteristics h_{FE} Max.	h_{FE} Min.	@ I_C (mA)	$V_{CE(SAT)}$ (V)	@ I_C	h_{fe}	f_T Typical (MHz)	Exact "2N" Type Page	Suggested GE Replacement Type	Page
2N1777A					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157												890		
2N1778																	894		
2N1792																	894		
2N1793																	894		
2N1794																	894		
2N1795																	894		
2N1796																	894		
2N1797																	894		
2N1798																	894		
2N1799																		C52E	943
2N1800																		C52M	943
2N1801																		C52S	943
2N1802																		C52N	943
2N1803																		C52T	943
2N1804																		C152P	1011
2N1805																		C50E	943
2N1806																		C50M	943
2N1807																		C50S	943
2N1837A		x		x	800	A	175	80	30	40	120	.15	0.8	.15		140		D40D1	1233
2N1842					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157												454		
2N1843																	454		
2N1844																	454		
2N1845																	454		
2N1846																	454		
2N1847																	454		
2N1848																	454		
2N1849																	454		
2N1850																	454		
2N1869																		2N2322	880
2N1869A																		2N2322	880
2N1870																		2N2323	880
2N1870A																		2N2323	880
2N1871																		2N2324	880
2N1871A																		2N2324	880
2N1872																		2N2324	880
2N1872A																		2N2324	880
2N1873																		2N2325	880
2N1873A																		2N2325	880
2N1874																		2N2326	880
2N1875																		2N2322A	880
2N1876																		2N2323A	880
2N1877																		2N2324A	880
2N1878																		2N2324A	880
2N1879																		2N2325A	880
2N1880																		2N2326A	880
2N1881																		C6F	886
2N1882																		C6A	886
2N1883																		C6A	886
2N1884																		C6G	886
2N1885																		C6B	886
2N1886		x		x	20W	C	175	60	60	20	80	0.5	5.0	1.0		2.0		D44C8	1255
2N1889		x		x	800	A	200	100	80	40	120	150	5.0	150	30	50		D40D7	1233
2N1890		x		x	800	A	200	100	80	100	300	150	5.0	150	50	60		D40D8	1233
2N1893		x		x	800	A	200	120	100	40	120	150	5.0	150	30	50		D44R1	1261
2N1909					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157												943		
2N1910																	943		
2N1911																	943		
2N1912																	943		
2N1913																	943		
2N1914																	943		
2N1915																	943		
2N1916																	943		
2N1924	x		x		225	A	100	60	40	34	65	20	.11	20	30	1.0	458		
2N1925	x		x		225	A	100	60	40	53	90	20	.11	20	44	1.3	458		
2N1926	x		x		225	A	100	60	40	72	121	20	.11	20	60	1.5	458		
2N1929																	123		
2N1943		x		x	800	A	200	60	60	30	90	200	5.0	200	12			D40D7	1233
2N1969	x		x		150	A	85	30	15	50	200					10		2N1307	436
2N1973		x		x	800	A	200	100	80	75		10	1.2	50	76	60		D40D8	1233
2N1974		x		x	800	A	200	100	80	35		10	1.2	50	36	50		D40D7	1233

Type	Germanium	Silicon	PNP	NPN	Maximum Ratings					Electrical Characteristics							Exact "2N" Type Page	Suggested GE Replacement	
					P_D @ 25°C (mw)	PT.	T_J °C	V_{CB} (V)	V_{CEO} (V)	h_{FE} Max.	h_{FE} Min.	@ I_C (mA)	$V_{CE(SAT)}$ (V)	@ I_C	h_{fe}	f_T Typical (MHz)		Type	Page
2N1975		x		x	800	A	200	100	80	15		10	1.2	50	18	40		D40N1	1237
2N1997	x		x		250	A	100	45	15	40	200	100	0.2	10		3.0		2N527	417
2N1998	x		x		250	A	100	35	15	70	225	100	0.2	10		5.6		2N527	417
2N2997		x		x	800	A	200	175	110	30	90	10	2.5	25	20	40		D44R1	1261
2N2009					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157													2N2322	880
2N2010																		2N2323	880
2N2011																		2N2324	880
2N2012																		2N2326	880
2N2013																		2N2328	880
2N2014																		2N2329	880
2N2017		x		x	1W	A	200	60	60	50	200	200			30			D40D7	1233
2N2023					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157												949		
2N2024																	949		
2N2025																	949		
2N2026																	949		
2N2027																	949		
2N2028																	949		
2N2029																	949		
2N2030																	949		
2N2033		x		x	5W	C	200	80	60	20	60	500	0.4	500		1.0		D42C8	1247
2N2034		x		x	14W	C	200	80	60	20	60	1.0	0.3	1.0		1.0		D42C8	1247
2N2035		x		x	17W	C	200	80	60	20	60	1.5	.45	1.5		1.0		D44C7	1255
2N2036		x		x	17.5W	C	200	80	60	20	60	2.0	1.0	2.0		1.0		D44C8	1255
2N2060		x		x	500	A	200	100	80	50	150	10	1.2	50	50	60	462		
2N2094	x		x		100	A	85	25	25	40		1.0	—		40	30		D40D8	1233
2N2102		x		x	5W	C	200	120	80	35		10	0.5	150	35			D44C8	1255
2N2102A		x		x	1W	A	200	120	65	40	120	150	0.3	150	30			D40D7	1233
2N2106		x		x	1W	A	150	60	60	12	36	200	5.0	200				D40D7	1233
2N2107		x		x	1W	A	150	60	60	30	90	200	2.0	200				D40D7	1233
2N2108		x		x	1W	A	150	60	60	75	200	200	2.0	200				D40D7	1233
2N2160																	463		
2N2171	x		x		200	A	100	50	25	110	250	20			120			2N508A	413
2N2172	x		x		200	A	85	20	15	30	150	10	0.2	10	.97	5.0		2N524	417
2N2173	x		x		240	A	100	25	15	30		200	0.4	200				2N527	417
2N2192		x		x	800	A	200	60	40	100	300	150	.35	150				D40D4	1233
2N2192A		x		x	800	A	200	60	40	100	300	150	.25	150				D40D4	1233
2N2192B		x		x	800	A	200	60	40	100	300	150	.18	150				D40D4	1233
2N2193		x		x	800	A	200	80	50	40	120	150	.35	150				D40D7	1233
2N2193A		x		x	800	A	200	80	50	40	120	150	.25	150				D40D7	1233
2N2193B		x		x	800	A	200	80	50	40	120	150	.18	150				D40D7	1233
2N2194		x		x	800	A	200	60	40	20	60	150	.35	150				D40D4	1233
2N2194A		x		x	800	A	200	60	40	20	60	150	.25	150				D40D4	1233
2N2194B		x		x	800	A	200	60	40	20	60	150	.18	150				D40D4	1233
2N2196		x		x	2W	A	175	80	60	30	90	0.2	2.0	0.2	30			D44C7	1255
2N2197		x		x	2W	A	175	80	60	75	200	0.2	2.0	0.2	30			D44C7	1255
2N2218		x		x	800	A	175	60	30	40	120	150	0.4	150		250		GET2221	1296
2N2218A		x		x	800	A	175	75	40	40	120	.15	0.3	.15	30	250		GET2221A	1298
2N2219		x		x	800	A	175	60	30	100	300	150	0.4	150		250		GET2222	1296
2N2219A		x		x	800	A	175	75	40	100	200	.15	0.3	.15	50	300		GET2222A	1298
2N2221		x		x	500	A	175	60	30	40	120	150	0.4	150		250		GET2221	1296
2N2221A		x		x	500	A	175	75	40	40	120	.15	0.3	.15	30	250		GET2221A	1298
2N2222		x		x	500	A	175	60	30	100	300	150	0.4	150		250		GET2222	1296
2N2222A		x		x	500	A	175	75	40	100	300	.15	0.3	.15	50	300		GET2222A	1298
2N2223		x		x	500	A	200	100	80	50	200	10	1.2	50	40	50	465		
2N2223A		x		x	500	A	200	100	80	50	200	10	1.2	50	40	50	465		
2N2224		x		x	800	A	175	65	40	35	115	10	0.4	150		250		D40D4	1233
2N2239		x		x	1W	A	150	60	50	30	200	200	3.0	200				D40D7	1233
2N2270		x		x	5W	C	200	60	45	30		1.0	0.9	150	50			D40D4	1233
2N2297		x		x	800	A	200	80	35	40	120	150	0.2	150		60		D40D4	1233
2N2322					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157												880		
2N2322A																	880		
2N2323																	880		
2N2323A																	880		
2N2324																	880		
2N2324A																	880		
2N2325																	880		
2N2325A																	880		
2N2326																	880		

Type	Germanium	Silicon	PNP	NPN	Maximum Ratings					Electrical Characteristics							Exact "2N" Type Page	Suggested GE Replacement	
					P_D @ 25°C (mw)	PT.	T_J °C	V_{CB} (V)	V_{CEO} (V)	h_{FE} Max.	Min.	@ I_C (mA)	$V_{CE(SAT)}$ (V)	@ I_C	h_{fe}	f_T Typical (MHz)		Type	Page
2N2326A					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157												880		
2N2327																	880		
2N2327A																	880		
2N2328																	880		
2N2328A																	880		
2N2329																	880		
2N2329A																	880		
2N2330		x		x	800	A	150	30	20	50	10					100		D40D1	1233
2N2339		x		x	40W	C	200	60	40	6.0		1.5	1.5	0.3	12	0.7		D44C4	1255
2N2344					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157												467		
2N2345																	467		
2N2346																	467		
2N2347																	467		
2N2348																	467		
2N2356		x		x	600	A	200	25	7.0							50	35.10*		
2N2356A		x		x	600	A	200	25	7.0							50	35.10*		
2N2369		x		x	360	A	200	40	40	40	120	10	.25	10		500		GET2369	1300
2N2374	x		x		250	A	100	35	35	100	300	100			100			2N508A	413
2N2375	x		x		250	A	100	35	35	35	110	100			35			2N526	417
2N2376	x		x		250	A	100	35	35	35	110	100			35			2N526	417
2N2410		x		x	800	A	200	60	30	30	120	10				200		D40D1	1233
2N2417					UNIJUNCTIONS - FOR OTHER TYPES SEE SELECTOR GUIDE P 124												405		
2N2417A																	405		
2N2417B																	405		
2N2418																	405		
2N2418A																	405		
2N2418B																	405		
2N2419																	405		
2N2419A																	405		
2N2419B																	405		
2N2420																	405		
2N2420A																	405		
2N2420B																	405		
2N2421																	405		
2N2421A																	405		
2N2421B																	405		
2N2422																	405		
2N2422A																	405		
2N2422B																	405		
2N2430	x			x	280	A	75	32	32	60	210	0.1				10		2N527	417
2N443		x		x	800	A	200	120	100	50	150	50	1.2	50	45	50		D44R1	1261
2N447	x		x		75	A	85	45	24						25			2N1415	442
2N448	x		x		75	A	85	45	24						25			2N1415	442
2N449	x		x		75	A	85	35	20						50			2N527	417
2N2453		x		x	500	A	200	60	30	150	600	1.0	1.0	5.0	150	60	471		
2N2453A		x		x	500	A	200	80	50	150	600	1.0	1.0	5.0	150	60	471		
2N2480		x		x	500	A	200	75	40	30	350	1.0	1.3	50		50	473		
2N2480A		x		x	500	A	200	80	40	50	200	1.0	1.2	50	50	50	473		
2N2483		x		x	360	A	200	60	60	40	120	10	.35	1.0	80	12		GET2483	1302
2N2484		x		x	360	A	200	60	60	100	500	10	.35	1.0	150	15		GET2484	1302
2N2503					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157													C178F	*
2N2504																		C178A	*
2N2505																		C178B	*
2N2506																		C178C	*
2N2507																		C178D	*
2N2508																		C178E	*
2N2537		x		x	800	A	200	60	30	50	150	150	.45	150		250		D40D1	1233
2N2538		x		x	800	A	200	60	30	100	300	150	.45	150		250		D40D1	1233
2N2573					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157													C38U	930
2N2574																		C38F	930
2N2575																		C38A	930
2N2576																		C38B	930
2N2577																		C38C	930
2N2578																		C38D	930
2N2579																		C38E	930
2N2594		x		x	5.0	C	200	80	90	50	150	100	1.0	200	15	40		D40D7	1233
2N2619																	894		
2N2632		x		x	40	C	175	90	60	40	120	1.0	.25	1.0	40	20		D44C8	1255
2N2639		x		x	300	A	200	45	45	50	300	10	1.0	10	65	35	475		
2N2640		x		x	300	A	200	45	45	50	300	10	1.0	10	65	35	475		

* = Contact Factory

Type	Germanium	Silicon	PNP	NPN	Maximum Ratings					Electrical Characteristics							Exact "2N" Type Page	Suggested GE Replacement	
					P_D @ 25°C (mw)	PT.	T_J °C	V_{CB} (V)	V_{CEO} (V)	h_{FE} Max.	h_{FE} Min.	@ I_C (mA)	$V_{CE(SAT)}$ (V)	@ I_C	h_{fe}	f_T Typical (MHz)		Type	Page
2N2641		x		x	300	A	200	45	45	50	300	10	1.0	10	65	35	475		
2N2642		x		x	300	A	200	45	45	100	300	10	1.0	10	130	35	475		
2N2643		x		x	300	A	200	45	45	100	300	10	1.0	10	130	35	475		
2N2644		x		x	300	A	200	45	45	100	300	10	1.0	10	130	35	475		
2N2646					UNIJUNCTIONS - FOR OTHER TYPES SEE SELECTOR GUIDE P 124												477		
2N2647																	477		
2N2652		x		x	300	A	200	100	60	50	200	1.0	1.2	50	50	60	481		
2N2652A		x		x	300	A	200	100	60	50	200	1.0	1.2	50	50	60	481		
2N2657		x		x	1.25W	A	200	80	60	40	120	1.0	0.5	1.0		20		D42C7	1247
2N2699	x		x		150	A	100	15	8.0	40	200	10	.18	10		300		D42C8	1247
2N2711		x		x	200	A	125	18	18	30	90	2.0			30		482		
2N2712		x		x	200	A	125	18	18	75	225	2.0			80		482		
2N2713		x		x	200	A	125	18	18	30	90	2.0	0.3	50	30		484		
2N2714		x		x	200	A	125	18	18	75	225	2.0	0.3	50	80		484		
2N2720		x		x	300	A	200	80	60	30	120	0.1	1.0	10	30	80		2N2652A	481
2N2721		x		x	300	A	200	80	60	30	120	0.1	1.0	10	30	80		2N2652	481
2N2722		x		x	300	A	200	45	45	50	250	1.0	1.0	10	100	100		2N2642	475
2N2723		x		x	500	A	200	80	60	2	10	10	1.0	10	1500	100		D40C7	1229
2N2724		x		x	500	A	200	80	60	7	50	10	1.0	10	5000	100		D40C7	1229
2N2725		x		x	500	A	200	45	45	2	10	0.1	1.0	10	1500	100		D40C8	1229
2N2726		x		x	1W	A	200	200	200	30	90	0.2	2.0	0.2	30	15		D40C7	1229
2N2727		x		x	1W	A	200	200	200	75	150	0.2	2.0	0.2	75	15		D40C8	1229
2N2785		x		x	500	A	175	60	40	2	20	0.1	1.0	15	600	10	490		
2N2787		x		x	800	A	175	75	35	20	50	150	0.4	150	15	250		D40D4	1233
2N2788		x		x	800	A	175	75	35	40	120	150	0.4	150	30	250		D40D5	1233
2N2789		x		x	800	A	175	75	35	100	300	150	0.4	150	80	250		D40D5	1233
2N2800		x	x		800	A	200	50	35	30	90	150	0.4	150		120		D41D4	1243
2N2801		x	x		800	A	200	50	35	75	225	150	0.4	150		120		D41D4	1243
2N2828		x		x	40W	C	200	80	60	20	60	0.5	0.4	0.5		1.0		D44C5	1255
2N2829		x		x	40W	C	200	80	60	20	60	1.0	0.3	1.0		1.0		D44C8	1255
2N2840					UNIJUNCTIONS - FOR OTHER TYPES SEE SELECTOR GUIDE P 124												491		
2N2846		x		x	800	A	200	60	30	30	120	150	0.4	150		250		D40D1	1233
2N2848		x		x	800	A	200	60	20	40	140	150	0.4	150		250		D40D1	1233
2N2853-1		x		x	850	A	200	60	40	40		1.0	1.5	5.0		30		D42C5	1247
2N2854-1		x		x	850	A	200	60	40	100	300	1.0	0.4	1.0		30		D42C3	1247
2N2855-1		x		x	850	A	200	60	40	40	120	1.0	0.4	1.0		30		D42C5	1247
2N2856-1		x		x	850	A	200	60	40	20	60	1.0	0.4	1.0		30		D42C5	1247
2N2863		x		x	800	A	200	60	25	30	200	200	1.0	500		150		D40D1	1233
2N2864		x		x	800	A	200	60	25	20	200	200	1.0	500		150		D40D1	1233
2N2868		x		x	800	A	200	60	40	40	120	.15	.25	.15				D40D4	1233
2N2875		x	x		20W	C	200	60	50	15	60	50	1.5	0.5	20	25		D45C8	1265
2N2876		x		x	17.5W	C	200	80	60	5.0		2.5	1.0	2.5		150		D42C7	1247
2N2877		x		x	53W	C	200	80	60	20	60	1.0	.25	1.0	20	30		D44C8	1255
2N2878		x		x	53W	C	200	80	60	40	120	1.0	.25	1.0	40	50		D44C8	1255
2N2883		x		x	800	A	200	40	20	20		100	0.5	100		400		D40D1	1233
2N2884		x		x	800	A	200	40	20	20		100	0.5	100		400		D40D1	1233
2N2888					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157													C140B	990
2N2889																		C140H	990
2N2903		x		x	600	C	200	60	30	125	625	1.0	1.0	5.0	150	60	168		
2N2904		x	x		3W	C	200	60	40	40	120	150	0.4	150		200		GET2904	1304
2N2905		x	x		3W	C	200	60	40	100	300	150	0.4	150		200		GET2905	1306
2N2906		x	x		1.8W	C	200	60	40	40	120	150	0.4	150		200		GET2906	1304
2N2907		x	x		1.8W	C	200	60	40	100	300	150	0.4	150		200		GET2907	1306
2N2910		x		x	300	A	200	45	25	70		0.1	1.0	10	50	11	494		
2N2913		x		x	300	A	200	45	45	60	240	10	.35	1.0		60	496		
2N2914		x		x	300	A	200	45	45	150	600	10	.35	1.0		60	496		
2N2915		x		x	300	A	200	45	45	60	240	10	.35	1.0		60	496		
2N2916		x		x	300	A	200	45	45	150	600	10	.35	1.0		60	496		
2N2917		x		x	300	A	200	45	45	60	240	10	.35	1.0		60	496		
2N2918		x		x	300	A	200	45	45	150	600	10	.35	1.0		60	496		
2N2919		x		x	300	A	200	60	60	60	240	10	.35	1.0		60	496		
2N2920		x		x	300	A	200	60	60	150	600	10	.35	1.0		60	496		
2N2923		x		x	200	A	125	25	25						90		498		
2N2924		x		x	200	A	125	25	25						150		498		
2N2925		x		x	200	A	125	25	25						235		498		
2N2926		x		x	200	A	125	18	18						35		499		
2N2927		x	x		800	A	200	25	25	30	130	50	.25	50	25	100		D41D1	1243
2N2939		x		x	800	A	300	75	60	60	240	.15	.75	.15		150		D40D8	1233
2N2941		x		x	800	A	200	150	100	60	240	.15				150		D44R1	1261
2N2947		x		x	25W	C	175	60	60	2.5	55	0.4	0.5	1.0		100		D44C7	1255

Type	Germanium	Silicon	PNP	NPN	Maximum Ratings					Electrical Characteristics							Exact "2N" Type Page	Suggested GE Replacement	
					P_D @ 25°C (mw)	PT.	T_J °C	V_{CB} (V)	V_{CEO} (V)	h_{FE} Max.	h_{FE} Min.	@ I_C (mA)	$V_{CE(SAT)}$ (V)	@ I_C	h_{fe}	f_T Typical (MHz)		Type	Page
2N2948		x		x	25W	C	175	40	40	2.5	100	0.4	0.5	1.0		100		D44C4	1255
2N2949		x		x	6W	C	175	60	60	5.0	100	40	0.5	0.4		100		D40D7	1233
2N2950		x		x	6W	C	175	60	60	5.0	100	40	0.5	0.4		100		D40D7	1233
2N2951		x		x	3W	C	175	60	60	20	150	10	0.5	.15		200		D40D7	1233
2N2952		x		x	1.8W	C	-75	60	60	20	150	10	0.5	.15		200		D40D7	1233
2N3008					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157													2N881	425
2N3013		x		x	360	A	200	40	15	30	120	30	.18	30		350		GET3013	1308
2N3014		x		x	360	A	200	40	20	30	120	30	.18	10		350		GET3014	1308
2N3015		x		x	800	A	200	60	30	30	120	150	0.4	150		250		D40D1	1233
2N3016		x		x	3.33W	C	150	100	50	60	150	1.0	.75	1.0		200		D40D7	1233
2N3017		x		x	3.33W	C	150	100	50	60	150	1.0	.75	5.0		200		D40D7	1233
2N3021		x	x		25W	C	175	30	30	20	60	1.0	1.5	3.0		60		D45C5	1265
2N3022		x	x		25W	C	175	45	45	20	60	1.0	1.5	3.0		60		D45C2	1265
2N3023		x	x		25W	C	175	60	60	20	60	1.0	1.5	3.0		60		D45C6	1265
2N3024		x	x		25W	C	175	30	30	50	180	1.0	1.0	3.0		60		D45C8	1265
2N3025		x	x		25W	C	175	45	45	50	180	1.0	1.0	3.0		60		D45C6	1265
2N3026		x	x		25W	C	175	60	60	50	180	1.0	1.0	3.0		60		D45C8	1265
2N3053		x		x	5W	C	200	60	40	50	250	.15	1.4	.15		100		D40D4	1233
2N3054		x		x	25W	C	200	90	60	25	100	0.5	1.0	0.5	25	30		D44C8	1255
2N3072		x	x		800	A	200	60	60	30	130	50	.25	50	25	130		D40D1	1233
2N3091					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157													C50M	943
2N3092																		C50S	943
2N3093																		C50N	943
2N3094																		C50T	943
2N3095																		C150P	1011
2N3096																		C150PA	1011
2N3097																		C150PB	1011
2N3098																		C150PC	1011
2N3099																		C50M	943
2N3100																		C50S	943
2N3101																		C50N	943
2N3102																		C50T	943
2N3103																		C150P	1011
2N3104																		C150PA	1011
2N3105																		C150PB	1011
2N3106																		C150PC	1011
2N3107		x		x	800	A	200	100	60	100	300	.15	1.0	1.0	60	70		D40D8	1233
2N3108		x		x	800	A	200	100	60	40	120	150	.25	150		60		D40D7	1233
2N3109		x		x	800	A	200	80	40	100	300	.15	1.0	1.0	60	70		D40D8	1233
2N3110		x		x	800	A	200	80	40	40	120	150	.25	150		60		D40D4	1233
2N3114		x		x	800	A	200	150	150	30	120	30	1.0	50	25	40		D44R1	1261
2N3118		x		x	1W	A	200	85	60	50	275	25				250		D40D7	1233
2N3120		x	x		800	A	200	45	45	30	130	50	.25	50	25	130		D41D4	1243
2N3122		x		x	800	A	200	50	30	25	100	300	1.5	300		60		D40D1	1233
2N3133		x	x		600	A	200	50	35	40	120	.15	0.6	.15		200		2N6005	682
2N3134		x	x		600	A	200	50	35	100	300	.15	0.6	.15		200		2N6005	682
2N3135		x	x		400	A	200	50	35	40	120	.15	0.6	.15		200		2N6005	682
2N3136		x	x		400	A	200	50	35	100	300	.15	0.6	.15		200		2N6005	682
2N3138		x		x	20W	C	200	65	65	10		1.0				100		D44C7	1255
2N3140		x		x	20W	C	200	65	65	10		1.0				100		D44C7	1255
2N3142		x		x	25W	C	200	65	65	10		1.0				100		D44C7	1255
2N3144		x		x	25W	C	200	65	65	10		1.0				100		D44C7	1255
2N3199		x	x		40W	C	200	40	40	20	60	1.0	0.3	1.0	10	1.0		D45C5	1265
2N3200		x	x		40W	C	200	60	60	20	60	1.0	0.3	1.0	10	1.0		D45C8	1265
2N3205		x	x		40W	C	200	40	40	20	60	0.5	0.4	0.5	10	1.0		D45C4	1265
2N3206		x	x		40W	C	200	60	60	20	60	0.5	0.4	0.5	10	1.0		D45C7	1265
2N3210		x		x	360	A	200	40	15	30	120	10	.75	0.2		300		GET914	1288
2N3226		x		x	75W	C	200	35	35	20	50	2.0	1.2	2.7	20	30		D44C5	1255
2N3228					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157													C22B	910
2N3229		x		x	17.5W	C	200	105	60	5.0		2.5	1.0	2.5		150		D42C7	1247
2N3244		x	x		1W	A	200	40	40	50	150	0.5	0.3	.15		175		D41D4	1243
2N3245		x	x		1W	A	200	50	50	30	90	0.5	.35	.15		150		D41D7	1243
2N3252		x		x	1W	A	200	60	30	30	90	0.5	0.3	.15		200		D40D7	1233
2N3253		x		x	1W	A	200	75	40	25	75	375	.35	.15		175		D40D4	1233
2N3273					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157													2N2324	880
2N3274																		2N2326	880
2N3275																		2N2328	880
2N3276																		2N2329	880
2N3295		x		x	800	A	175	60	60	20	60	10	0.5	.15		200		D40D7	1233
2N3296		x		x	700	A	175	60	60	5.0	50	40	0.5	0.4		100		D40D4	1233

Type	Germanium	Silicon	PNP	NPN	Maximum Ratings					Electrical Characteristics							Exact "2N" Type Page	Suggested GE Replacement	
					P_D @ 25°C (mw)	PT.	T_J °C	V_{CB} (V)	V_{CEO} (V)	h_{FE} Max.	h_{FE} Min.	@ I_C (mA)	$V_{CE(SAT)}$ (V)	@ I_C	h_{fe}	f_T Typical (MHz)		Type	Page
2N3297		x		x	25W	C	175	60	60	2.5	35	0.4	0.5	1.0		100		D44C4	125
2N3298		x		x	1W	C	175	25	15	80	240	10				200		D40D2	123
2N3299		x		x	800	A	200	60	30	40	120	.15	.22	.15		250		D40D1	123
2N3300		x		x	800	A	200	60	30	100	300	.15	.22	.15		250		D40D1	123
2N3301		x		x	360	A	200	60	30	40	120	.15	.22	.15		250		2N6000	670
2N3302		x		x	360	A	200	60	30	100	300	.15	.22	.15		250		2N6000	670
2N3309		x		x	3.5W	C	175	50	50	5.0	100	30	0.5	.25		300		D40D7	123
2N3326		x		x	800	A	175	60	45	40	120	.15	0.4	.15		250		D40D4	123
2N3375		x		x	11.6W	C	200	65	40	10	100	.25	1.0	.25		400		D40D4	123
2N3390		x		x	200	A	125	25	25	400	800	2.0			400		501		
2N3391		x		x	200	A	125	25	25	250	500	2.0			250		502		
2N3391A		x		x	200	A	125	25	25	250	500	2.0			250		502		
2N3392		x		x	200	A	125	25	25	150	300	2.0			150		504		
2N3393		x		x	200	A	125	25	25	90	180	2.0			90		504		
2N3394		x		x	200	A	125	25	25	55	110	2.0			55		504		
2N3395		x		x	200	A	125	25	25	150	500	2.0			150		507		
2N3396		x		x	200	A	125	25	25	90	500	2.0			90		507		
2N3397		x		x	200	A	125	25	25	55	500	2.0			55		507		
2N3398		x		x	200	A	125	25	25	55	800	2.0			55		507		
2N3402		x		x	560	A	150	25	25	75	225	2.0	0.3	50	75		509		
2N3403		x		x	560	A	150	25	25	180	540	2.0	0.3	50	180		509		
2N3404		x		x	560	A	150	50	50	75	225	2.0	0.3	50	75		509		
2N3405		x		x	560	A	150	50	50	180	540	2.0	0.3	50	100		509		
2N3409		x		x	500	A	200	60	30	30	120	0.1	.15	10		250		2N2920	496
2N3414		x		x	500	A	160	25	25	75	225	2.0	0.3	50	75		509		
2N3415		x		x	500	A	160	25	25	180	540	2.0	0.3	50	180		509		
2N3416		x		x	500	A	160	50	50	75	225	2.0	0.3	50	75		509		
2N3417		x		x	500	A	160	50	50	180	540	2.0	0.3	50	100		509		
2N3418		x		x	800	A	175	85	60	20	60	1.0	.25	1.0		40		D42C8	1247
2N3420		x		x	800	A	175	85	60	40	120	1.0	.25	1.0		40		D42C8	1247
2N3440		x		x	1W	A	200	300	250	40	160	20			25	15		D44R2	1267
2N3444		x		x	1W	A	200	80	50	20	60	0.5	.35	.15		150		D40D7	1233
2N3462		x		x	300	A	200	50	35	100	300	10	.35	5.0	150	10		GET930	1292
2N3463		x		x	300	A	200	60	45	120	360	10	.35	1.0	150	45		GET930	1292
2N3464		x		x	5W	C	200	60	40	35	100	0.2	1.0	0.2	30	50		D42C4	1247
2N3467		x	x		1W	A	200	40	40	40	120	0.5	0.3	.15		175		D41D4	1243
2N3468		x	x		1W	A	200	50	50	25	75	0.5	.35	.15		150		D41D7	1243
2N3469		x		x	1.25W	A	200	35	25	100	350	0.5	0.5	1.0	100	20		D42C3	1247
2N3478		x		x	200	A	200	30	15	25	150	2.0			25	750		2N3663	518
2N3485		x	x		2W	C	200	60	40	40	120	.15	0.4	.15		200		D41D4	1243
2N3486		x	x		2W	C	200	60	40	100	300	.15	0.4	.15		200		D41D4	1243
2N3500		x		x	1W	A	200	150	150	40	120	.15	0.2	10	50	150		D44R2	1261
2N3506		x		x	1W	A	200	60	40	40	200	1.5	1.0	1.5		60		D42C6	1247
2N3507		x		x	1W	A	200	80	50	30	150	1.5	1.0	1.5		60		D42C6	1247
2N3508		x		x	400	A	200	40	20	40	120	10	.25	10		500		GET3646	1382
2N3510		x		x	360	A	200	40	10	25	150	.15	.25	10	20	350		GET3014	1308
2N3511		x		x	360	A	200	40	15	30	120	.15	.25	10	20	450		GET3013	1308
2N3512		x		x	800	A	200	60	35	10		0.5	1.0	0.5		250		D40D4	1233
2N3521		x		x	300	A	200	70	55	100	300	10	1.0	10		30	517		
2N3522		x		x	250	A	200	70	55	100	300	10	1.0	10		30	517		
2N3525																		C22D	910
2N2526		x		x	800	A	200	130	120	30	120	30	1.0	50	25	40		D44R1	1261
2N3528					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157													C22D	910
2N3529																		C22D	910
2N3544		x		x	300	A	175	25	25	25		10				600		2N3663	518
2N3547		x	x		360	A	200	60	60	100	500	1.0	1.0	1.0	120	45		2N5823	653
2N3548		x	x		400	A	200	60	45	100	300	10	1.0	10	150	60		2N5817	649
2N3553		x		x	7W	C	200	65	40	10	100	.25	1.0	.25		400		D40D4	1233
2N3554		x		x	800	A	200	60	30	25	100	.75	0.7	.75		150		D42C7	1247
2N3563		x		x	260	A	125	30	12	20	200	8.0			20	600		2N3663	518
2N3564		x		x	260	A	125	30	15	20	500	12	0.3	20	20	400		2N3855A	527
2N3565		x		x	260	A	125	30	25	150	600	1.0			120	40		2N5826	657
2N3566		x		x	300	A	125	40	30	150	600	10	1.0	0.1		40		2N6010	686
2N3567		x		x	300	A	125	80	40	40	120	.15	.25	.15		60		2N5814	649
2N3568		x		x	300	A	125	80	60	40	120	.15	.25	.15		60		2N5820	653
2N3569		x		x	300	A	125	80	40	100	300	.15	.25	.15		60		2N6010	686
2N3579		x	x		400	A	200	60	60	30	120	1.0	0.5	5.0	30	80		2N5821	653
2N3580		x	x		400	A	200	60	60	60	240	1.0	0.5	5.0	60	80		2N5823	653
2N3581		x	x		400	A	200	50	40	50	150	0.1	0.5	5.0	50	30		2N5815	649
2N3582		x	x		400	A	200	50	40	100	300	0.1	0.5	5.0	100	30		2N5817	649

Type	Germanium	Silicon	PNP	NPN	Maximum Ratings					Electrical Characteristics							Exact "2N" Type Page	Suggested GE Replacement	
					P_D @ 25°C (mw)	PT.	T_J °C	V_{CB} (V)	V_{CEO} (V)	h_{FE} Max.	Min.	@ I_C (mA)	$V_{CE(SAT)}$ (V)	@ I_C	h_{fe}	f_T Typical (MHz)		Type	Page
2N3583		x		x	35W	C	200	250	175	40	200	0.5	5.0	1.0	25	10		D44R2	1261
2N3589		x		x	2W	A	175	200	200	30	90	0.2	2.0	0.2	30	15		D44R1	1261
2N3590		x		x	2W	A	175	200	200	75	150	0.2	2.0	0.2	75	15		D44R2	1261
2N3591		x		x	1W	A	175	200	200	30	90	0.2	2.0	0.2	30	15		D44R1	1261
2N3592		x		x	1W	A	175	200	200	75	150	0.2	2.0	0.2	75	15		D44R2	1261
2N3593		x		x	1W	A	175	200	200	30	90	0.2	2.0	0.2	30	15		D44R1	1261
2N3594		x		x	1W	A	175	200	200	75	150	0.2	2.0	0.2	75	15		D44R2	1261
2N3600		x		x	200	A	200	30	15	20	150	3.0			40	850		2N3663	518
2N3605		x		x	200	A	150	18	14	30		10	.25	10		300		GET914	1288
2N3606		x		x	200	A	150	18	14	30		10	.25	10		300		GET708	1288
2N3607		x		x	200	A	150	18	14	30		10	.25	10		300		GET706	1288
2N3619		x		x	7.5W	C	175	75	40	40		1.0	.75	1.0		200		D42C6	1247
2N3620		x		x	7.5W	C	175	75	40	40		1.0	1.0	3.0		200		D42C2	1247
2N3621		x		x	30W	C	175	75	40	40		1.0	1.25	5.0		200		D44C6	1255
2N3622		x		x	30W	C	175	75	40	40		1.0	1.25	5.0		200		D44C6	1255
2N3623		x		x	7.5W	C	175	75	40	40		1.0	.75	1.0		200		D42C6	1247
2N3624		x		x	7.5W	C	175	75	40	40		1.0	1.0	3.0		200		D42C6	1247
2N3625		x		x	30W	C	175	75	40	40		1.0	1.25	5.0		200		D44C6	1255
2N3626		x		x	30W	C	175	75	40	40		1.0	1.25	5.0		200		D44C6	1255
2N3627		x		x	7.5W	C	175	100	50	40		1.0	.75	1.0		200		D42C8	1247
2N3628		x		x	7.5W	C	175	100	50	40		1.0	1.0	3.0		200		D42C8	1247
2N3629		x		x	30W	C	175	100	50	40		1.0	1.25	5.0		200		D44C8	1255
2N3630		x		x	30W	C	175	100	50	40		1.0	1.25	5.0		200		D44C8	1255
2N3632		x		x	23W	C	200	65	40	10	150	.25	1.0	1.0		250		D44C5	1255
2N3633		x		x	300	A	200	15	6.0	50	150	10	.21	3.0				D44C5	1255
2N3638		x	x		300	A	125	25	25	30		50	.25	50	25	100		GET3638	1380
2N3638A		x	x		300	A	125	25	25	100		50	.25	50	100	150		GET3638A	1380
2N3641		x		x	350	A	125	60	30	40	120	.15	.22	.15		250		2N6010	686
2N3642		x		x	350	A	125	60	45	40	120	.15	.22	.15		250		2N6010	686
2N3643		x		x	350	A	125	60	30	100	300	.15	.22	.15		250		2N6010	686
2N3644		x	x		300	A	125	45	45	115	300	50	.25	50		200		2N6005	682
2N3645																		2N6015	698
2N3646																		GET3646	1382
2N3647																		GET3646	1382
2N3648																		GET3646	1382
2N3649					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157													C140F	990
2N3650																		C140A	990
2N3651																		C140B	990
2N3652																		C140C	990
2N3653																		C140D	990
2N3654																		C141F	990
2N3655																		C141A	990
2N3656																		C141B	990
2N3657																		C141C	990
2N3658																		C141D	990
2N3659		x		x	4W	C	200	220	170	20		10			20	50		D44R1	1261
2N3660		x	x		5W	C	200	40	30	25	100	0.5	1.2	0.5		25		D43C3	1251
2N3661		x	x		5W	C	200	60	50	25	100	0.5	1.2	0.5		25		D43C8	1251
2N3662		x		x	200	A	125	18	12	20		8.0				700	518		
2N3663		x		x	200	A	125	30	12	20		8.0				700	518		
2N3668					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157													C32A	913
2N3669																		C32B	913
2N3670																		C32C	913
2N3675		x		x	8.8W	C	200	90	55	12	60	1.0	0.8	1.0		1.0		D42C7	1247
2N3678		x		x	800	A	200	75	55	40	120	.15	0.4	.15		250		D40D7	1233
2N3681		x		x	200	A	200	10	7.0	20	220	2.0	.37	4.0	20	1.0		2N3662	518
2N3682		x		x	360	A	200	40	15	40	120	10			45	600		2N3663	518
2N3683		x		x	200	A	200	30	12	20	150	8.0			30	1.0		2N3663	518
2N3688		x		x	200	A	125	40	40	30		4.0				400		2N3663	518
2N3689		x		x	200	A	125	40	40	30		4.0				400		2N3663	518
2N3690		x		x	200	A	125	40	40	30		4.0				400		2N3663	518
2N3691		x		x	200	A	125	35	20	40	160	10	0.7	10	40	200		2N6004	678
2N3692		x		x	200	A	125	35	20	100	400	10	0.7	10	100	200		2N6004	678
2N3693		x		x	200	A	125	45	45	40	160	10				200		2N3855A	527
2N3694		x		x	200	A	125	45	45	100	400	10				200		2N3856A	527
2N3702		x	x		300	A	150	40	25	60	300	50	.25	50		100		2N5447	639
2N3703		x	x		300	A	150	50	30	30	150	50	.25	50		100		2N5448	639
2N3704		x		x	360	A	150	50	30	100	300	50	0.6	0.1		100		2N5449	641
2N3705		x		x	360	A	150	50	30	50	150	50	0.8	0.1		100		2N5450	641
2N3706		x		x	360	A	150	40	20	30	600	50	1.0	0.1		100		2N5451	641

Type	Germanium	Silicon	PNP	NPN	Maximum Ratings					Electrical Characteristics							Exact "2N" Type Page	Suggested GE Replacement	
					P_D @ 25°C (mw)	PT.	T_J °C	V_{CB} (V)	V_{CEO} (V)	h_{FE} Max.	h_{FE} Min.	@ I_C (mA)	$V_{CE(SAT)}$ (V)	@ I_C	h_{fe}	f_T Typical (MHz)		Type	Page
2N3707		x		x	250	A	150	30	30	100	400	0.1	1.0	10	100			2N3860	537
2N3708		x		x	250	A	150	30	30	45	660	1.0	1.0	10	45			2N2926	499
2N3709		x		x	250	A	150	30	30	45	165	1.0	1.0	10	45			2N3858	537
2N3710		x		x	250	A	150	30	30	90	330	1.0	1.0	10	90			2N3859	537
2N3711		x		x	250	A	150	30	30	180	660	1.0	1.0	10	180			2N5232	599
2N3712		x		x	800	A	200	150	.150	30	150	30	2.0	50	25	40		D44R1	1261
2N3719		x	x		6W	C	200	40	40	25	180	1.0	1.5	0.3		60		D43C6	1251
2N3720		x	x		6W	C	200	60	60	25	180	1.0	1.5	3.0		60		D43C8	1251
2N3721		x		x	200	A	125	18	18						60		522		
2N3722		x		x	800	A	200	80	60	40	150	0.1	.22	0.1		300		D40D7	1233
2N3724		x		x	800	A	200	50	30	60	150	0.1	0.2	0.1		300		D40D1	1233
2N3724A		x		x	1W	A		50	30	60	150	100	0.2	100				D40D1	1233
2N3725A		x		x	1W	A		80	50	60	150	100	.26	100	3			D40D4	1233
2N3734		x		x	1W	A	200	50	30	30	120	1.0	0.2	10		300		D40D1	1233
2N3735		x		x	1W	A	200	75	50	20	80	1.0	0.2	10		250		D40D7	1233
2N3738		x		x	20W	C	175	250	225	40	200	0.1	2.5	.25	35	15		D44R2	1261
2N3739		x		x	20W	C	175	325	300	40	200	0.1	2.5	.25	35	15		D44R4	1261
2N3740		x	x		25W	C	200	60	60	30	100	.25	0.6	1.0	25	4.0		D45C7	1265
2N3740A		x	x		25W	C	200	60	60	30	100	.25	0.6	1.0	25	4.0		D45C7	1265
2N3742		x		x	1W	A	200	300	300	20	200	30	1.0	10	20	30		D40N3	1237
2N3744		x		x	30W	C	200	60	40	20	60	1.0	.25	1.0	20	30		D44C5	1255
2N3745		x		x	30W	C	200	80	60	20	60	1.0	.25	1.0	20	30		D44C8	1255
2N3747		x		x	30W	C	200	60	40	40	120	1.0	.25	1.0	40	40		D44C6	1255
2N3748		x		x	30W	C	200	80	60	40	120	1.0	.25	1.0	40	40		D44C8	1255
2N3753					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157													C137F	978
2N3754																		C137A	978
2N3755																		C137B	978
2N3756																		C137C	978
2N3757																		C137D	978
2N3758																		C137E	978
2N3759																		C137M	978
2N3760																		C137S	978
2N3761																		C137N	978
2N3762		x	x		1W	A	200	40	40	30	120	1.0	0.1	10		180		D43C6	1251
2N3763		x	x		1W	A	200	60	60	20	80	1.0	0.1	10		150		D43C8	1251
2N3766		x		x	20W	C	175	80	60	40	160	0.5	2.5	1.0	40	15		D44C8	1255
2N3798		x	x		360	A	200	60	60	150	450	0.5	0.2	0.1	150	30		2N5820	653
2N3818		X		X	25W	C	175	60	60	5.0	50	400	0.5	1.0A	3.0			D44C7	1255
2N3825		X		X	250	A	150	30	15	20		2.0	0.25	2.0		200		2N3663	518
2N3830		X		X	1.0W	A	200	80	50	30		150	0.3	150		200		D40D7	1233
2N3831		X		X	1.0W	A	200	70	40	35		150	0.3	150		200		D40D4	1233
2N3843,A		X		X	200	A	125	30	30	20	40	2.0				60	523		
2N3844,A		X		X	200	A	125	30	30	35	70	2.0				90	523		
2N3845		X		X	200	A	125	30	40	60	120	2.0				126	523		
2N3845A		X		X	200	A	125	30	30	60	120	2.0				126	523		
2N3852		X		X	30W	C	200	60	40	50	150	1.0A	0.25	1.0A		20		D42C6	1247
2N3853		X		X	30W	C	200	60	40	30	90	1.0A	0.25	1.0A		20		D42C5	1247
2N3854		X		X	200	A	150	18	18	35	70	2.0				100	527		
2N3854A		X		X	200	A	150	30	30	35	70	2.0				100	527		
2N3855		X		X	200	A	150	18	18	60	120	2.0				130	527		
2N3855A		X		X	200	A	150	30	30	60	120	2.0				130	527		
2N3856		X		X	200	A	150	18	18	100	200	2.0				140	527		
2N3856A		X		X	200	A	150	30	30	100	200	2.0				140	527		
2N3858		X		X	200	A	125	30	30	60	120	2.0				90	537		
2N3858A		X		X	200	A	100	60	60	45		1.0				90	537		
2N3859		X		X	200	A	125	30	30	100	200	2.0				90	537		
2N3859A		X		X	200	A	100	60	60	75		1.0				90	537		
2N3860		X		X	200	A	125	30	30	150	300	2.0				90	537		
2N3866		X		X	5.0W	C	200	55	30	10	200	50	1.0	100		250		D40D1	1233
2N3867		X	X		1.0W	A	200	40	40	40	200	1.5A	0.75	1.5A		60		D43C6	1251
2N3868		X	X		1.0W	A	200	60	60	30	150	1.5A	0.75	1.5A		60		D43C8	1251
2N3869		X		X	2.5W	C	175	40	20	20	150	30	0.7	450				D40D1	1233
2N3870					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157											400		C32A	913
2N3871																		C32B	913
2N3872																		C32D	913
2N3873																		C137M	978
2N3877		X		X	200	A	150	70	70	20	250	2.0					548		
2N3877A		X		X	200	A	150	85	85	20	250	2.0					548		
2N3878		X		X	35W	C	200	120	50	40	200	5W	2.0	4.0A	40	40		D44C8	1255
2N3880		X		X	200	A	200	30	15	30	200	3.0			50	1200		2N3663	518

Type	Germanium	Silicon	PNP	NPN	Maximum Ratings					Electrical Characteristics							Exact "2N" Type Page	Suggested GE Replacement	
					P_D @ 25°C (mw)	PT.	T_J °C	V_{CB} (V)	V_{CEO} (V)	h_{FE} Max.	h_{FE} Min.	@ I_C (mA)	$V_{CE(SAT)}$ @ I_C (V)		h_{fe}	f_T Typical (MHz)		Type	Page
N3896					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157													C30A	913
N3897																		C30B	913
N3898																		C30D	913
N3899																		C137M	978
N3900,A		X		X	200	A	125	18	18	250	500	2.0			170		550		
N3901		X		X	200	A	125	18	18	350	700	2.0			350		552		
N3903		X		X	310	A	135	60	40	50	150	10	0.2	10	50	250		2N6004	678
N3904		X		X	310	A	135	60	40	100	300	10	0.2	10	100	300		2N6004	678
N3905		X	X		310	A	135	40	40	50	150	10	0.25	10	50	200		2N6005	682
N3906		X	X		310	A	135	40	40	100	300	10	0.25	10	100	250		2N6005	682
N3910		X	X		500	A	200	60	50	40	160	1.0	0.3	10		4.0		2N5823	653
N3911		X	X		500	A	200	60	40	60	240	1.0	0.3	10		8.0		2N5817	649
N3912		X	X		500	A	200	60	30	90		1.0	0.3	10		10		2N5813	647
N3913		X	X		400	A	200	60	50	40	160	1.0	0.3	10		4.0		2N5823	653
N3914		X	X		400	A	200	60	40	60	240	1.0	0.3	10		8.0		2N5817	649
N3915		X	X		400	A	200	60	30	90		1.0	0.3	10		10		2N5813	647
N3916		X		X	5.0W	C	150	150	150	40	200	150	5.0	150	30	50		D44R2	1261
N3917		X		X	20W	C	150	80	40	30	120	1.0A	1.2	1.0A	15	50		D44C8	1255
N3918		X		X	20W	C	150	80	40	100	300	1.0A	1.2	1.0A	30	50		D44C8	1255
N3919		X		X	15W	C	150	120	60	40	120	2.0A	1.2	10A		80		D42CA	1255
N3923		X		X	8W	A	200	150	150	30	120	25	1.0	25	20	40		D44R1	1261
N3924		X		X	7.0W	C	200	36	18							250		D40D1	1233
N3925		X		X	10W	C	200	36	18							250		D42C1	1247
N3926		X		X	11.6W	C	200	36	18							250		D40D1	1233
N3927		X		X	23.2W	C	200	36	18							200		D44C1	1255
N3932		X		X	200	A	200	30	20	40	150	2.0			50	750		2N3663	518
N3933		X		X	200	A	200	40	30	60	200	2.0			60	750		2N3663	518
N3945		X		X	5.0W	C	200	70	50	40	250	150	0.5	150		60		D40D7	1233
N3946		X		X	360	A	200	60	40	50	150	10	0.3	50	50	250		GET2221A	1298
N3947		X		X	360	A	200	60	40	100	300	10	0.3	50	100	300		GET2222A	1298
N3948		X		X	1.0W	A	200	36	20	15		50				700		D40D1	1233
N3953		X		X	200	A	200	15	12	30	360	2.0			40	1300		2N3662	518
N3959		X		X	400	A	200	20	12	40	200	10	0.3	30	13	1300		2N3662	518
N3960		X		X	400	A	200	20	12	40	200	10	0.3	30	16	1600		2N3663	518
N3961		X		X	10W	C	200	65	40							400		D42C4	1247
N3962		X	X		360	A	200	60	60	100	300	.01	0.25	10	100	40		2N6015	698
N3964		X	X		360	A	200	45	45	250	500	.01	0.25	10	250	50		2N6013	690
N3965		X	X		360	A	200	60	60	250	500	.01	0.25	10	250	50		2N6015	698
N3973		X		X	360	A	150	60	30	35	100	10	0.3	150		200		2N5418	637
N3974		X		X	360	A	150	60	30	55	200	10	0.3	150		200		2N5419	637
N3975		X		X	360	A	150	60	30	35	100	10	0.3	150		200		2N5418	637
N3976		X		X	360	A	150	60	30	55	200	10	0.3	150		200		2N5419	637
N3980																		2N2647	477
N3983		X		X	200	A	150	30	12	30		4.0				500		2N3662	518
N3984		X		X	200	A	150	30	12	20		4.0				400		2N3662	518
N3985		X		X	200	A	150	30	12	20		4.0				300		2N3662	518
N3986					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157													C150E	1011
N3987																		C150M	1011
N3988																		C150S	1011
N3989																		C150N	1011
N3990																		C150T	1011
N3991																		C150P	1011
N3992																		C150PA	1011
N4012		X		X	11.6W	C	200	65	40	4.0	40	1.0A	1.0	250		400		D40D4	1233
N4013		X		X	360	A	200	60	40		150	100				300		D32K1	1221
N4014		X		X	360	A	200	80	50		150	100				300		D32K2	1221
N4026		X	X		500	A	200	60	60	40	120	100	1.0	1.0A		100		2N6015	698
N4028		X	X		500	A	200	60	60	100	300	100	1.0	1.0A		150		2N6015	698
N4030		X	X		800	A	200	60	60	40	120	100	1.0	1.0A		100		D41D8	1243
N4032		X	X		800	A	200	60	60	100	300	100	1.0	1.0A		150		D41D8	1243
N4034		X	X		360	A	200	40	40	70	200	10	0.13	1	50	400		GET2906	1304
N4035		X	X		360	A	200	40	40	150	300	10	0.13	1	150	450		GET2907	1306
N4036		X	X		5W	A	200	90	65	40	140	150				60		D41D7	1243
N4037		X	X		1W	A	200	60	40	50	250	150				60		D41D4	1243
N4040		X		X	17.5W	C	200	60	40	10	80	100	2.0	1.0A		400		D42C4	1247
N4041		X		X	10W	C	200	60	40	10	80	75	2.0	500		400		D42C4	1247
N4043		X		X	300	C	200	45	45	80	800	.01	0.35	1.0		150		2N6014	694
N4046		X		X	800	A	200	50	30		150	100				250		D40D2	1233
N4047		X		X	800	A	200	80	50		150	100				250		D40D8	1233
N4054		X		X	6.25W	C	150	300	300	30	90	50	5.0	75		15		D40N3	1237

Type	Germanium	Silicon	PNP	NPN	Maximum Ratings					Electrical Characteristics							Exact "2N" Type Page	Suggested GE Replacement	
					P_D @ 25°C (mw)	PT.	T_J °C	V_{CB} (V)	V_{CEO} (V)	h_{FE} Max.	h_{FE} Min.	@ I_C (mA)	$V_{CE(SAT)}$ @ I_C (V)		h_{fe}	f_T Typical (MHz)		Type	Page
2N4055		X		X	6.25W	C	150	250	250	30	90	50	5.0	75		15		D40N1	1237
2N4056		X		X	6.25W	C	150	200	200	30	90	50	5.0	75		15		D40N1	1237
2N4057		X		X	6.25W	C	150	150	150	30	90	50	5.0	75		15		D40N1	1237
2N4058		X	X		250	A	150	30	30	100	400	.1	0.7	10	100			2N5999	666
2N4059		X	X		250	A	150	30	30	45	660	1.0	0.7	10	45			2N6076	592
2N4060		X	X		250	A	150	30	30	45	165	1.0	0.7	10	45			2N5354	617
2N4061		X	X		250	A	150	30	30	90	330	1.0	0.7	10	90			2N5355	617
2N4062		X	X		250	A	150	30	30	180	660	1.0	0.7	10	180			2N5356	617
2N4064		X		X	10W	C	200	300	250	40	160	20				15		D44R2	1261
2N4069		X		X	1W	C	175	150	150	30		30	0.68			50		D44R2	1261
2N4072		X		X	1.5W	C	200	40	20	10		25A				550		2N3854	527
2N4073		X		X	1.5W	C	200	40	20	10		25A				550		D40D7	1233
2N4074		X		X	400	A	175	40	40						400			2N5816	649
2N4081		X		X	200	A		40	40	40	180	2.0			40	600		2N3663	518
2N4104		X		X	300	A	175	60	60						1400	540		2N5828	664
2N4111		X		X	30W	C		100	60	40	120	2A				70		D44C8	1255
2N4121		X	X		200	A	125	40	40	70		10			50	400		GET2907	1306
2N4122		X	X		200	A	125	40	40	150		10			150	450		GET2907	1306
2N4123		X		X	310	A	125	40	30	50	150	2.0	0.3	50	50	250		GET2221	1296
2N4124		X		X	310	A	135	30	25	120	360	2.0	0.3	50	120	300		GET2222	1296
2N4125		X	X		310	A	135	30	30	50	150	2.0	0.4	50	50	200		GET2906	1304
2N4126		X	X		310	A	135	25	25	120	360	2.0	0.4	50	120	250		GET2907	1306
2N4127		X		X	25W	C		60	40	10	80	200				300		D44C2	1255
2N4128		X		X	40W	C		60	40	10	80	200				200		D44C4	1255
2N4134		X		X	200	A	200	30	30						200	350		2N3663	518
2N4135		X		X	200	A	200	30	30						200	425		2N3663	518
2N4137		X		X	360	A	200	40	40	40	120	10				500		GET3646	1382
2N4138		X		X	300	A	200	30	30	50		1				20		D33D21	1209
2N4140		X		X	300	A	125	60	30		120	150				250		GET2221	1296
2N4141		X		X	300	A	125	60	30		300	150				250		GET2222	1296
2N4142		X	X		300	A	125	60	40		120	150				200		GET2906	1304
2N4143		X	X		300	A	125	60	40		300	150				200		GET2907	1306
2N4151					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157													C22/122U	910
2N4152																		C22/122F	910
2N4153																		C22/122A	910
2N4154																		C22/122B	910
2N4155																		C22/122C	910
2N4156																		C22/122D	910
2N4157																		C22/122E	910
2N4159																		C22/122U	910
2N4160																		C22/122F	910
2N4161																		C22/122A	910
2N4162																		C22/122B	910
2N4163																		C22/122C	910
2N4164																		C22/122D	910
2N4165																		C22/122E	910
2N4167																		C20U	910
2N4168																		C20F	910
2N4169																		C20A	910
2N4170																		C20B	910
2N4171																		C20C	910
2N4172																		C20D	910
2N4173																		C20E	910
2N4175																		C20U	910
2N4176																		C20F	910
2N4177																		C20A	910
2N4178																		C20B	910
2N4179																		C20C	910
2N4180																		C20D	910
2N4181																		C20E	910
2N4183																		C22/122U	910
2N4184																		C22/122F	910
2N4185																		C22/122A	910
2N4186																		C22/122B	910
2N4187																		C22/122C	910
2N4188																		C22/122D	910
2N4189																		C22/122E	910
2N4191																		C22/122U	910
2N4192																		C22/122F	910
2N4193																		C22/122A	910

Type	Germanium	Silicon	PNP	NPN	Maximum Ratings					Electrical Characteristics							Exact "2N" Type Page	Suggested GE Replacement	
					P_D @ 25°C (mw)	PT.	T_J °C	V_{CB} (V)	V_{CEO} (V)	h_{FE} Max.	Min.	@ I_C (mA)	$V_{CE(SAT)}$ @ I_C (V)		h_{fe}	f_T Typical (MHz)		Type	Page
N4194					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157													C22/122B	910
N4195																		C22/122C	910
N4196																		C22/122D	910
N4197																		C22/122E	910
N4207		X	X		300	A	200	6.0	6.0	50	120	10				650		GET2221	1296
N4208		X	X		300	A	200	12	12	30	120	10				700		GET2221	1296
N4209		X	X		300	A	200	15	15	50	120	10				850		GET2221	1296
N4212					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157													2N2322	880
N4213																		2N2323	880
N4214																		2N2324	880
N4215																		2N2325	880
N4216																		2N2326	880
N4217																		2N2327	880
N4218																		2N2328	880
N4219																		2N2329	880
N4225		X		X	5W	C		100	40	40	150	1A				150		D42C6	1247
N4226		X		X	5W	C		200	60	40	150	1A				150		D42C8	1247
N4227		X		X	300	A	125	60	30		150	150				250		GET2222	1296
N4228		X	X		300	A	125	60	40		150	150				200		GET2907	1306
N4231		X		X	35W	C	200		40	25	100	1.5A	0.7	1.5A		1		D44C6	1255
N4232		X		X	36W	C	200		60	25	100	1.5A	0.7	1.5A		1		D44C8	1255
N4234		X	X		1W	A	200	40	40	30	150	250	0.6	1A		3		D41D4	1243
N4235		X	X		1W	A	200	60	60	30	150	250	0.6	1A		3		D41D7	1243
N4237		X	X		5W	C	175	50	40	40	160	500	2.5	1A	40	10		D40D4	1233
N4238		X	X		5W	C	175	80	60	40	160	500	2.5	1A	40	10		D40D7	1233
N4248		X	X		200	A	125	40	40						50	40		2N6005	682
N4249		X	X		200	A	125	60	60						100	40		2N6005	682
N4250		X	X		200	A	125	40	40						250	40		2N6007	682
N4251		X		X	250	A	200	15	10	100		10				1300		GET706	1288
N4252		X		X	200	A	175	30	18	50		2				600		2N3663	518
N4253		X		X	200	A	175	30	18	30		2				600		2N3663	518
N4254		X		X	200	A	175	30	18	50		2						2N3663	518
N4255		X		X	200	A	175	30	18	30		2						2N3663	518
N4256		X		X	200	A		30	30		500	2					556		
N4257		X	X		200	A	125	6	6	30	120	10				500		2N6001	674
N4258		X	X		200	A	125	12	12	30	120	10				700		2N6001	674
N4259		X		X	175	A	175	40	30						70			2N3663	518
N4260		X	X		200	A	200	15	15	30	150	10	15	10	16	1500		GET2906	1304
N4261		X	X		200	A	200	5	15	30	150	15A	15	10	20	2000		GET2907	1306
N4262		X		X	1.5W	C		25	10	75		300				600		GET706	1288
N4263		X		X	1.5W	C		25	10	75		300				800		GET708	1288
N4264		X		X	310	A	135	30	15	4	160	10				300		GET914	1288
N4265		X	X		310	A	135	30	12	100	400	15A	0.22	10		300		GET914	1288
N4271		X		X	5W	C		175	140	20	140	200				20		D44R1	1261
N4274		X		X	280	A	125	30	12	18		100				400		GET3646	1382
N4275		X		X	280	A	125	40	15	18		100				400		GET3646	1382
N4284		X	X		250	A	165	25	25		600	1						2N5354	617
N4285		X	X		250	A	165	35	35		600	1						2N5365	625
N4286		X		X	250	A	150	30	25						600	40		2N3860	537
N4287		X		X	250	A	150	45	45						600	40		2N5232	599
N4288		X	X		250	A	150	30	25						600	40		2N5999	666
N4289		X	X		250	A	150	60	45						600	40		2N5367	625
N4290		X	X		250	A	150	30	20						600	40		2N6011	690
N4291		X	X		250	A	150	40	30						600	40		2N6011	690
4292		X		X	200	A	150	30	15	20		3				600		2N3663	518
4293		X		X	200	A	150	30	15						60	600		2N3663	518
4294		X		X	200	A	150	30	12	30	120	10				400		GET914	1288
4295		X		X	200	A	150	40	15	40	120	10				500		GET914	1288
4296		X		X	20W	C		350	250	50	150	50				20		D44R2	1261
4297		X		X	20W	C		350	250	75	300	50				20		D44R2	1261
4307		X		X	1.5W	A		100	60	50	150	1A						D42C8	1247
4308		X		X	4W	A		100	60	50	150	1A						D42C8	1247
4311		X		X	1.5W	A		100	60	40	120	1A						D42C8	1247
4312		X		X	4W	A		100	60	40	120	1A						D42C8	1247
4314		X	X		1W	A		90	65	50	250	150				200		D41D7	1243
4315																		2N6003	674
4349																		D40D1	1233
4350		X		X	7W	C		65	40	10	200	350				300		D40D4	1233
4354		X	X		350	A	125	60	60	25		100				500		2N6015	698
4355		X	X		350	A	125	60	60	60		100				500		2N6015	698

Type	Germanium	Silicon	PNP	NPN	Maximum Ratings					Electrical Characteristics							Exact "2N" Type Page	Suggested GE Replacement	
					P_D @ 25°C (mw)	PT.	T_J °C	V_{CB} (V)	V_{CEO} (V)	h_{FE}		@ I_C	$V_{CE(SAT)}$ @ I_C		h_{fe}	f_T Typical (MHz)		Type	Page
										Max.	Min.	(mA)	(V)						
2N4911		X		X	25W	C	200	60	60	20	100	500	0.6	1A	25	3		D44C8	1255
2N4916		X	X		500	C	125	30	30	70	200	10	0.14	10		400		2N6001	674
2N4917		X	X		500	C	125	30	30	150	300	10	0.14	10		450		2N6001	674
2N4918		X	X		30W	C	150	40	40	20	100	500	0.6	1A	25	3		D45C5	1265
2N4919		X	X		30W	C	150	60	60	20	100	500	0.6	1A	25	3		D45C8	1265
2N4921		X		X	30W	C	150	40	40	20	100	500	0.6	1A	25	3		D44C5	1255
2N4922		X		X	30W	C	150	60	60	20	100	500	0.6	1A	25	3		D44C8	1255
2N4923		X		X	30W	C	150	80	80	20	100	500	0.6	1A	25	3		D44R1	1261
2N4924		X		X	1W	A	175	100	100	40	200	150	0.4	50		100		D40N1	1237
2N4925		X		X	1W	A	175	150	150	40	200	150	0.4	50		100		D44R2	1261
2N4926		X		X	1W	A	175	200	200	20	200	30	2.0	30	25	300		D40N1	1237
2N4927		X		X	1W	A	175	250	250	20	200	30	2.0	30	25	300		D40N1	1237
2N4944		X		X	600	C	125	80	40	40	100	150	0.25	150		60		2N5814	649
2N4945		X		X	600	C	125	80	60	40	100	150	0.25	150		60		2N5820	649
2N4946		X		X	600	C												2N5816	649
2N4947					UNIJUNCTIONS - FOR OTHER TYPES SEE SELECTOR GUIDE P 124													2N2646	477
2N4948																		2N2647	477
2N4949																		D5E45	1179
2N4951		X		X	360	A	150	60	30	60	200	150	0.3	150		250		2N5418	637
2N4952		X		X	360	A	150	60	30	100	300	150	0.3	150		250		2N5419	637
2N4953		X		X	360	A	150	60	30	200	600	150	0.3	150		250		2N5420	637
2N4954		X		X	360	A	150	40	30	60	600	150	0.3	150		250		2N5420	637
2N4957		X	X		200	A	200	30	30	20	40	2.0				1200		GET2905	1306
2N4958		X	X		200	A	200	30	30	20	40	2.0				1000		GET2905	1306
2N4959		X	X		200	A	200	30	30	20	40	2.0				1000		GET2905	1306
2N4964		X	X		200	A		50	40	30	120	.01	0.4	10	40			2N5999	666
2N4965		X	X		200	A		50	40	80	400	.01	0.4	10	100			2N6009	666
2N4966		X		X	200	A		50	40	40	200	.01	0.4	10	40			2N5998	666
2N4967		X		X	200	A		50	40	100	600	.01	0.4	10	100			2N6008	666
2N4968		X		X	200	A		30	25	40	200	.01	0.4	10	40			2N5998	666
2N4969		X		X	200	A		50	30	40	120	150	0.4	150				2N5814	649
2N4970		X		X	200	A		50	30	100	350	150	0.4	150				2N6000	670
2N4971		X	X		200	A		50	40	40	120	150	0.4	150				2N6011	690
2N4972		X	X		200	A		50	40	100	300	150	0.4	150				2N6011	690
2N4976		X		X	5W	C		55	30	20	250	50				1000		D40D1	1233
2N4983					SILICON UNILATERIAL SWITCH												562		
2N4984																	566		
2N4985																	566		
2N4986																	562		
2N4987																	570		
2N4988																	574		
2N4989																	574		
2N4990																	570		
2N4991																	578		
2N4992																	582		
2N4993																	586		
2N4994		X		X	200	A		60	45	40	160	10					590		
2N4995		X		X	200	A		60	45	100	400	10					590		
2N4996		X		X	200	A		30	18	50		2						2N3663	518
2N4997		X		X	200	A		30	18	30	150	2						2N3663	518
2N5022		X	X		1W	A		50	50	25	100	500	0.2	100				D41D7	1243
2N5023		X	X		1W	A		30	30	40	100	500	0.17	100				D41D1	1243
2N5027		X		X	320	A	120		30	50	150	150	0.45	150			45.41*		
2N5028		X		X	320	A	120		30	100	300	150	0.45	150			45.41*		
2N5029		X		X	320	A	120		15	40	120	10	0.25	10			45.42*		
2N5030		X		X	320	A	120		12	30		10	0.25	10			45.42*		
2N5031		X		X	200	A		15	10	25	300	1						2N3663	518
2N5032		X		X	200	A		15	40	25	300	1						2N3663	518
2N5040		X	X		300	A	125	25	25	30	60	150	1.0	500		100		2N6001	674
2N5041		X	X		300	A	125	40	40	40	150	150	0.5	500		80		2N6001	674
2N5042					800	A	200	40	40	40	150	150	1.1	500		100		2N6001	674
2N5053		X		X	200	A	200	30	15	25	150	2				1300		2N3663	518
2N5054		X		X	200	A	200	30	15	25	150	2				1300		2N3663	518
2N5055		X	X		200	A	125	12	12	30	100	30	.13	1				2N6001	674
2N5056		X	X		360	A	200	15	15	30	100	30	.13	1				2N6001	674
2N5058		X		X	1W	C	200	300	300	35	150	30						D44R2	1261
2N5059		X		X	1W	C	200	250	250	30	150	30						D44R4	1261
2N5065		X		X	2.5W	C	200	25	15	50	120	300	.23	100		550		2N6010	686
2N5066		X		X	400	A		30	20							5		2N6010	686
2N5079		X		X	1.8W	C		60	30	100	300	150	.2	150		400		D40D2	1233

Type	Germanium	Silicon	PNP	NPN	Maximum Ratings					Electrical Characteristics							Exact "2N" Type Page	Suggested GE Replacement	
					P_D @ 25°C (mw)	PT.	T_J °C	V_{CB} (V)	V_{CEO} (V)	h_{FE}		@ I_C (mA)	$V_{CE(SAT)}$ @ I_C (V)		h_{fe}	f_T Typical (MHz)		Type	Page
										Max.	Min.								
2N4359		X	X		360	A	200	45	45	50	600	1	0.25	10	50			2N6005	682
2N4361					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157													C50A	943
2N4362																		C50B	943
2N4363																		C50D	943
2N4364																		C50M	943
2N4365																		C50N	943
2N4366																		C150P	1011
2N4367																		C150PB	1011
2N4371																		C52A	943
2N4372																		C52B	943
2N4373																		C52D	943
2N4374																		C152M	1011
2N4375																		C152N	1011
2N4376																		C152P	1011
2N4377																		C152PB	1011
2N4383		X		X	800	A	200	40	30						1000	120		D40D2	1233
2N4384		X		X	500	A	200	40	30						1000	120		GET2484	1302
2N4385		X		X	800	A	200	40	30						1000	120		D40D2	1233
2N4386		X		X	500	A	200	40	30						1000	120		2N6003	674
2N4387		X	X		20W	A	200	40	40	25	100	500						D45C5	1265
2N4388		X	X		20W	A	200	60	60	25	100	500						D45C8	1265
2N4389		X		X	200	A	125	12	12	30	80	10	0.15	10	4			GET706	1288
2N4400		X		X	310	A	135	60	40	50	150	150	0.4	150	20	200		2N5814	649
2N4401		X		X	310	A	135	60	40	100	300	150	0.4	150	40	250		2N5816	649
2N4402		X	X		310	A	135	40	40	50	150	150	0.4	150	30	150		2N5815	649
2N4403		X	X		310	A	135	40	40	100	300	150	0.4	150	60	200		2N5817	649
2N4409		X		X	310	A	135	80	50	60	400	1	0.2	1				2N5826	657
2N4410		X		X	310	A	135	120	80	60	400	1	0.2	1				GET2484	1302
2N4412		X		X	600	A	200	40	30						1000	100		2N6003	674
2N4413		X	X		400	A	200	40	30						1000	100		2N6003	674
2N4414		X	X		600	A	200	40	30						1000	100		2N6001	674
2N4415		X	X		400	A	200	40	30						1000	100		2N6001	674
2N4418		X		X	250	A	125	40	40	40	120	10				500		GET3646	1382
2N4419		X		X	250	A	125	30	30	30		10				400		GET3646	1382
2N4420		X		X	250	A	125	40	40	30	120	30				350		GET3646	1382
2N4421		X		X	250	A	125	30	30	25		30				300		GET708	1288
2N4423		X		X	250	A	125	12	12	40	150	30				400		2N6001	674
2N4424		X		X	360	A	150	40	40						180		558		
2N4425		X		X	560	A	150	40	40	180		2					558		
2N4428		X		X	3.5W	C		55	35	20	200	50				700		D42C2	1247
2N4429		X		X	5W	C		55	35	20	200	50				700		D40D4	1233
2N4430		X		X	10W	C		55	40	20	200	100				600		D40D4	1233
2N4432		X		X	600	A		50	30	40	130	6			45			2N6004	678
2N4432A		X		X	600	A		50	30	80	150	6			90			2N6004	678
2N4436		X		X	200	A	125	60	30	40	120	150	0.22	150		250		GET2221	1296
2N4437		X		X	200	A	125	60	30	100	300	150	0.22	150		250		GET2222	1296
2N4440		X		X	11.6W	C		65	40	10	200	125				400		D40D4	1233
2N4442					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157													C22/122B	910
2N4443																		C22/122D	910
2N4452		X	X		0.35W	A	200	45	45	115	300	50	0.4	15	135	200		2N6005	682
2N4453		X	X		0.3W	A			18	40		30	0.25	30		400		2N6001	674
2N4851					UNIJUNCTIONS - FOR OTHER TYPES SEE SELECTOR GUIDE P 124													2N2646	477
2N4852																		2N2647	477
2N4853																		D5E45	1179
2N4870																		GET4870	1384
2N4871																		GET4871	1384
2N4872		X	X		700	C	200	12	12	50	120	10	0.13	1	9			2N6001	674
2N4873		X		X	360	A	200	40	15	110	150	10	0.2	10	7			GET3646	1382
2N4874		X		X	720	A	175	30	20						200	900		2N3662	518
2N4875		X		X	720	A	175	40	25						200	800		2N3662	518
2N4876		X		X	720	A	175	40	30						200	650		2N3662	518
2N4877		X		X	10W	C	200		60	20	200	4A	1	4A		4		D42C7	1247
2N4890		X	X		1W	A		60	40	50	250	150	1.4	150	5			D41D4	1243
2N4891					UNIJUNCTIONS - FOR OTHER TYPES SEE SELECTOR GUIDE P 124													2N2646	477
2N4892																		2N2646	477
2N4893																		2N2647	477
2N4894																		2N2647	477
2N4898		X	X		25W	C	200	40	40	20	100	500	0.6	1A	25	3		D45C5	1265
2N4899		X	X		25W	C	200	60	60	20	100	500	0.6	1A	25	3		D45C8	1265
2N4910		X		X	25W	C	200	40	40	20	100	500	0.6	1A	25	3		D44C5	1255

Type	Germanium	Silicon	PNP	NPN	Maximum Ratings					Electrical Characteristics							Exact "2N" Type Page	Suggested GE Replacement	
					P_D @ 25°C (mw)	PT.	T_J °C	V_{CB} (V)	V_{CEO} (V)	h_{FE} Max.	h_{FE} Min.	@ I_C (mA)	$V_{CE(SAT)}$ (V)	@ I_C	h_{fe}	f_T Typical (MHz)		Type	Page
2N5080		X		X	1.8W	C		60	30	200	500	150	.2	150		500		D40D2	1233
2N5081		X		X	1.2W	C		70	50	100	400	1	.2	10	100	600		2N6014	694
2N5082		X		X	1.2W	C		60	30	100	400	1	.2	10	100	600		2N6010	686
2N5086		X	X		310	A	135	50	50	150	500	.1	.3	10	150	40		2N6015	698
2N5087		X	X		310	A	135	50	50	250	800	.1	.3	10	250	40		2N6017	698
2N5088		X		X	310	A	135	35	30	300	900	.1	.5	10	350	50		2N5827	662
2N5089		X		X	310	A	135	30	25	400	1200	.1	.5	10	450	50		2N5828	664
2N5106		X		X	800	A	200	60	30	100	300	150	.22	150		250		2N6010	686
2N5107		X		X	360	A	200	60	30	100	300	150	.22	150		250		2N6010	686
2N5112		X	X		34W	C	175	40	40	15	60	500	.9	500	10	1		D45C4	1265
2N5127		X		X	200	A	125	20	12	15	300	2	.3	10	12			GET706	1288
2N5128		X		X	200	A	125	15	12	35	350	50	.25	150				GET3646	1382
2N5130		X		X	200	A	125	30	12	15	250	8	.6	10	12			2N3662	518
2N5131		X		X	200	A	125	20	15	30	500	10	1	10	25			GET706	1288
2N5132		X		X	200	A	125	20	20	30	400	10	2	10	20			2N5826	657
2N5133		X		X	200	A	125	20	18	60	1000	1	.4	1	50			2N5826	657
2N5134		X		X	200	A	125	20	10	20	150	10	.2	10				GET3646	1382
2N5135		X		X	300	A	125	30	25	50	600	10	1	100				2N6010	686
2N5136		X		X	220	A	125	30	20	20	400	150	.25	150				2N6010	686
2N5137		X		X	300	A	125	30	20	20	400	150	.25	150				2N6010	686
2N5138		X	X		200	A	125	30	20	50	800	.1	.3	10	40			2N6001	674
2N5139		X	X		200	A	125	20	20	40		1	.15	1				2N6001	674
2N5142		X	X		300	A	125	20	20	30		50	.5	50				2N6001	674
2N5143		X	X		200	A	125	20	20	30		50	.5	50				2N6001	674
2N5160		X	X		5W	C		60	40	10		50				500		D41D4	1243
2N5161		X	X		20W	C		60	40	10		250						D45C5	1265
2N5164					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157													C30F	913
2N5165																		C30B	913
2N5166																		C30D	913
2N5168																		C32F	913
2N5169																		C32B	913
2N5170																		C32D	913
2N5172		X		X	200	A		25	25	100	500	10	.25	10	100		592		
2N5174		X		X	200	A		90	75	40	600	10	.95	10	40		594		
2N5175		X		X	200	A		130	100	55	160	10	.95	10	55		594		
2N5176		X		X	200	A		130	100	140	300	10	.95	10	140		594		
2N5189		X		X	1W	A		60	55	15		1	1	1A				D42C6	1247
2N5190		X		X	40W	C	150	40	40	25	100	1.5A	1.4	4A	20			D44C6	1255
2N5191		X		X	40W	C	150	60	60	25	100	1.5A	1.4	4A	20			D44C8	1255
2N5193		X	X		40W	C	150	40	40	25	100	1.5A	1.4	4A	20			D45C6	1265
2N5194		X	X		40W	C	150	60	60	25	100	1.5A	1.4	4A	20			D45C8	1265
2N5204					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157												595		
2N5205																	595		
2N5206																	595		
2N5207																	595		
2N5209		X		X	310	A		50	50	100	300	.1	.7	10	150			2N5826	657
2N5210		X		X	310	A		50	50	200	600	.1	.7	10	250			2N5827	662
2N5213		X		X	7.5W	C	200	70	40	10	80	200	.5	500		350		D40D7	1233
2N5219		X		X	310	A		20	15	35	500	2	.4	10	35			GET706	1288
2N5220		X		X	310	A		15	15	30	600	50	.5	150	30			2N6010	686
2N5221		X	X		310	A		15	15	30	600	50	.5	150	30			2N6011	690
2N5222		X		X	310	A		20	15	20	1500	4	1	4	20			2N3663	518
2N5223		X		X	310	A		25	20	50	800	2	.7	10	50			2N5825	657
2N5224		X		X	310	A		25	12	40	400	10	.35	10				GET3646	1382
2N5225		X		X	310	A		25	25	30	600	50	.8	100	30			2N6010	686
2N5226		X	X		310	A		25	25	30	600	50	1	100	30			2N6011	690
2N5227		X	X		310	A		30	30	50	700	2	.4	10	10			2N6001	674
2N5232		X		X	330	A		70	50	250	500	2	.125	10	250		599		
2N5232A		X		X	330	A		70	50	250	500	2	.125	10	250		599		
2N5236		X		X	1W	C	200	40	20	30	120	50	.2	50		500		2N3663	518
2N5242		X	X		500	A			20	25	100	500	.38	500		170		2N5810	647
2N5243		X	X		500	A			30	25	100	500	.38	500		170		2N5810	647
2N5244		X	X		1W	C	200		40	150	300	10	.12	10		450		2N6005	682
2N5249		X		X	330	A		70	50	400	800	2	.125	10	400		602		
2N5249A		X		X	330	A		70	50	400	800	2	.125	10	400		602		
2N5252		X		X	7W	C		300	300	40	120	100	1	200		30		D44R3	1261
2N5253		X		X	7W	C		300	300	80	250	100	1	200		30		D44R4	1261
2N5262		X		X	1W	A		75	50	35		100	.8	1A				D42C7	1247
2N5272		X		X	360	A		40	40	100	400	10	.25	10		500		2N6000	670
2N5273																		SC60B	1483

Type	Germanium	Silicon	PNP	NPN	Maximum Ratings					Electrical Characteristics							Exact "2N" Type Page	Suggested GE Replacement	
					P_D @ 25°C (mw)	PT.	T_J °C	V_{CB} (V)	V_{CEO} (V)	h_{FE} Max.	h_{FE} Min.	@ I_C (mA)	$V_{CE(SAT)}$ (V)	@ I_C	h_{fe}	f_T Typical (MHz)		Type	Page
2N5274					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157													SC60D	1483
2N5276		X		X	360	A		25	15	30	90	1	.2	20		600		GET708	1288
2N5279		X		X	5W	C		400		40	160	20	.5	50		15		D44R4	1261
2N5292		X	X		1W	C	200		12	40	100	30	.12	10		800		2N6001	674
2N5295		X		X	360	C	150	60	50	30	120	1A	2	3.6A	20			D44C8	1255
2N5296		X		X	360	C	150	60	50	30	120	1A	2	3.6A	20			D44C8	1255
2N5297		X		X	360	C	150	80	70	20	80	1.5A	2	3.6A	25			D44C8	1255
2N5298		X		X	360	C	150	80	70	20	80	1.5A	2	3.6A	25			D44C8	1255
2N5305		X		X	450	A		25	25	2000	20000	2	1.4	200	2000	60	604		
2N5306		X		X	400	A		25	25	7000	70000	2	1.4	200	7000	60	604		
2N5306A		X		X	400	A		25	25	7000	70000	2	1.4	200	7000	60	604		
2N5307		X		X	400	A		40	40	2000	20000	2	1.4	200	2000	60	609		
2N5308		X		X	400	A		40	40	7000	70000	2	1.4	200	7000	60	609		
2N5308A		X		X	400	A		40	40	7000	70000	2	1.4	200	7000	60	609		
2N5309		X		X	330	A		70	50	60	120	.01	.125	10	66		613		
2N5310		X		X	330	A		70	50	100	300	.01	.125	10	10		613		
2N5311		X		X	330	A		70	50	250	500	.01	.125	10			613		
2N5321		X		X	10W	C	200	75	50	40	250	500	.8	500		50		D42C3	1247
2N5322		X	X		10W	C	200	100	75	30	130	500	.7	500		50		D42C8	1247
2N5323		X	X		10W	C	200	75	50	40	250	500	1.2	500		50		D43C7	1251
2N5334		X		X	6W	C	200	60	60	30	150	1A	.7	2A		40		D42C7	1247
2N5354		X	X		360	A		25	25	40	120	50	.25	50	32		617		
2N5355		X	X		360	A		25	25	100	300	50	.25	50	80		617		
2N5356		X	X		360	A		25	25	250	500	50	.25	50	200		617		
2N5365		X	X		360	A		40	40	40	120	50	.25	50	32		625		
2N5366		X	X		360	A		40	40	100	300	50	.25	50	80		625		
2N5367		X	X		360	A		40	40	250	500	50	.25	50	200		625		
2N5368		X		X	360	A	150	60	30	60	200	150	.3	150		250	633		
2N5369		X		X	360	A	150	60	30	100	300	150	.3	150		250	633		
2N5370		X		X	360	A	150	60	30	200	600	150	.3	150		250	633		
2N5371		X		X	360	A	150	40	30	60	600	150	.3	150		250	633		
N5372		X	X		360	A	150	60	30	40	120	150	.3	150		150	635		
N5373		X	X		360	A	150	60	30	100	300	150	.3	150		150	635		
N5374		X	X		360	A	150	60	30	200	400	150	.3	150		150	635		
N5375		X	X		360	A	150	40	30	40	400	150	.3	150		150	635		
N5376		X		X	360	A	150	60	30	100	500	.01	.2	10	120	300		2N5816	649
N5377		X		X	360	A	150	60	30	40	200	.01	.2	10	100	300		2N5818	649
N5378		X	X		360	A	150	40	30	100	500	.01	.2	10	120	200		2N5817	649
N5379		X	X		360	A	150	40	30	40	200	.01	.2	10	100	200		2N5819	649
N5417		X		X	500	A		40	35	80	250	150	.55	150		250		2N6010	686
N5418		X		X	360	A		25	25	40	120	50	.25	50	25		637		
N5419		X		X	360	A		25	25	100	300	50	.25	50	70		637		
N5420		X		X	360	A		25	25	250	500	50	.25	50	150		637		
N5421		X		X	3W	C		3.6	18	10	60	100	.5	200		300		D40D1	1233
N5422		X		X	5W	C		36	18	10	60	500	.5	500		300		D40D1	1233
N5423		X		X	12W	C		36	18	20	70	1A	.5	1A		300		D42C1	1247
N5424		X		X	20W	C		36	18	20	100	2A	.5	2A		250		D44C1	1255
N5431					UNIJUNCTIONS - FOR OTHER TYPES SEE SELECTOR GUIDE P 124													2N2840	491
N5447		X		X	360	A		40	25	60	300	50	.25	50			639		
N5448		X		X	360	A		50	30	30	150	50	.25	50			639		
N5449		X		X	360	A		50	30	100	300	50	.6	100			641		
N5450		X		X	360	A		50	30	50	150	50	.8	100			641		
N5451		X		X	360	A		50	40	30	600	50	1	100			641		
N5455		X	X		340	A	200	15	15	30	120	30	.5	300		450		2N6001	674
N5456		X	X		340	A	200	25	25	30	120	30	.55	300		450		2N6001	674
N5470																		D40D7	1233
N5471		X		X	5W	C		50	30	20		50						D40D1	1233
N5482		X		X	10W	C		50	30	20		50						D40D1	1233
N5483		X		X	20	C		45	30	20		100						D44C1	1255
N5489		X		X			200	100	100	15	50	40A	1.5	40A	10			D42C2	1247
N5567					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157													SC46B	1467
N5568																		SC46D	1467
N5569																		SC45B	1467
N5570																		SC45D	1467
N5571																		SC51B	1475
N5572																		SC51D	1475
N5573																		SC50B	1475
N5574																		SC50D	1475
N5590		X		X	30W	C		36	18	5		250				200		D44C2	1255
N5597		X	X		20W	C	200	80	60	70	200	1A	.46	1A	50	60		D45C8	1265

Type	Germanium	Silicon	PNP	NPN	Maximum Ratings					Electrical Characteristics							Exact "2N" Type Page	Suggested GE Replacement	
					P_D @ 25°C (mw)	PT.	T_J °C	V_{CB} (V)	V_{CEO} (V)	h_{FE} Max.	h_{FE} Min.	@ I_C (mA)	$V_{CE(SAT)}$ (V)	@ I_C	h_{fe}	f_T Typical (MHz)		Type	Page
2N5598		X		X	20W	C	200	80	60	70	200	1A	.46	1A	50	60		D44C8	1255
2N5606		X		X	25W	C	200	80	60	70	200	2.5A	.75	2.5A	50	70		D44C8	1255
2N5614		X		X	58W	C	200	80	60	70	200	2.5A	.75	2.5A	50	70		D44C9	1255
2N5637		X		X	30W	C		60	35	5		500				400		D44C5	1255
2N5642		X		X	30W	C		65	35	5		200				250		D44C4	1255
2N5644		X		X	3.5W	C		36	18	15		100				400		D40D1	1233
2N5645		X		X	12W	C		36	18	15		500				400		D42C1	1247
2N5646		X		X	30W	C		36	18	15	1A					400		D44C1	1255
2N5650		X		X	150	A		20	15	30	300	3				2000		2N3663	518
2N5651		X		X	150	A		20	15	30	300	3				2000		2N3663	518
2N5652		X		X	150	A		20	15	30	300	3				2000		2N3663	518
2N5655		X		X	20W	C	150	275	250	30	250	100	1	100	20			D44R2	1261
2N5656		X		X	20W	C	150	325	300	30	250	100	1	100	20			D44R4	1261
2N5660		X		X			200	250	200	40	150	500	.4	1A		20		D44R2	1261
2N5661		X		X			200	400	300	40	150	500	.4	1A		20		D44R4	1261
2N5662		X		X			200	250	200	40	150	500	.4	1A		20		D44R1	1261
2N5663		X		X			200	400	300	40	150	500	.4	1A		20		D44R3	1261
2N5682		X		X	10W	C	200	120	120	40	150	250	.6	250	40	30		D44R2	1261
2N5687		X		X	5W	C		40	20	15		50						D40D1	1233
2N5688		X		X	10W	C		40	20	15		50						D42C1	1247
2N5689		X		X	25W	C		60	40	15		100						D44C4	1255
2N5690		X		X	50W	C		50	30	10		100						D44C1	1255
2N5697		X		X	3.5W	C		40	18	30		40						D40D1	1233
2N5698		X		X	5W	C		40	18	30		40						D40D1	1233
2N5699		X		X	10W	C		40	18	15		50						D40D1	1233
2N5700		X		X	35W	C		40	18	30		50						D44C1	1255
2N5701		X		X	35W	C		40	18	30		50						D44C1	1255
2N5703		X		X	750	C		40	18	15		50						D40D1	1233
2N5704		X		X	25W	C		40	18	15		50						D44C1	1255
2N5705		X		X	44W	C		36	18	15		100						D44C1	1255
2N5710		X		X	3.5W	C		40	20	20		10						D40D1	1233
2N5712		X		X	25W	C		60	40	10		100						D44C4	1255
2N5713		X		X	45W	C		60	40	10		10						D44C1	1255
2N5719																		2N2324A	880
2N5720					THYRISTORS - FOR OTHER TYPES SEE SELECTOR GUIDES P 138-157													2N2324A	880
2N5721																		2N2326A	880
2N5722																		2N2328A	880
2N5723																		2N2329	880
2N5754																		SC141A	1455
2N5755																		SC141B	1455
2N5755																		SC141D	1455
2N5764		X		X	10W	S		55	25	20		100						D40D4	1233
2N5765		X		X	19W	S		55	25	20		100						D44C1	1255
2N5766		X		X	5W	S		55	25	20		50						D40D4	1233
2N5767		X		X	10W	S		55	25	20		100						D40D1	1233
2N5768		X		X	20W	S		55	25	20		100						D44C1	1255
2N5777-80					PHOTO TRANSISTOR												643	D43C8	1251
2N5782		X	X		10W	C	200	65	65	4		3.2A	2	3.2A	25	8		D43C5	1251
2N5783		X	X		10W	C	200	45	45	4		3.2A	2	3.2A	25	8		D42C7	1247
2N5785		X		X	10W	C	200	65	65	4		3.2A	2	3.2A	25	2.5		D42C6	1247
2N5786		X		X	10W	C	200	45	45	4		3.2A	2	3.2A	25	2.5			
2N5810		X		X	500	A	135	35	25	60	200	2	.75	500			647		
2N5811		X		X	500	A	135	35	25	60	200	2	.75	500			647		
2N5812		X		X	500	A	135	35	25	150	500	2	.75	500			647		
2N5813		X	X		500	A	135	35	25	150	500	2	.75	500			647		
2N5814		X		X	500	A	135	50	40	60	120	2	.75	500			649		
2N5815		X	X		500	A	135	50	40	60	120	2	.75	500			649		
2N5816		X		X	500	A	135	50	40	100	200	2	.75	500			649		
2N5817		X	X		500	A	135	50	40	100	200	2	.75	500			649		
2N5818		X		X	500	A	135	50	40	150	300	2	.75	500			649		
2N5819		X	X		500	A	135	50	40	150	300	2	.75	500			649		
2N5820		X		X	500	A	135	70	60	60	120	2	.75	500			653		
2N5821		X	X		500	A	135	70	60	60	120	2	.75	500			653		
2N5822		X		X	500	A	135	70	60	100	200	2	.75	500			653		
2N5823		X	X		500	A	135	70	60	100	200	2	.75	500			653		
2N5824		X		X	360	A	125	50	40	60	120	2	.125	10	60		657		
2N5825		X		X	360	A	125	50	40	100	200	2	.125	10	100		657		
2N5826		X		X	360	A	125	50	40	150	300	2					657		
2N5827		X		X	360	A	125	50	40	250	500	2					662		
2N5828		X		X	360	A	125	50	40	400	800	2					664		

Type	Germanium	Silicon	PNP	NPN	Maximum Ratings					Electrical Characteristics							Exact "2N" Type Page	Suggested GE Replacement	
					P_D @ 25°C (mw)		T_J °C	V_{CB} (V)	V_{CEO} (V)	h_{FE}		@ I_C (mA)	$V_{CE(SAT)}$ @ I_C		h_{fe}	f_T Typical (MHz)		Type	Page
						PT.				Max.	Min.		(V)						
2N5835		X		X	200	A	125	15	10	25		10						GET706	1288
2N5841		X		X	350	C	200	20	10	25		25				2000		2N3663	518
2N5842				X	350	C	200	20	10	25		25				2000		2N3663	518
2N5845																		2N6010	686
2N5851		X		X	500	C	200	30	15	40		10				800		2N3663	518
2N5852		X		X	500	C	200	30	15	40		10				1000		2N3663	518
2N5855		X	X		750	A	135	60	55	50	300	150	.4	150		100		2N6015	698
2N5856		X		X	750	A	135	60	55	50	300	150	.4	150		100		2N6014	694
2N5857		X	X		750	A	135	80	80	50	300	150	.4	150		100		2N6015	698
2N5858		X		X	750	A	135	80	80	50	300	150	.4	150		100		2N6014	694
2N5961		X		X	625	A	135	60	60	150	700	10	.2	10		150		2N6014	694
2N5998		X		X	360	A	150	35	25	150	300	10	.25	50		250	666		
2N5999		X	X		360	A	150	35	25	150	300	10	.25	50		250	666		
2N6000		X		X	360	A	150	35	25	100	300	10	.175	100		250	670		
2N6001		X	X		360	A	150	35	25	100	300	10	.175	100		250	674		
2N6002		X		X	360	A	150	35	25	250	500	10	.175	100		250	670		
2N6003		X	X		360	A	150	35	25	250	500	10	.175	100		250	674		
2N6004		X		X	360	A	150	50	40	100	300	10	.175	100		250	678		
2N6005		X	X		360	A	150	50	40	100	300	10	.175	100		250	682		
2N6006		X		X	360	A	150	50	40	250	500	10	.175	100		250	678		
2N6007		X	X		360	A	150	50	40	250	500	10	.175	100		250	682		
2N6008		X		X	360	A	150	35	25	250	500	10	.25	50		250	666		
2N6009		X	X		360	A	150	35	25	250	500	10	.25	50		250	666		
N6010		X		X	625	A	150	50	40	100	300	10	.25	300		200	686		
N6011		X	X		500	A	150	50	40	100	300	10	.6	300		200	690		
N6012		X		X	625	A	150	50	40	250	500	10	.25	300		200	686		
N6013		X	X		500	A	150	50	40	250	500	10	.6	300		200	690		
N6014		X		X	625	A	150	70	60	100	300	10	.25	300		200	694		
N6015		X	X		500	A	150	70	60	100	300	10	.6	300		200	698		
N6016		X		X	675	A	150	70	60	250	500	10	.25	300		200	694		
N6017		X	X		500	A	150	70	60	250	500	10	.25	300		200	698		
N6027																	702		
N6028					UNIJUNCTIONS - FOR OTHER TYPES SEE SELECTOR GUIDE P 124												702		
N6076		X	X		360	A	150	25	25	100	500	10	.25	10		200	592		
N6116																	706		
N6117					UNIJUNCTIONS - FOR OTHER TYPES SEE SELECTOR GUIDE P 124												706		
N6118																	706		
N6218		X		X	500	A	150	300	300	10		2	1	10		50	708		
N6219		X		X	500		150	250	250	10		2	1	10		50	708		
N6220		X		X	500		150	200	200	10		2	2	20		50	708		
N6221		X		X	500	A	150	150	150	10		2	2.3	20		50	708		
N6222		X		X	360	A	150	60	60	75	200	2	.125	10	300		711		
N6223		X	X		360	A	150	60	60	75	200	2	.125	10	300		711		
N6224		X		X	360	A	150	60	60	150	300	2	.175	10	300		711		
N6225		X	X		360	A	150	60	60	150	300	2	.175	10	300		711		
N81					SILICON CONTROL SWITCHES												715		
N82																	715		
N83																	720		
N84																	724		
N85																	724		
N86																	728		

MANUFACTURERS' CODES

AME	Amelco Semiconductors
AM	American Micro Semiconductors
AMD	Advanced Micro Devices
APX	Amperex Electronic Corp.
ATL	Atlantic Semiconductor, Inc.
CL	Centra Lab
CMI	CMI, Inc.
DI	Diodes, Inc.
ECC	Electronics Component Corp.
ECD	Unisem Corp.
EDL	Edal Industries
ED	Electronic Devices, Inc.
ELN	Electro-Nuclear Labs
ESM	Societe European De Semiconducteurs, France
FER	Ferranti Ltd., England
FSC	Fairchild Semiconductor
GI	General Instruments
GSI	General Semiconductors, Inc.
HEI	Hei, Inc.
HP	Hewlett-Packard Co.
HUN	Hunt Semiconductors
HUT	Hutson Semiconductors
IR	International Rectifier
INT	Intel
ITC	Industro Transistor Corp.
KMC	KMC Semiconductor Corp.
LIT	Litronix
LUC	Lucas, England
MAT	Matsushita, Japan
MEH	Micro Electronics, Hong Kong
MIC	Microsemiconductor Corp.
MS	Micro State
MIT	Mitsubishi, Japan
MON	Monsanto Co.
MOS	Mosek
MOT	Motorola Semiconductor Products, Inc.
MS	Micro Systems Int.
MST	MS Transistor Corp.
NAT	National Electronics
NEC	Nippon Electronic, Japan
NSC	National Semiconductor Corp.
OPC	Opcoa, Inc.
OPT	Optron, Inc.
PHF	Philco-Ford Corp.
PIR	Pirgo Electronics, Inc.
PLY	Plessey, Ltd.
PPC	Power Physics
RAD	La Radiotechnique, France
RAY	Raytheon Co.
RCA	RCA/Electronics Components
RC	Rectifier Components
SK	Semicon, Inc.
SM	Semteck Corp.
SER	Servex Semiconductor Division, Austral
SGS	Societa Generale Semiconductors, Italy
SHW	Siemens, W. Germany
SIG	Signetics
SG	Silicon General
SIL	Silicon Transistor Corp.
SOD	Solitron Devices, Inc.
SPE	Spectronics, Inc.
SPR	Sperry Gyroscope Co.
SPG	Sprague
SSI	Solid State Products, Inc.
STC	Silicon Transistor Corp.
SYL	Sylvania Electric Products, Inc.
TAG	Transistor AG, Switzerland
TEC	Transitron Electronic Corp.
TI	Texas Instruments, Inc.
TOS	Toshiba, Japan
TRW	TRW Semiconductor Division
TSC	Teledyne Semiconductors
UNI	Unitrode Corp.
UNS	Unisem, Inc.
UPI	United Page, Inc.
VAR	Varo, Inc.
VAD	Varadyne
W	Westinghouse Electric Corp.

Industry Type	Mfg.	Device Type	Exact Type Page	Suggested GE Replacement	
				Type	Page
2S012	--	PWR TRAN		D44CB	1255
2S017	--	PWR TRAN		D40D7	1233
2S019	--	PWR TRAN		D40D7	1233
2SA257	--	PWR TRAN		D43C5	1251
2SA258	--	PWR TRAN		D43C5	1251
2SA527	--	PWR TRAN		D43C5	1251
2SA528	--	PWR TRAN		D43C5	1251
2SA547	--	PWR TRAN		D43C8	1251
2SA565	--	PWR TRAN		D41D7	1243
2SA571	--	PWR TRAN		D41D4	1243
2SA597	--	PWR TRAN		D41D4	1243
2SA613	--	PWR TRAN		D45C6	1265
2SA614	--	PWR TRAN		D45C8	1265
2SC22	--	PWR TRAN		D42C8	1247
2SC23	--	PWR TRAN		D42C8	1247
2SC24	--	PWR TRAN		D42C8	1247
2SC51	--	PWR TRAN		D40D1	1233
2SC59	--	PWR TRAN		D40D7	1233
2SC61	--	PWR TRAN		D40D1	1233
2SC69	--	PWR TRAN		D40D8	1233
2SC92	--	PWR TRAN		D44C8	1255
2SC93	--	PWR TRAN		D44C8	1255
2SC94	--	PWR TRAN		D44C7	1255
2SC97	--	PWR TRAN		D40D1	1233
2SC101A	--	PWR TRAN		D44C8	1255
2SC106	--	PWR TRAN		D42C7	1247
2SC107	--	PWR TRAN		D42C7	1247
2SC108A	--	PWR TRAN		D40D8	1233
2SC109A	--	PWR TRAN		D40D5	1233
2SC130	--	PWR TRAN		D40D7	1233
2SC213	--	PWR TRAN		D40D1	1233
2SC214	--	PWR TRAN		D40D1	1233
2SC215	--	PWR TRAN		D40D1	1233
2SC223	--	PWR TRAN		D40D1	1233
2SC224	--	PWR TRAN		D40D1	1233
2SC225	--	PWR TRAN		D40D1	1233
2SC291	--	PWR TRAN		D42C5	1247
2SC292	--	PWR TRAN		D42C7	1247
2SC297	--	PWR TRAN		D42C7	1247
2SC298	--	PWR TRAN		D42C8	1247
2SC306	--	PWR TRAN		D40D2	1233
2SC307	--	PWR TRAN		D40D5	1233
2SC310	--	PWR TRAN		D44R	1261
2SC354	--	PWR TRAN		D42C5	1247
2SC490	--	PWR TRAN		D44C5	1255
2SC491	--	PWR TRAN		D44C1	1255
2SC5120	--	PWR TRAN		D42C8	1247
2SC512R	--	PWR TRAN		D42C7	1247
2SC5130	--	PWR TRAN		D42C5	1247
2SC513R	--	PWR TRAN		D42C4	1247
2SC515	--	PWR TRAN		D44R4	1261
2SC516	--	PWR TRAN		D40D7	1233
2SC516A	--	PWR TRAN		D44R1	1261
2SC517	--	PWR TRAN		D42C7	1247
2SC524	--	PWR TRAN		D40C7	1229
2SC525	--	PWR TRAN		D40D4	1233
2SC541	--	PWR TRAN		D40D4	1233
2SC542	--	PWR TRAN		D40D4	1233
2SC543	--	PWR TRAN		D44C5	1255
2SC547	--	PWR TRAN		D40D4	1233
2SC548	--	PWR TRAN		D40D1	1233
2SC549	--	PWR TRAN		D40D4	1233
2SC550	--	PWR TRAN		D44C7	1255
2SC551	--	PWR TRAN		D44C1	1255
2SC552	--	PWR TRAN		D44C5	1255
2SC553	--	PWR TRAN		D40D1	1233
2SC554	--	PWR TRAN		D40D1	1233
2SC571	--	PWR TRAN		D40D1	1233
2SC572	--	PWR TRAN		D42C1	1247

Industry Type	Mfg.	Device Type	Exact Type Page	Suggested GE Replacement	
				Type	Page
2SC573	--	PWR TRAN		D44C3	1255
2SC582	--	PWR TRAN		D40N3	1237
2SC585	--	PWR TRAN		D44C5	1255
2SC591	--	PWR TRAN		D44C7	1255
2SC592	--	PWR TRAN		D42C8	1247
2SC597	--	PWR TRAN		D40D4	1233
2SC598	--	PWR TRAN		D40D4	1233
2SC599	--	PWR TRAN		D44C5	1255
2SC600	--	PWR TRAN		D44C5	1255
2SC608	--	PWR TRAN		D40D7	1233
2SC609	--	PWR TRAN		D40D7	1233
2SC635	--	PWR TRAN		D40D4	1233
2SC636	--	PWR TRAN		D44C5	1255
2SC637	--	PWR TRAN		D40D1	1233
2SC638	--	PWR TRAN		D44C1	1255
2SC646	--	PWR TRAN		D44C8	1255
2SC685	--	PWR TRAN		D40N3	1237
2SC685A	--	PWR TRAN		D40N3	1237
2SC686	--	PWR TRAN		D40N2	1237
2SC688	--	PWR TRAN		D44C5	1255
2SC690	--	PWR TRAN		D44C4	1255
2SC691	--	PWR TRAN		D42C4	1247
2SC692	--	PWR TRAN		D42C5	1247
2SC697	--	PWR TRAN		D40D1	1233
2SC700	--	PWR TRAN		D40D4	1233
2SC702	--	PWR TRAN		D42C1	1247
2SC703	--	PWR TRAN		D44C1	1255
2SC704	--	PWR TRAN		D44C1	1255
2SC730	--	PWR TRAN		D40D4	1233
2SC737	--	PWR TRAN		D44C5	1255
2SC756	--	PWR TRAN		D42C6	1247
2SC774	--	PWR TRAN		D40D4	1233
2SC777	--	PWR TRAN		D40D7	1233
2SC781	--	PWR TRAN		D40D4	1233
2SC788	--	PWR TRAN		D44R1	1261
2SC795	--	PWR TRAN		D40N1	1237
2SC799	--	PWR TRAN		D42C6	1247
2SC802	--	PWR TRAN		D40D4	1233
2SC803	--	PWR TRAN		D40D4	1233
2SC816	--	PWR TRAN		D40D1	1233
2SC821	--	PWR TRAN		D40D1	1233
2SC822	--	PWR TRAN		D40D1	1233
2SC830	--	PWR TRAN		D44C6	1255
2SC831	--	PWR TRAN		D45C2	1265
2SC840	--	PWR TRAN		D44C8	1255
2SC867	--	PWR TRAN		D44R2	1261
2SC890	---	PWR TRAN		D40D1	1233
2SC891	--	PWR TRAN		D42C1	1247
2SC892	--	PWR TRAN		D44C1	1255
2SC893	--	PWR TRAN		D42C8	1247
2SC909	--	PWR TRAN		D40D4	1233
2SC911	--	PWR TRAN		D42C4	1247
2SC916	--	PWR TRAN		D42C8	1247
2SC931	--	PWR TRAN		D42C6	1247
2SC932	--	PWR TRAN		D42C3	1247
2SC990	--	PWR TRAN		D42C2	1247
2SC996	--	PWR TRAN		D40N3	1237
2SC1012A	--	PWR TRAN		D40N1	1237
2SC1024	--	PWR TRAN		D44C8	1255
2SC1104	---	PWR TRAN		D44R4	1261
2SC1105	--	PWR TRAN		D40N4	1237
2SCD24	--	PWR TRAN		D40N3	1237
2SD28	--	PWR TRAN		D44C6	1255
2SD29	--	PWR TRAN		D44C8	1255
2SD48	--	PWR TRAN		D44C8	1255
2SD49	--	PWR TRAN		D44C8	1255
2SD50	--	PWR TRAN		D44C8	1255
2SD57	--	PWR TRAN		D44C3	1255
2SD58	--	PWR TRAN		D44C5	1255
2SD78	--	PWR TRAN		D42C8	1247

Industry Type	Mfg.	Device Type	Exact Type Page	Suggested GE Replacement	
				Type	Page
2SD79	--	PWR TRAN		D44C8	1255
2SD90	--	PWR TRAN		D44C5	1255
2SC91	--	PWR TRAN		D44C8	1255
2SD92	--	PWR TRAN		D40D4	1233
2SD120	--	PWR TRAN		D40D7	1233
2SD121	--	PWR TRAN		D44C7	1255
2SD130	--	PWR TRAN		D40N1	1237
2SD136	--	PWR TRAN		D40N3	1237
2SD137	--	PWR TRAN		D42C2	1247
2SD141	--	PWR TRAN		D42C2	1247
2SD142	--	PWR TRAN		D44C2	1255
2SD146	--	PWR TRAN		D44C8	1255
2SD150	--	PWR TRAN		D44C5	1255
2SD152	--	PWR TRAN		D42C8	1247
3SD154	--	PWR TRAN		D44C8	1255
2SD155	--	PWR TRAN		D44C8	1255
2Sd156	--	PWR TRAN		D40N1	1237
2SD157	--	PWR TRAN		D40N3	1237
2SD158	--	PWR TRAN		D44R1	1261
2SD159	--	PWR TRAN		D44R3	1261
2SD174	--	PWR TRAN		D44C6	1255
2SD175	--	PWR TRAN		D44C8	1255
2SD182	--	PWR TRAN		D40D3	1233
2SD183	--	PWR TRAN		D40D7	1233
2SD184	--	PWR TRAN		D44C5	1255
2SD185	--	PWR TRAN		D44C8	1255
2SD226	--	PWR TRAN		D44C5	1255
2SD226A	--	PWR TRAN		D44C7	1255
2SD2340	--	PWR TRAN		D44C8	1255
2SD234R	--	PWR TRAN		D44C8	1255
2SD2350	--	PWR TRAN		D44C6	1255
2SD235R	--	PWR TRAN		D44C5	1255
2SF11	TOS	SCR		C20U	910
2SF12	TOS	SCR		C20A	910
2SF14	TOS	SCR		C20B	910
2SF16	TOS	SCR		C20C	910
2SF18	TOS	SCR		C20D	910
2SF24	TOS	SCR		C30B	913
2SF28	TOS	SCR		C30D	913
2SF63	TOS	SCR		C30F	913
2SF64	TOS	SCR		C30F	913
2SF65	TOS	SCR		C30A	913
2SF66	TOS	SCR		C30B	913
2SF67	TOS	SCR		C30B	913
2SF69	TOS	SCR		C30C	913
2SF70	TOS	SCR		C30D	913
2SF71	TOS	SCR		C30F	913
2Sf72	TOS	SCR		C30F	913
2SF73	TOS	SCR		C30A	913
2SF74	TOS	SCR		C30B	913
2SF75	TOS	SCR		C30B	913
2SF76	TOS	SCR		C30C	913
2SF77	TOS	SCR		C30D	913
2SF101	NEC	SCR		C103YY	953
2SF102	NEC	SCR		C103A	953
2SF104	NEC	SCR		C103B	953
2SF139	TOS	SCR		C30E	913
2SF200	TOS	SCR		C20E	910
2SF221	TOS	SCR		C20U	910
2SF222	TOS	SCR		C20F	910
2SF223	TOS	SCR		C20A	910
2SF224	TOS	SCR		C20B	910
2SF225	TOS	SCR		C20B	910
2SF226	TOS	SCR		C20C	910
2SF227	TOS	SCR		C20D	910
2SF228	TOS	SCR		C20E	910
2SF261	TOS	SCR		C20F	910
2SF262	TOS	SCR		C20A	910
2SF263	TOS	SCR		C20B	910
2SF264	TOS	SCR		C20B	910
2SF265	TOS	SCR		C20C	910
2SF266	TOS	SCR		C20C	910
2SF267	TOS	SCR		C20D	910
2SF268	TOS	SCR		C20D	910
2SF269	TOS	SCR		C20E	910

Industry Type	Mfg.	Device Type	Exact Type Page	Suggested GE Replacement	
				Type	Page
2SF271	TOS	SCR		C20F	910
2SF272	TOS	SCR		C20A	910
2SF273	TOS	SCR		C20B	910
2SF274	TOS	SCR		C20B	910
2SF275	TOS	SCR		C20C	910
2SF276	TOS	SCR		C20C	910
2SF277	TOS	SCR		C20D	910
2SF278	TOS	SCR		C20D	910
2SF279	TOS	SCR		C20E	910
2SF291	TOS	SCR		C30F	913
2SF292	TOS	SCR		C30A	913
2SF293	TOS	SCR		C30B	913
2SF294	TOS	SCR		C30B	913
2SF295	TOS	SCR		C30C	913
2SF296	TOS	SCR		C30C	913
2SF298	TOS	SCR		C30D	913
2SF299	TOS	SCR		C30E	913
2SF322	TOS	SCR		C20F	910
2SF323	TOS	SCR		C20A	910
2SF324	TOS	SCR		C20B	910
2SF325	TOS	SCR		C20B	910
2SF326	TOS	SCR		C20C	910
2SF327	TOS	SCR		C20C	910
2SF328	TOS	SCR		C20D	910
2SF329	TOS	SCR		C20E	910
2SF436	TOS	SCR		C30E	913
2SF441	TOS	SCR		C20A	910
2SF442	TOS	SCR		C20B	910
2SF443	TOS	SCR		C20D	910
2SF521	NEC	SCR		C103YY	953
2SF522	NEC	SCR		C103A	953
2SF523	NEC	SCR		C103B	953
2SF656	NEC	SCR		C103YY	953
2SF657	NEC	SCR		C103A	953
2SF658	NEC	SCR		C103B	953
2SM11	TOS	TRIAC		SC40B	1459
2SM12	TOS	TRIAC		SC40B	1459
2SM13	TOS	TRIAC		SC40E	1459
2SM20	TOS	TRIAC		SC45B	1467
2SM21	TOS	TRIAC		SC45B	1467
2SM22	TOS	TRIAC		SC45E	1467
2SM58	TOS	TRIAC		SC45B	1467
3A05	SOD	RECTIFIER		A15F	805
3A1	SOD	RECTIFIER		A15A	805
3A2	SOD	RECTIFIER		IN5624	316
3A4	SOD	RECTIFIER		IN5625	316
3A6	SOD	RECTIFIER		IN5626	316
3A3060	UNI	SCR		C103A	953
3A3060A	UNI	SCR		C103A	953
3A3100	UNI	SCR		C103A	953
3A3100A	UNI	SCR		C103A	953
3A3150	UNI	SCR		C103B	953
3A3150A	UNI	SCR		C103B	953
3A3200	UNI	SCR		C103B	953
3A3200A	UNI	SCR		C103B	953
3C6030	UNI	SCR		C103Y	953
3C6100	UNI	SCR		C103A	953
3C6150	UNI	SCR		C103B	953
3C6200	UNI	SCR		C103B	953
3F15	UNI	SCR		C103Y	953
3F30	UNI	SCR		C103Y	953
3F60	UNI	SCR		C103YY	953
3F100	UNI	SCR		C103A	953
3F150	UNI	SCR		C103A	953
3F200	UNI	SCR		C103B	953
3J15	UNI	SCR		C103Y	953
3J30	UNI	SCR		C103Y	953
3J60	UNI	SCR		C103YY	953
3J100	UNI	SCR		C103A	953
3K15	UNI	SCR		C103Y	953
3L1015	UNI	SCR		C103Y	953
3L1030	UNI	SCR		C103Y	953
3L1060	UNI	SCR		C103YY	953
3L1100	UNI	SCR		C103A	953
3L2015	UNI	SCR		C103Y	953

Industry Type	Mfg.	Device Type	Exact Type Page	Suggested GE Replacement Type	Suggested GE Replacement Page
3L2030	UNI	SCR		C103Y	953
3L2060	UNI	SCR		C103YY	953
3L2100	UNI	SCR		C103A	953
3RC10A	IR	SCR		C20A	910
3RC20A	IR	SCR		C20B	910
3RC30A	IR	SCR		C20C	910
3RC40A	IR	SCR		C20D	910
3RC50A	IR	SCR		C20E	910
4K30	UNI	SCR		C103Y	953
4L30	UNI	SCR		C103Y	953
4L60	UNI	SCR		C103YY	953
4L100	UNI	SCR		C103A	953
5A15	UNI	SCR		C103Y	953
5A30	UNI	SCR		C103Y	953
5A60	UNI	SCR		C103YY	953
5A100	UNI	SCR		C103A	953
5RC10A	IR	SCR		C11A	894
5RC20A	IR	SCR		C11B	894
5RC30A	IR	SCR		C11C	894
5RC40A	IR	SCR		C11D	894
5RC50A	IR	SCR		C11E	894
5RC60A	IR	SCR		C11M	894
8RCM5	IR	SCR		C34F	918
8RCM10	IR	SCR		C34A	918
8RCM20	IR	SCR		C34B	918
8RCM30	IR	SCR		C34C	918
8RCM40	IR	SCR		C34D	918
8RCM50	IR	SCR		C34E	918
10C05	IR	RECTIFIER		A14F	801
10C1	IR	RECTIFIER		A114A	819
10C2	IR	RECTIFIER		1N5059	312
10C4	IR	RECTIFIER		1N5060	312
10C6	IR	RECTIFIER		1N5061	312
10C8	IR	RECTIFIER		1N5062	312
10C10	IR	RECTIFIER		A14P	803
10DB1P	IR	RECT BRIDGE		GEB101	1284
10DB2P	IR	RECT BRIDGE		GEB102	1284
10DB4P	IR	RECT BRIDGE		GEB104	1284
10DB6P	IR	RECT BRIDGE		GEB106	1284
10RC10A	IR	SCR		C35,30A	922
10RC10AS24	IR	SCR		C34A	918
10RC20A	IR	SCR		C35,30B	922
10RC20AS24	IR	SCR		C34B	918
10RC30A	IR	SCR		C35,30C	922
10RC30AS24	IR	SCR		C34C	918
10RC40A	IR	SCR		C35,30D	922
10RC40AS24	IR	SCR		C34D	918
10RC50A	IR	SCR		C35,30E	922
10RC50AS24	IR	SCR		C34E	918
10RC60A	IR	SCR		C35M	922
10RC80A	IR	SCR		C35N	922
12F80B	IR	RECTIFIER		IN3671A	219
12F100B	IR	RECTIFIER		IN3673A	219
15S05	AM	RECTIFIER		A14F	801
15S1	AM	RECTIFIER		A14A	801
15S2	AM	RECTIFIER		1N5059	312
15S4	AM	RECTIFIER		1N5059	312
15S6	AM	RECTIFIER		1N5061	312
16RC10A	AM	SCR		C30,35A	913
16RC10AS24	IR	SCR		C34,40A	918
16RC20A	IR	SCR		C30,35B	913
16RC20AS24	IR	SCR		C34,40B	918
16RC30A	IR	SCR		C30,35C	913
16RC30AS24	IR	SCR		C34,40C	918
16RC40A	IR	SCR		C30,35D	913
16RC40AS24	IR	SCR		C34,40D	918
16RC50A	IR	SCR		C137E	978
16RC50AS24	IR	SCR		C34,40E	918
16RC60A	IR	SCR		C137M	978
16RC80A	IR	SCR		C137N	978
16RC100A	IR	SCR		C137P	978
20S05	AM	RECTIFIER		A15F	805
20S1	AM	RECTIFIER		A15A	805
20S2	AM	RECTIFIER		1N5624	316
20S4	AM	RECTIFIER		1N5625	316
20S6	AM	RECTIFIER		1N5626	316
22RC10	IR	SCR		C38A	930
22RC20	IR	SCR		C38B	930
22RC30	IR	SCR		C38C	930
22RC40	IR	SCR		C38D	930
22RC50	IR	SCR		C38E	930
22RC60	IR	SCR		C38M	930
36RA-B	IR	SCR		C150X167	1011
36RA-S66	IR	SCR		C158X58	1025
36RA-T60	IR	SCR		C158-X58	1025
36RC-A	IR	SCR		C46	937
36REH	IR	SCR		C150	1011
37RA-B	IR	SCR		C152-X167	1011
37RA-S66	IR	SCR		C159-X58	1025
37RA-T60	IR	SCR		C159-X58	1025
37RC-A	IR	SCR		C46	880
37REH	IR	SCR		C152	1011
40HF5	IR	RECTIFIER		1N1183A	215
40HF10	IR	RECTIFIER		1N1184A	215
40HF15	IR	RECTIFIER		1N1185A	215
40HF20	IR	RECTIFIER		1N1186A	215
40HF30	IR	RECTIFIER		1N1187A	215
40HF40	IR	RECTIFIER		1N1188A	215
40HF50	IR	RECTIFIER		1N1189A	215
40HF60	IR	RECTIFIER		1N1190A	215
40HF70	IR	RECTIFIER		1N3765	215
40HF80	IR	RECTIFIER		1N3766	215
40HF90	IR	RECTIFIER		1N3767	215
40HF100	IR	RECTIFIER		1N3768	215
40RCS	IR	SCR		C45/145	937
51RCG	IR	SCR		C155-X127	1017
51RCG-S53	IR	SCR		C155-X126	1017
52RCG	IR	SCR		C157-X127	1017
52RCG-S53	IR	SCR		C157-X126	1017
60T4	IR	SCR		C103Y	953
61T4	IR	SCR		C103YY	953
62T4	IR	SCR		C103A	953
64T4	IR	SCR		C103B	953
71RA	IR	SCR		C150	1011
71RB	IR	SCR		C150	1011
71RB-S68	IR	SCR		C158	1025
71RB-T62	IR	SCR		C158	1025
71RC-B	IR	SCR		C60	949
71RCG	IR	SCR		C155	1017
71RCG-S54	IR	SCR		C155	1017
71REH	IR	SCR		C150,C60	1011
71T2	IR	SCR		D40D7	1233
72RA	IR	SCR		C152	1011
72RB	IR	SCR		C152	1011
72RB-S68	IR	SCR		C159	1025
72RB-T62	IR	SCR		C159	1025
72RC-A	IR	SCR		C52	943
72RC-B	IR	SCR		C62	949
72RCG	IR	SCR		C157	1017
72RCG-S54	IR	SCR		C157	1017
72REH	IT	SCT		C152,C62	1011
72T2	--	PWR TRAN		D40D7	1233
73T2	--	PWR TRAN		D40D7	1233
74T2	--	PWR TRAN		D40D7	1233
81RLA	IR	SCR		C158	1025
81RLB	IR	SCR		C158	1025
82RLA	IR	SCR		C159	1025
82RLB	--	PWR TRAN		C159	1025
82T2	IR	SCR		D40D7	1233
101RA	IR	SCR		C180	1035
101RC	IR	SCR		C180	1035
101RC-S	IR	SCR		C185	1040
115PA	IR	SCR		C350	1067
115PA-S64	IR	SCR		C355,C358	1071
115PA-S66	IR	SCR		C358	1079
115PA-S69	IR	SCR		C358	1079
151RA	IR	SCR		C180	1035
151RB	IR	SCR		C180	1035

Industry Type	Mfg.	Device Type	Exact Type Page	Suggested GE Replacement	
				Type	Page
151RB-S64	IR	SCR		C185,C358	1040
151RB-S67	IR	SCR		C185,C358	1040
151RB-T62	IR	SCR		C185,C358	1040
151RC	IR	SCR		C180,C280	1035
151REH	IR	SCR		C180	1035
151RF	IR	SCR		C185	1040
175PA	IR	SCR		C380,C387	1089
175PA-S	IR	SCR		C35,220F	922
204A	WES	SCR		C35,220F	922
204B	WES	SCR		C35,220A	922
204D	WES	SCR		C35,220B	922
204F	WES	SCR		C35,220C	922
204H	WES	SCR		C35,220D	922
204K	WES	SCR		C35,220E	922
204M	WES	SCR		C35M	922
204S	WES	SCR		C35N	922
206A	WES	SCR		C20F	910
206B	WES	SCR		C20A	910
206D	WES	SCR		C20B	910
206F	WES	SCR		C20C	910
206H	WES	SCR		C20D	910
206K	WES	SCR		C20E	910
207A	WES	SCR		C11/20F	894
207B	WES	SCR		C11/20A	894
207D	WES	SCR		C11/20B	894
207F	WES	SCR		C11/20C	894
207H	WES	SCR		C11/20D	894
207K	WES	SCR		C11/20E	894
207M	WES	SCR		C11/20M	894
208A	WES	SCR		C11/20F	894
208B	WES	SCR		C11/20A	894
208D	WES	SCR		C11/20B	894
208F	WES	SCR		C11/20C	894
208H	WES	SCR		C11/20D	894
208K	WES	SCR		C11/20E	894
208M	WES	SCR		C11M	894
218	WES	SCR		C178	1035
220	WES	SCR		C150,152	1011
240U	WES	SCR		C350	1067
240A	WES	SCR		C35F	922
240B	WES	SCR		C35A	922
240C	WES	SCR		C35G	922
240D	WES	SCR		C35B	922
240E	WES	SCR		C35H	922
240F	WES	SCR		C35C	922
240H	WES	SCR		C35D	922
240K	WES	SCR		C35E	922
240M	WES	SCR		C35M	922
240P	WES	SCR		C35S	922
240S	WES	SCR		C35N	922
240V	WES	SCR		C137T	978
240Z	WES	SCR		C137P	978
240ZB	WES	SCR		C137PA	978
240ZD	WES	SCR		C137PB	978
241U	WES	SCR		C30U	913
241A	WES	SCR		C30F	913
241B	WES	SCR		C30A	913
241C	WES	SCR		C30G	913
241D	WES	SCR		C30B	913
241E	WES	SCR		C30H	913
241F	WES	SCR		C30A	913
241H	WES	SCR		C30D	913
241K	WES	SCR		C30E	913
241M	WES	SCR		C35M	922
241P	WES	SCR		C35S	922
241S	WES	SCR		C35N	922
241V	WES	SCR		C137T	978
241Z	WES	SCR		C137P	978
241ZB	WES	SCR		C137PA	978
241ZD	WES	SCR		C137PB	978
250	WES	SCR		C150,152	1011
250PA	IR	SCR		C380	1089
250RA	IR	SCR		C286	1056
250RA-S	IR	SCR		C387	1101
251	WES	SCR		C150,152	1011
260	WES	SCR		C282,C180	1056
261	WES	SCR		C178	1035
263	WES	SCR		C350-X42	1067
270	WES	SCR		C501	1133
271	WES	SCR		C290	1062
272	WES	SCR		C380	1089
273	WES	SCR		C380-X46	1089
282	WES	SCR		C501	1133
283	WES	SCR		C501	1133
300RA	IR	SCR		C290	1062
300RB-S	IR	SCR		C387	1101
303RA	IR	SCR		C291	1062
350RA	IR	SCR		C501	1133
368Z	WES	Rectifier		1N3673	219
368V	WES	Rectifier		1N3672	219
368S	WES	Rectifier		1N3671	219
368P	WES	Rectifier		1N3670	219
368D	WES	Rectifier		1N1202	219
368A	WES	Rectifier		1N1199	219
368B	WES	Rectifier		1N1200	219
368C	WES	Rectifier		1N1201	219
368F	WES	Rectifier		1N1203	219
368H	WES	Rectifier		1N1204	219
368K	WES	Rectifier		1N1205	219
368M	WES	Rectifier		1N1206	219
3781A	WES	Rectifier		A28F	807
3781B	WES	Rectifier		A28A	807
3781C	WES	Rectifier		A28B	807
3781D	WES	Rectifier		A28B	807
3781F	WES	Rectifier		A28C	807
3781H	WES	Rectifier		A28D	807
3791A	WES	Rectifier		A28F	807
3791B	WES	Rectifier		A28A	807
3791C	WES	Rectifier		A28B	807
3791D	WES	Rectifier		A28B	807
3791F	WES	Rectifier		A28C	807
3791H	WES	Rectifier		A28D	807
407A	WES	Rectifier		1N1341	223
407B	WES	Rectifier		1N1342	223
407C	WES	Rectifier		1N1343	223
407D	WES	Rectifier		1N1344	223
407F	WES	Rectifier		1N1345	223
407H	WES	Rectifier		1N1346	223
407K	WES	Rectifier		1N1347	223
407M	WES	Rectifier		1N1348	223
407P	WES	Rectifier		1N3670	219
407S	WES	Rectifier		1N3671	219
407V	WES	Rectifier		1N3672	219
407Z	WES	Rectifier		1N3673	219
408A	WES	Rectifier		1N1199	219
408B	WES	Rectifier		1N1200	219
408C	WES	Rectifier		1N1201	219
408D	WES	Rectifier		1N1202	219
408F	WES	Rectifier		1N1203	219
408H	WES	Rectifier		1N1204	219
408K	WES	Rectifier		1N1205	219
408M	WES	Rectifier		1N1206	219
408P	WES	Rectifier		1N3670	219
408S	WES	Rectifier		1N3671	219
408V	WES	Rectifier		1N3672	219
408Z	WES	Rectifier		1N3673	219
409A	WES	Rectifier		1N1199A	219
408B	WES	Rectifier		1N1200A	219
409C	WES	Rectifier		1N1201A	219
409D	WES	Rectifier		1N1202A	219
409F	WES	Rectifier		1N1203A	219
409H	WES	Rectifier		1N1204A	219
409K	WES	Rectifier		1N1205A	219
409M	WES	Rectifier		1N1206A	219
409P	WES	Rectifier		1N3670A	219
409S	WES	Rectifier		1N3671A	219
409V	WES	Rectifier		1N3672A	219
409Z	WES	Rectifier		1N3673A	219
419A	WES	Rectifier		1N1183A	215
419B	WES	Rectifier		1N1184A	215

Industry Type	Mfg.	Device Type	Exact Type Page	Suggested GE Replacement	
				Type	Page
419C	WES	Rectifier		1N1185A	215
419D	WES	Rectifier		1N1186A	215
419F	WES	Rectifier		1N1187A	215
419H	WES	Rectifier		1N1188A	215
419K	WES	Rectifier		1N1189A	215
419M	WES	Rectifier		1N1190A	215
419P	WES	Rectifier		1N3765	215
419S	WES	Rectifier		1N3766	215
419V	WES	Rectifier		1N3767	215
419Z	WES	Rectifier		1N3768	215
420PA-S55	IR	SCR		C398	1123
420PA-T50	IR	SCR		C397	1123
420PA-T52	IR	SCR		C398	1123
420PM	IR	SCR		C398,397	1123
424C	WES	Rectifier		1N3911	275
424K	WES	Rectifier		A139E	833
426M	WES	Rectifier		A139M	833
425C	WES	Rectifier		1N3901	273
425K	WES	Rectifier		A139E	833
425M	WES	Rectifier		A139M	833
470PA	IR	SCR		C501	1133
470PA-S57	IR	SCR		C398	1123
470PA-T50	IR	SCR		C397	1123
470PA-T52	IR	SCR		C397	1123
478A	WES	Rectifier		1N3879	269
478B	WES	Rectifier		1N3880	269
478C	WES	Rectifier		1N3881	269
478D	WES	Rectifier		1N3881	269
478F	WES	Rectifier		1N3882	269
478H	WES	Rectifier		1N3883	269
478K	WES	Rectifier		A129E	831
478M	WES	Rectifier		A129M	831
479A	WES	Rectifier		1N3889	271
479B	WES	Rectifier		1N3890	271
479C	WES	Rectifier		1N3891	271
479D	WES	Rectifier		1N3891	271
479F	WES	Rectifier		1N3892	271
479H	WES	Rectifier		1N3893	271
479K	WES	Rectifier		A129E	831
479M	WES	Rectifier		A129M	831
673-1	IR	Rect Bridge		GEB101	1284
673-1S	IR	Rect Bridge		GEB101	1284
673-2	IR	Rect Bridge		GEB102	1284
673-2S	IR	Rect Bridge		GEB102	1284
673-4	IR	Rect Bridge		GEB104	1284
673-4S	IR	Rect Bridge		GEB104	1284
673-6	IR	Rect Bridge		GEB106	1284
673-6S	IR	Rect Bridge		GEB106	1284
713A	WES	Rectifier		1N1183	215
713B	WES	Rectifier		1N1184	215
713C	WES	Rectifier		1N1185	215
713D	WES	Rectifier		1N1186	215
713F	WES	Rectifier		1N1187	215
713H	WES	Rectifier		1N1188	215
713K	WES	Rectifier		1N1189	215
713M	WES	Rectifier		1N1190	215
714A	WES	Rectifier		1N1183	215
714B	WES	Rectifier		1N1184	215
714C	WES	Rectifier		1N1185	215
714D	WES	Rectifier		1N1186	215
714F	WES	Rectifier		1N1187	215
714H	WES	Rectifier		1N1188	215
714K	WES	Rectifier		1N1189	215
714M	WES	Rectifier		1N1190	215
1714-0402	WES	Pwr Tran		D44C6	1255
1714-0405	WES	Pwr Tran		D44C6	1255
1714-0602	WES	Pwr Tran		D44C8	1255
1714-0605	WES	Pwr Tran		D44C8	1255
2191	WES	SCR		C155,157	1017
2192	WES	SCR		C155,158	1017
2193	WES	SCR		C154,156	1017
2505	WES	SCR		C150,152	1011
2515	WES	SCR		C150,C60	1011
2541	WES	SCR		C155,157	1017
2542	WES	SCR		C155,C158	1017
2543	WES	SCR		C154,156	1017
2611	WES	SCR		C185,C358	1040
2612	WES	SCR		C185,C358	1040
2615	WES	SCR		C180,C282	1035
2631	WES	SCR		C355,C358	1071
2632	WES	SCR		C355,C358	1071
2721	WES	SCR		C385	1093
2722	WES	SCR		C385,C387	1093
2731	WES	SCR		C385,C387	1093
2732	WES	SCR		C385,C387	1093
2853-1	UNI	Pwr Tran		D42C6	1247
2853-2	UNI	Pwr Tran		D44C6	1255
2853-3	UNI	Pwr Tran		D42C6	1247
2854-1	UNI	Pwr Tran		D42C6	1247
2854-2	UNI	Pwr Tran		D44C6	1255
2854-3	UNI	Pwr Tran		D42C6	1247
2855-1	UNI	Pwr Tran		D42C6	1247
2855-2	UNI	Pwr Tran		D44C6	1255
2855-3	UNI	Pwr Tran		D42C6	1247
2856-1	UNI	Pwr Tran		D42C6	1247
2856-2	UNI	Pwr Tran		D44C6	1255
2856-3	UNI	Pwr Tran		D42C6	1247
5082-4120	HP	SSL		SSL-4	130
5082-4403	HP	SSL		SSL-22L	130
5082-7300	HP	SSL		SSL-190	130
5082-7302	HP	SSL		SSL-190	130
40081	RCA	Pwr Tran		D40D1	1233
40082	RCA	Pwr Tran		D40D1	1233
40216	RCA	SCR		C144M	998
40250	RCA	Pwr Tran		D44C6	1255
40250V1	RCA	Pwr Tran		D40D4	1233
40279	RCA	Pwr Tran		D40D4	1233
40280	RCA	Pwr Tran		D40D1	1233
40281	RCA	Pwr Tran		D40D1	1233
40282	RCA	Pwr Tran		D44C1	1255
40290	RCA	Pwr Tran		D40D7	1233
40291	RCA	Pwr Tran		D40D7	1233
40292	RCA	Pwr Tran		D44C4	1255
40305	RCA	Pwr Tran		D40D4	1233
40306	RCA	Pwr Tran		D40D4	1233
40307	RCA	Pwr Tran		D44C4	1255
40209	RCA	Pwr Tran		D40D2	1233
40310	RCA	Pwr Tran		D44C5	1255
40311	RCA	Pwr Tran		D40D2	1233
40312	RCA	Pwr Tran		D44C8	1255
40314	RCA	Pwr Tran		D40D5	1233
40315	RCA	Pwr Tran		D40D5	1233
40316	RCA	Pwr Tran		D44C5	1255
40317	RCA	Pwr Tran		D40D5	1233
40319	RCA	Pwr Tran		D41D4	1243
40320	RCA	Pwr Tran		D40D5	1233
40321	RCA	Pwr Tran		D44R3	1261
40323	RCA	Pwr Tran		D40D2	1233
40324	RCA	Pwr Tran		D44C5	1255
40326	RCA	Pwr Tran		D40D1	1233
40327	RCA	Pwr Tran		D40D1	1233
40346	RCA	Pwr Tran		D44R1	1261
40346V1	RCA	Pwr Tran		D44R1	1261
40346V2	RCA	Pwr Tran		D44R1	1261
40347	RCA	Pwr Tran		D40D4	1233
40347V1	RCA	Pwr Tran		D40D4	1233
40347V2	RCA	Pwr Tran		D40D5	1233
40348	RCA	Pwr Tran		D40D7	1233

Industry Type	Mfg.	Device Type	Exact Type Page	Suggested GE Replacement	
				Type	Page
40348V1	RCA	Pwr Tran		D40D7	1233
40348V2	RCA	Pwr Tran		D40D7	1233
40355	RCA	Pwr Tran		D40N1	1237
40360	RCA	Pwr Tran		D40D8	1233
40361	RCA	Pwr Tran		D40D8	1233
40362	RCA	Pwr Tran		D41D8	1243
40366	RCA	Pwr Tran		D40D8	1233
40367	RCA	Pwr Tran		D40D8	1233
40368	RCA	Pwr Tran		D44C6	1255
40372	RCA	Pwr Tran		D42C8	1247
40378	RCA	SCR		C20/122B	910
40379	RCA	SCR		C20/122D	910
40389	RCA	Pwr Tran		D40D1	1233
40390	RCA	Pwr Tran		D44R2	1261
40391	RCA	Pwr Tran		D41D4	1243
40392	RCA	Pwr Tran		D40D4	1233
40394	RCA	Pwr Tran		D43C5	1251
40406	RCA	Pwr Tran		D41D7	1243
40407	RCA	Pwr Tran		D40D7	1233
40412	RCA	Pwr Tran		D44R2	1261
40412V1	RCA	Pwr Tran		D44R2	1261
40412V2	RCA	Pwr Tran		D44R2	1261
40422	RCA	Pwr Tran		D44R4	1261
40424	RCA	Pwr Tran		D44R4	1261
40426	RCA	Pwr Tran		D44R3	1261
40429	RCA	Triac		SC41/141B	1459
40430	RCA	Triac		SC41/141D	1459
40446	RCA	Pwr Tran		D40D6	1233
40450	RCA	Pwr Tran		D40D2	1233
40451	RCA	Pwr Tran		D40D4	1233
40452	RCA	Pwr Tran		D40D3	1233
40453	RCA	Pwr Tran		D40D2	1233
40454	RCA	Pwr Tran		D40D1	1233
40455	RCA	Pwr Tran		D40D2	1233
40456	RCA	Pwr Tran		D40D1	1233
40459	RCA	Pwr Tran		D40D4	1233
40485	RCA	Triac		SC41/141B	1459
40486	RCA	Triac		SC41/141D	1459
40491	RCA	Pwr Tran		D44R4	1261
40537	RCA	Pwr Tran		D41D7	1243
40538	RCA	Pwr Tran		D41D7	1243
40544	RCA	Pwr Tran		D40D7	1243
40561	RCA	Tunnel Diode		STD952	C.F.
40562	RCA	Tunnel Diode		SMTD942	C.F.
40563	RCA	Tunnel Diode		SMTD945	C.F.
40564	RCA	Tunnel Diode		SMTD948	C.F.
40565	RCA	Tunnel Diode		SMTD951	C.F.
40566	RCA	Tunnel Diode		STD953	C.F.
40567	RCA	Tunnel Diode		SMTD943	C.F.
40569	RCA	Tunnel Diode		SMTD949	C.F.
40570	RCA	Tunnel Diode		SMTD952	C.F.
40571	RCA	Tunnel Diode		STD954	C.F.
40572	RCA	Tunnel Diode		SMTD944	C.F.
40573	RCA	Tunnel Diode		SMTD947	C.F.
40574	RCA	Tunnel Diode		SMTD950	C.F.
40575	RCA	Triac		SC51B	1475
40576	RCA	Triac		SC51D	1475
40578	RCA	Pwr Tran		D40D1	1233
40581	RCA	Pwr Tran		D40D1	1233
40582	RCA	Pwr Tran		D40D1	1233
40594	RCA	Pwr Tran		D42C7	1247
40595	RCA	Pwr Tran		D43C7	1251
40598A	RCA	SSL		SSL-315	131
40605	RCA	Pwr Tran		D40D4	1233
40608	RCA	Pwr Tran		D40D3	1233
40611	RCA	Pwr Tran		D40D2	1233
40613	RCA	Pwr Tran		D44C2	1255
40616	RCA	Pwr Tran		D40D2	1233
40618	RCA	Pwr Tran		D44C2	1255
40621	RCA	Pwr Tran		D44C2	1255
40622	RCA	Pwr Tran		D44C6	1255
40629	RCA	Pwr Tran		D44C6	1255
40630	RCA	Pwr Tran		D44C6	1255
40631	RCA	Pwr Tran		D44C6	1255
40634	RCA	Pwr Tran		D41D7	1243
40635	RCA	Pwr Tran		D40D7	1233
40654	RCA	SCR		C20/122B	910
40655	RCA	SCR		C20/122D	910
40660	RCA	Triac		SC61B	1483
40661	RCA	Triac		SC61D	1483
40662	RCA	Triac		SC60B	1483
40663	RCA	Triac		SC60D	1483
40664	RCA	Triac		SC41E	1459
40665	RCA	Pwr Tran		D44C4	1255
40666	RCA	Pwr Tran		D40D4	1233
30667	RCA	Triac		SC41E	1459
40668	RCA	Triac		SC146B	1491
40669	RCA	Triac		SC146D	1491
40680	RCA	SCR		C32AX179	913
40681	RCA	SCR		C32BX179	913
40682	RCA	SCR		C32DX179	913
40705	RCA	Triac		SC61B13	1483
40706	RCA	Triac		SC61D13	1483
30707	RCA	Triac		SC60B13	1483
40708	RCA	Triac		SC60D13	1483
40711	RCA	Triac		SC51B13	1475
40712	RCA	Triac		SC51D13	1475
40713	RCA	Triac		SC50B13	1475
40714	RCA	Triac		SC50D13	1475
40715	RCA	Triac		SC51B13	1475
40716	RCA	Triac		SC51D13	1475
40717	RCA	Triac		SC46B13	1467
40718	RCA	Triac		SC46D13	1467
40719	RCA	Triac		SC45B13	1467
40720	RCA	Triac		SC45D13	1467
40721	RCA	Triac		SC146B	1491
40722	RCA	Triac		SC146D	1491
40723	RCA	Triac		SC41E13	1459
40724	RCA	Triac		SC41E13	1459
40725	RCA	Triac		SC141B	1491
40726	RCA	Triac		SC141D	1491
40727	RCA	Triac		SC41B13	1459
40728	RCA	Triac		SC41D13	1459
40735	RCA	SCR		C139M	982
40736R	RCA	SSL		SSL-315	131
40737	RCA	SCR		C22A	910
40738	RCA	SCR		C22B	910
40739	RCA	SCR		C22D	910
40741	RCA	SCR		C20A	910
40742	RCA	SCR		C20B	910
40743	RCA	SCR		C20D	910
40745	RCA	SCR		C22AX179	910
40746	RCA	SCR		C22BX179	910
40747	RCA	SCR		C22DX179	910
40748	RCA	SCR		C22EX179	910
40749	RCA	SCR		C32A	913
40750	RCA	SCR		C32B	913
40751	RCA	SCR		C32D	913
40753	RCA	SCR		C30A	913
40754	RCA	SCR		C30B	913
40755	RCA	SCR		C30D	913
40757	RCA	SCR		C32AX179	913
40758	RCA	SCR		C32BX179	913
40759	RCA	SCR		C32DX179	913
40843R	RCA	SSL		SSL-315	
A5T5058	TI	Pwr Tran		D44R3	1261
A14*	GE	Rectifier	801		
A14P	GE	Rectifier	312		
A14PD*	GE	Rectifier	803		
A15*	GE	Rectifier	805		
A27BR1200*	GE	Rectifier	162		
A27DR1200*	GE	Rectifier	162		
A37MR1200*	GE	Rectifier	162		
A28/29*	GE	Rectifier	807		
A28BR1200*	GE	Rectifier	162		
A28DR1200*	GE	Rectifier	162		
A28BR1201*	GE	Rectifier	162		
A28DR1201*	GE	Rectifier	162		
A38BR1200*	GE	Rectifier	162		
A38DR1200*	GE	Rectifier	162		
A38MR1200*	GE	Rectifier	162		
A38BR1202*	GE	Rectifier	162		

* = Series
C.F. = Contact Factory

Industry Type	Mfg.	Device Type	Exact Type Page	Suggested GE Replacement	
				Type	Page
A38DR1202*	GE	Rectifier	162		
A40/41*	GE	Rectifier	247		
A44/45*	GE	Rectifier	811		
A70/71*	GE	Rectifier	251		
A90*	GE	Rectifier	263		
A96/97*	GE	Rectifier	813		
A114*	GE	Rectifier	819		
A115*	GE	Rectifier	825		
A129*	GE	Rectifier	831		
A139*	GE	Rectifier	833		
A201,3	APX	Pwr Tran		D40D1	1233
A202	APX	Pwr Tran		D44C1	1255
A208	APX	Pwr Tran		D42C2	1247
A210	APX	Pwr Tran		D40D1	1233
A211	APX	Pwr Tran		D40D1	1233
A211*	GE	Rectifier	C.F.		
A220*	GE	Rectifier	C.F.		
A245	APX	Pwr Tran		D40D1	1233
A246	APX	Pwr Tran		D40D1	1233
A247	APX	Pwr Tran		D40D1	1233
A253	APX	Pwr Tran		D42C2	1247
A270	APX	Pwr Tran		D40D5	1233
A271	APX	Pwr Tran		D42C5	1247
A272	APX	Pwr Tran		D44C4	1255
A273	APX	Pwr Tran		D44C1	1255
A275	APX	Pwr Tran		D42C2	1247
A276	APX	Pwr Tran		D44C3	1255
A277	APX	Pwr Tran		D44C1	1255
A278	APX	Pwr Tran		D40N1	1237
A279	SER	Pwr Tran		D40N1	1237
A291*	GE	Rectifier	835		
A295/296*	GE	Rectifier	837		
A390*	GE	Rectifier	839		
A396*	GE	Rectifier	842		
A411*	GE	Rectifier	231		
A420-22*	GE	Rectifier	231		
A500*	GE	Rectifier	844		
A540*	GE	Rectifier	847		
A570*	GE	Rectifier	850		
A1423*	GE	Rectifier	231		
A1425*	GE	Rectifier	231		
A2011*	GE	Rectifier	853		
A2511*	GE	Rectifier	859		
A3511*	GE	Rectifier	865		
A3512*	GE	Rectifier	865		
A7011-14*	GE	Rectifier	871		
A9013-16*	GE	Rectifier	871		
AA100	UNI	SCR		C103YY	953
AA101	UNI	SCR		C103A	953
AA102	UNI	SCR		C103B	953
AA107	UNI	SCR		C103YY	953
AA108	UNI	SCR		C103A	953
AA109	UNI	SCR		C103B	953
AA114	UNI	SCR		C103YY	953
AA115	UNI	SCR		C103A	953
AA116	UNI	SCR		C103B	953
AC06BR	NEC	Triac		SC40B	1459
AC06BSR	NEC	Triac		SC40B	1459
AC06DR	NEC	Triac		SC40D	1459
AC06DSR	NEC	Triac		SC40D	1459
AC10BR	NEC	Triac		SC45B	1467
AC10BSR	NEC	Triac		SC45B	1467
AC10DR	NEC	Triac		SC45D	1467
AC10DSR	NEC	Triac		SC45D	1467
AD100	UNI	SCR		2N2323A	880
AD101	UNI	SCR		2N2324A	880
AD102	UNI	SCR		2N2326A	880
AD103	UNI	SCR		2N2328A	880
AD104	UNI	SCR		2N2329	880
AD107	UNI	SCR		2N2323A	880
AD110	UNI	SCR		2N2328A	880
AD111	UNI	SCR		2N2329	880
AEY23	RAD	Tunnel Diode		1N3712	259
AEY25	RAD	Tunnel Diode		TD262	1537
AEY26	RAD	Tunnel Diode		STD957	120
AEY27	RAD	Tunnel Diode		TD263	1537
AEY28	RAD	Tunnel Diode		SMTD974	120
A01002	ECC	Triac		SC141B	1491
A01004	ECC	Triac		SC141D	1491
A01021	ECC	Triac		SC141B	1491
A01022	ECC	Triac		SC141D	1491
A01061	ECC	Triac		SC141B	1491
A01062	ECC	Triac		SC141D	1491
A01101	ECC	Triac		SC146B	1491
A01102	ECC	Triac		SC146D	1491
A01141	ECC	Triac		SC146B	1491
A01142	ECC	Triac		SC146D	1491
AS1 942-1	ATL	Rect Bridge		GEB100	1284
ASI 942-2	ATL	Rect Bridge		GEB101	1284
AS1 942-3	ATL	Rect Bridge		GEB102	1284
AS1 942-5	ATL	Rect Bridge		GEB104	1284
AS1 942-6	ATL	Rect Bridge		GEB106	1284
AS1 942-8	ATL	Rect Bridge		GEB108	1284
AT470	SER	Pwr Tran		D40D4	1233
AT471	SER	Pwr Tran		D40D7	1233
AT473	SER	Pwr Tran		D40D5	1233
AT474	SER	Pwr Tran		D40D8	1233
AT476	SER	Pwr Tran		D40D4	1233
AT477	SER	Pwr Tran		D40D7	1233
B55	TRW	SCR		C150-X167	1011
B110	TRW	SCR		C150,152	1011
B150	UNI	SCR		C103Y	953
B151	UNI	SCR		C103YY	953
B152	UNI	SCR		C103A	953
B3465	SOD	Pwr Tran		D40D8	1233
B3466	SOD	Pwr Tran		D40D8	1233
B3531	SOD	Pwr Tran		D40D3	1233
B3533	SOD	Pwr Tran		D40D5	1233
B3537	SOD	Pwr Tran		D42C5	1247
B3538	SOD	Pwr Tran		D40D4	1233
B3539	SOD	Pwr Tran		D40D7	1233
B3540	SOD	Pwr Tran		D40D4	1233
B3541	SOD	Pwr Tran		D40D4	1233
B3542	SOD	Pwr Tran		D40D5	1233
B3543	SOD	Pwr Tran		D40D7	1233
B3544	SOD	Pwr Tran		D40D7	1233
B3545	SOD	Pwr Tran		D40D8	1233
B3547	SOD	Pwr Tran		D44C8	1255
B3548	SOD	Pwr Tran		D44C8	1255
B3550	SOD	Pwr Tran		D44C6	1255
B3551	SOD	Pwr Tran		D44C8	1255
B3570	SOD	Pwr Tran		D42C5	1247
B3576	SOD	Pwr Tran		D42C5	1247
B3577	SOD	Pwr Tran		D44C7	1255
B3578	SOD	Pwr Tran		D44C6	1255
B3580	SOD	Pwr Tran		D44C6	1255
B3584	SOD	Pwr Tran		D44C8	1255
B3585	SOD	Pwr Tran		D44C5	1255
B3586	SOD	Pwr Tran		D44C8	1255
B3588	SOD	Pwr Tran		D44C6	1255
B3589	SOD	Pwr Tran		D44C8	1255
B3606	SOD	Pwr Tran		D42C3	1247
B3607	SOD	Pwr Tran		D42C6	1247
B3608	SOD	Pwr Tran		D42C8	1247
B3609	SOD	Pwr Tran		D42C3	1247
B3610	SOD	Pwr Tran		D42C6	1247
B3611	SOD	Pwr Tran		D42C8	1247
B3612	SOD	Pwr Tran		D42C3	1247
B3613	SOD	Pwr Tran		D42C6	1247
B3614	SOD	Pwr Tran		D42C8	1247
B3747	SOD	Pwr Tran		D40D1	1233
B3748	SOD	Pwr Tran		D40D1	1233
B3750	SOD	Pwr Tran		D42C6	1247
B5001	SOD	Pwr Tran		D44C5	1255
B5002	SOD	Pwr Tran		D44C8	1255
B5021	SOD	Pwr Tran		D44C5	1255
B5022	SOD	Pwr Tran		D44C8	1255
B5031	SOD	Pwr Tran		D44C6	1255
B5032	SOD	Pwr Tran		D44C8	1255

* = Series
C.F. = Contact Factory

Industry Type	Mfg.	Device Type	Exact Type Page	Suggested GE Replacement	
				Type	Page
B143000	SOD	Pwr Tran		D42C5	1247
B143001	SOD	Pwr Tran		D42C5	1247
B143003	SOD	Pwr Tran		D42C3	1247
B143004	SOD	Pwr Tran		D42C7	1247
B143009	SOD	Pwr Tran		D42C4	1247
B143010	SOD	Pwr Tran		D42C4	1247
B143011	SOD	Pwr Tran		D42C7	1247
B143012	SOD	Pwr Tran		D42C7	1247
B143015	SOD	Pwr Tran		D42C5	1247
B143016	SOD	Pwr Tran		D42C5	1247
B143018	SOD	Pwr Tran		D42C8	1247
B143019	SOD	Pwr Tran		D42C8	1247
B143024	SOD	Pwr Tran		D42C4	1247
B143025	SOD	Pwr Tran		D42C4	1247
B143026	SOD	Pwr Tran		D42C7	1247
B143027	SOD	Pwr Tran		D42C7	1247
BA150	UNI	SCR		C103Y	953
BA151	UNI	SCR		C103YY	953
BA152	UNI	SCR		C103A	953
BC107	-	Sig Tran		GBC107	800
BC108	-	Sig Tran		GBC108	800
BC109	-	Sig Tran		GBC109	800
BC119	-	Pwr Tran		D40D2	1233
BC120	-	Pwr Tran		D40D2	1233
BC140	-	Pwr Tran		D40D4	1233
BC140C	-	Pwr Tran		D40D3	1233
BC140D	-	Pwr Tran		D40D4	1233
BC141	-	Pwr Tran		D40D7	1233
BC142	-	Pwr Tran		D40D7	1233
BC160	-	Pwr Tran		D40D5	1233
BC161	-	Pwr Tran		D41D7	1243
BC286	-	Pwr Tran		D40D7	1233
BC287	-	Pwr Tran		D41D7	1243
BC301	-	Pwr Tran		D40D7	1233
BC312	-	Pwr Tran		D44R1	1261
BC313	-	Pwr Tran		D40D4	1233
BCR5A2	MIT	Triac		SC40B	1459
BCR5A4	MIT	Triac		SC40B	1459
BCR5A6	MIT	Triac		SC40C	1459
BCR5A8	MIT	Triac		SC40D	1459
BCR5B2	MIT	Triac		SC40B	1459
BCR5B4	MIT	Triac		SC40B	1459
BCR5B6	MIT	Triac		SC40C	1459
BCR5B8	MIT	Triac		SC40D	1459
BCR5C2	MIT	Triac		SC40B	1459
BCR5C4	MIT	Triac		SC40B	1459
BCR5C6	MIT	Triac		SC40D	1459
BCR5C8	MIT	Triac		SC40D	1459
BCR10A2	MIT	Triac		SC45B	1467
BCR10A4	MIT	Triac		SC45B	1467
BCR10A6	MIT	Triac		SC45D	1467
BCR10A8	MIT	Triac		SC45D	1467
BCR10B2	MIT	Triac		SC45B	1467
BCR10B4	MIT	Triac		SC45B	1467
BCR10B6	MIT	Triac		SC45D	1467
BCR10B8	MIT	Triac		SC45D	1467
BCR10C2	MIT	Triac		SC45B	1467
BCR10C4	MIT	Triac		SC45B	1467
BCR10C6	MIT	Triac		SC45D	1467
BCR10C8	MIT	Triac		SC45D	1467
BCY65	-	Pwr Tran		D40D8	1233
BCY66	-	Pwr Tran		D40D5	1233
BD1-7*	GE	Back Diode	879		
BD106	-	Pwr Tran		D42C4	1247
BD107	-	Pwr Tran		D42C1	1247
BD109	-	Pwr Tran		D44C5	1255
BD112	-	Pwr Tran		D44C6	1255
BD115	-	Pwr Tran		D44R1	1261
BD124	-	Pwr Tran		D44C5	1255
BD127	-	Pwr Tran		D44R4	1261
BD131	-	Pwr Tran		D44C5	1255
BD135	-	Pwr Tran		D42C5	1247
BD136	-	Pwr Tran		D43C5	1251
BD137	-	Pwr Tran		D42C7	1247
BD138	-	Pwr Tran		D43C7	1251
BD145	-	Pwr Tran		D44C8	1255
BD162	-	Pwr Tran		D44C7	1255
BD163	-	Pwr Tran		D44C6	1255
BD402-7*	GE	Back Diode	121		
BDY12	-	Pwr Tran		D44C6	1255
BDY13	-	Pwr Tran		D44C8	1255
BDY15A	-	Pwr Tran		D42C8	1247
BDY16A	-	Pwr Tran		D42C8	1247
BDY34	-	Pwr Tran		D42C5	1247
BDY60	-	Pwr Tran		D44C8	1255
BDY61	-	Pwr Tran		D44C8	1255
BDY62	-	Pwr Tran		D44C6	1255
BF108	-	Pwr Tran		D44R1	1261
BF109	-	Pwr Tran		D40N1	1237
BF118	-	Pwr Tran		D40N1	1237
BF156	-	Pwr Tran		D44R1	1261
BF157	-	Pwr Tran		D44R1	1261
BF174	-	Pwr Tran		D40N1	1237
BF179A	-	Pwr Tran		D40N1	1237
BF179B	-	Pwr Tran		D40N1	1237
BF179C	-	Pwr Tran		D40N1	1237
BF257	-	Pwr Tran		D40N1	1237
BF258	-	Pwr Tran		D40N1	1237
BF259	-	Pwr Tran		D40N3	1237
BF292A	-	Pwr Tran		D40N1	1237
BF292B	-	Pwr Tran		D40N1	1237
BF292C	-	Pwr Tran		D40N1	1237
BF294	-	Pwr Tran		D40N2	1237
BFS23	-	Pwr Tran		D42C1	1247
BFS50	-	Pwr Tran		D40D1	1233
BFS51	-	Pwr Tran		D40D1	1233
BFX38	-	Pwr Tran		D41D8	1243
BFX39	-	Pwr Tran		D41D8	1243
BFX55	-	Pwr Tran		D40D4	1233
BFX69	-	Pwr Tran		D40D2	1233
BFX69A	-	Pwr Tran		D40D5	1233
BFX84	-	Pwr Tran		D40D7	1233
BFX85	-	Pwr Tran		D40D8	1233
BFX86	-	Pwr Tran		D40D5	1233
BFX96	-	Pwr Tran		D40D1	1233
BFX96A	-	Pwr Tran		D40D1	1233
BFX97	-	Pwr Tran		D40D2	1233
BFX98	-	Pwr Tran		D44R2	1261
BFY40	-	Pwr Tran		D40D1	1233
BFY41	-	Pwr Tran		D44R1	1261
BFY43	-	Pwr Tran		D40N1	1237
BFY44	-	Pwr Tran		D40D7	1233
BFY51	-	Pwr Tran		D40D8	1233
BFY52	-	Pwr Tran		D40D5	1233
BFY53	-	Pwr Tran		D40D1	1233
BFY56	-	Pwr Tran		D40D4	1233
BFY56A	-	Pwr Tran		D40D8	1233
BFY56B	-	Pwr Tran		D40D8	1233
BFY57	-	Pwr Tran		D40N1	1237
BFY70	-	Pwr Tran		D40D4	1233
BFY72	-	Pwr Tran		D40D2	1233
BLY12	-	Pwr Tran		D44C3	1255
BLY15A	-	Pwr Tran		D42C8	1247
BLY20	-	Pwr Tran		D42C1	1247
BLY21	-	Pwr Tran		D42C8	1247
BLY33	-	Pwr Tran		D40D1	1233
BLY34	-	Pwr Tran		D40D1	1233
BLY35	-	Pwr Tran		D44C1	1255
BLY36	-	Pwr Tran		D44C1	1255
BLY37	-	Pwr Tran		D42C5	1247
BLY38	-	Pwr Tran		D40D1	1233
BLY53	-	Pwr Tran		D42C2	1247
BLY61	-	Pwr Tran		D40D1	1233
BLY62	-	Pwr Tran		D42C1	1247
BLY63	-	Pwr Tran		D44C1	1255

* = Series
C.F. = Contact Factory

Industry Type	Mfg.	Device Type	Exact Type Page	Suggested GE Replacement	
				Type	Page
BLY78	-	Pwr Tran		D40D1	1233
BLY79	-	Pwr Tran		D44C1	1255
BLY88	-	Pwr Tran		D44C3	1255
BLY89	-	Pwr Tran		D44C1	1255
BLY91	-	Pwr Tran		D42C5	1247
BLY92	-	Pwr Tran		D44C6	1255
BLY93	-	Pwr Tran		D44C4	1255
BR-505	DI	Rect Bridge		GEB100	1284
BR-51	DI	Rect Bridge		GEB101	1284
BR-52	DI	Rect Bridge		GEB102	1284
BR-54	DI	Rect Bridge		GEB104	1284
BR-56	DI	Rect Bridge		GEB106	1284
BR-58	DI	Rect Bridge		GEB108	1284
BR-510	DI	Rect Bridge		GEB110	1284
BR-81B	DI	Rect Bridge		GEB101	1284
BR-81D	DI	Rect Bridge		GEB101	1284
BR-82B	DI	Rect Bridge		GEB102	1284
BR-82D	DI	Rect Bridge		GEB102	1284
BR-84B	DI	Rect Bridge		GEB104	1284
BR-84D	DI	Rect Bridge		GEB104	1284
BR-86B	DI	Rect Bridge		GEB106	1284
BR-86D	DI	Rect Bridge		GEB106	1284
BR-88B	DI	Rect Bridge		GEB108	1284
BR-88D	DI	Rect Bridge		GEB108	1284
BR100B	-	Pwr Tran		D42C5	1247
BR101B	-	Pwr Tran		D42C8	1247
BRH/T310	RC	Rect Bridge		GEB110	1284
BRY32	SGS	SCR		C103YY	953
BRY33	SGS	SCR		C103A	953
BRY34	SGS	SCR		C103B	953
BSK179	SK	Rect Bridge		GEB102	1284
BSK179	SK	Rect Bridge		GEB104	1284
BSK179	SK	Rect Bridge		GEB106	1284
BSK179	SK	Rect Bridge		GEB108	1284
BSK179	SK	Rect Bridge		GEB110	1284
BSV15	-	Pwr Tran		D40D5	1233
BSV16	-	Pwr Tran		D40D7	1233
BSV60	-	Pwr Tran		D42C6	1247
BSW28	-	Pwr Tran		D40D7	1233
BSW29	-	Pwr Tran		D40D1	1233
BSW66	-	Pwr Tran		D44R1	1261
BSW67	-	Pwr Tran		D44R1	1261
BSW68	-	Pwr Tran		D44R1	1261
BSX22	-	Pwr Tran		D42C1	1247
BSX30	-	Pwr Tran		D40D1	1233
BSX32	-	Pwr Tran		D40D4	1233
BSX45	-	Pwr Tran		D40D3	1233
BSX46	-	Pwr Tran		D40D4	1233
BSX48	-	Pwr Tran		D40D1	1233
BSX49	-	Pwr Tran		D40D1	1233
BSX59	-	Pwr Tran		D40D4	1233
BSX60	-	Pwr Tran		D40D1	1233
BSC61	-	Pwr Tran		D40D4	1233
BSX62	-	Pwr Tran		D40D4	1233
BSX63	-	Pwr Tran		D40D7	1233
BSY34	-	Pwr Tran		D40D3	1233
BSY58	-	Pwr Tran		D40D1	1233
BSY71	-	Pwr Tran		D40D8	1233
BSY91	-	Pwr Tran		D40D4	1233
BSY92	-	Pwr Tran		D40D7	1233
BTD0205	TEC	Triac		SC36F	1455
BTD0210	TEC	Triac		SC36A	1455
BTD0220	TEC	Triac		SC36B	1455
BTD0230	TEC	Triac		SC36C	1455
BTD0240	TEC	Triac		SC36D	1455
BTD0250	TEC	Triac		SC36E	1455
BTR0205	TEC	Triac		SC36F	1455
BTR0210	TEC	Triac		SC36A	1455
BTR0220	TEC			SC36B	1455
BTR0230	TEC	Triac		SC36C	1455
BTR0240	TEC	Triac		SC36D	1455
BTR0250	TEC	Triac		SC36E	1455
BTR0305	TEC	Triac		SC41E	1459
BTR0310	TEC	Triac		SC41A	1459
BTR0320	TEC	Triac		SC41B	1459
BTR0330	TEC	Triac		SC41C	1459
BTR0340	TEC	Triac		SC41D	1459
BTR0350	TEC	Triac		SC41E	1459
BTR0405	TEC	Triac		SC46E	1467
BTR0410	TEC	Triac		SC46B	1467
BTR0420	TEC	Triac		SC46B	1467
BTR0430	TEC	Triac		SC46C	1467
BTR0440	TEC	Triac		SC46D	1467
BTR0450	TEC	Triac		SC46E	1467
BTS0205	TEC	Triac		SC36F	1455
BTS0210	TEC	Triac		SC36A	1455
BTS0220	TEC	Triac		SC36B	1455
BTS0230	TEC	Triac		SC36C	1455
BTS0240	TEC	Triac		SC36D	1455
BTS0250	TEC	Triac		SC36E	1455
BTS0305	TEC	Triac		SC41E	1459
BTS0310	TEC	Triac		SC40B	1459
BTS0320	TEC	Triac		SC41B	1459
BTS0330	TEC	Triac		SC41C	1459
BTS0340	TEC	Triac		SC41D	1459
BTS0350	TEC	Triac		SC41E	1459
BTS0405	TEC	Triac		SC46E	1467
BTS0410	TEC	Triac		SC46B	1467
BTS0420	TEC	Triac		SC46B	1467
BTS0430	TEC	Triac		SC46C	1467
BTS0440	TEC	Triac		SC46D	1467
BTS0450	TEC	Triac		SC46E	1467
BTS0505	TEC	Triac		SC51E	1475
BTS0510	TEC	Triac		SC51B	1475
BTS0520	TEC	Triac		SC51B	1475
BTS0530	TEC	Triac		SC51C	1475
BTS0540	TEC	Triac		SC51D	1475
BTS0550	TEC	Triac		SC51E	1475
BTS0305	TEC	Triac		SC40E	1459
BTU0310	TEC	Triac		SC40B	1459
BTU0320	TEC	Triac		SC40B	1459
BTU0330	TEC	Triac		SC40C	1459
BTU0340	TEC	Triac		SC40D	1459
BTU0350	TEC	Triac		SC40E	1459
BTU0405	TEC	Triac		SC45E	1467
BTU0410	TEC	Triac		SC45B	1467
BTU0420	TEC	Triac		SC45B	1467
BTU0430	TEC	Triac		SC45C	1467
BTU0440	TEC	Triac		SC45D	1467
BTU0450	TEC	Triac		SC45E	1467
BTU0505	TEC	Triac		SC50E	1475
BTU0510	TEC	Triac		SC50B	1475
BTU0520	TEC	Triac		SC50B	1475
BTU0530	TEC	Triac		SC50C	1475
BTU0540	TEC	Triac		SC50D	1475
BTU0550	TEC	Triac		SC50E	1475
BTU0605	TEC	Triac		SC50E	1475
BTU0610	TEC	Triac		SC60B	1483
BTU0620	TEC	Triac		SC60B	1483
BTU0630	TEC	Triac		SC60C	1483
BTU0640	TEC	Triac		SC60D	1483
BTU0650	TEC	Triac		SC60E	1483
BTV0405	TEC	Triac		SC45E	1467
BTV0410	TEC	Triac		SC45B	1467
BTV0420	TEC	Triac		SC45B	1467
BTV0430	TEC	Triac		SC45C	1467
BTV0440	TEC	Triac		SC45D	1467
BTV0450	TEC	Triac		SC45E	1467
BTX94-100	TAG	Triac		SC60B	1483
BTX94-200	TAG	Triac		SC60B	1483
BTX94-300	TAG	Triac		SC60C	1483
BTX94-400	TAG	Triac		SC60D	1483
BTX94-500	TAG	Triac		SC60E	1483
BUY10	-	Pwr Tran		D44C1	1255
BUY11	-	Pwr Tran		D44C2	1255
BUY24	-	Pwr Tran		D44C8	1255
BUY43	-	Pwr Tran		D44C6	1255
BUY46	-	Pwr Tran		D44C8	1255

Industry Type	Mfg.	Device Type	Exact Type Page	Suggested GE Replacement	
				Type	Page
C5*	GE	SCR	880		
C5AR1200*	GE	Hi Rel SCR	170		
C5BR1200*	GE	Hi Rel SCR	170		
C5DR1200*	GE	Hi Rel SCR	880		
C6*	GE	SCR	886		
C7*	GE	SCR	467		
C10*	GE	SCR	890		
C10AR1200*	GE	Hi Rel SCR	170		
C10BR1200*	GE	Hi Rel SCR	170		
C10DR1200*	GE	Hi Rel SCR	170		
C11*	GE	SCR	894		
C11AR1200*	GE	Hi Rel SCR	170		
C11BR1200*	GE	Hi Rel SCR	170		
C11DR1200*	GE	Hi Rel SCR	170		
C11MR1200*	GE	Hi Rel SCR	170		
C12*	GE	SCR	900		
C13*	GE	SCR	902		
C15*	GE	SCR	906		
C20-22*	GE	SCR	910		
C30-33*	GE	SCR	913		
C34*	GE	SCR	918		
C35*	GE	SCR	922		
C35AR1200*	GE	Hi Rel SCR	170		
C35BR1200*	GE	Hi Rel SCR	170		
C35DR1200*	GE	Hi Rel SCR	170		
C35ER1200*	GE	Hi Rel SCR	170		
C35MR1200*	GE	Hi Rel SCR	170		
C37*	GE	SCR	926		
C38*	GE	SCR	930		
C38BR1200*	GE	Hi Rel SCR	170		
C38HR1200*	GE	Hi Rel SCR	170		
C38DR1200*	GE	Hi Rel SCR	170		
C45-46*	GE	SCR	937		
C50	GE	SCR	943		
C52*	GE	SCR	943		
C60	GE	SCR	949		
C62*	GE	SCR	949		
C103*	GE	SCR	953		
C106*	GE	SCR	957		
C107*	GE	SCR	965		
C122*	GE	SCR	970		
C137*	GE	SCR	978		
C137MR1200*	GE	Hi Rel SCR	170		
C138*	GE	SCR	982		
C139*	GE	SCR	982		
C140*	GE	SCR	990		
C141*	GE	SCR	990		
C144*	GE	SCR	998		
C145*	GE	SCR	1006		
C147*	GE	SCR	1010		
C150*	GE	SCR	1011		
C154-57*	GE	SCR	1017		
C158-59*	GE	SCR	1025		
C150-3*	GE	SCR	1011		
C180*	GE	SCR	1035		
C185*	GE	SCR	1040		
C180	PSI	SCR	1035		
C220-2*	GE	SCR	1048		
C280*	GE	SCR	1056		
C282*	GE	SCR	1056		
C283*	GE	SCR	1056		
C286*	GE	SCR	1056		
C287*	GE	SCR	1056		
C290*	GE	SCR	1062		
C291*	GE	SCR	1062		
C350*	GE	SCR	1067		
C350G6*	GE	SCR	1067		
C354-55*	GE	SCR	1071		
C354G6*	GE	SCR	1071		
C355G6*	GE	SCR	1071		
C358*	GE	SCR	1079		
C380*	GE	SCR	1089		
C380G6*	GE	SCR	1089		
C385*	GE	SCR	1093		
C385G6*	GE	SCR	1093		
C387*	GE	SCR	1101		
C387G6*	GE	SCR	1101		
C388*	GE	SCR	1101		
C388G6*	GE	SCR	1101		
C392-5*	GE	SCR	1111		
C397*	GE	SCR	1123		
C397G6*	GE	SCR	1123		
C398*	GE	SCR	1123		
C398G6*	GE	SCR	1123		
C420	-	Pwr Tran		D40D2	1233
C425	-	Pwr Tran		D40D8	1233
C426	-	Pwr Tran		D40D2	1233
C501*	GE	SCR	1133		
C501E7-A11*	GE	SCR	1133		
C501G5,G8*	GE	SCR	1133		
C501G7-A11*	GE	SCR	1133		
C507*	GE	SCR	1277		
C507G5,G8*	GE	SCR	1277		
C510*	GE	SCR	1138		
C510G5,G8*	GE	SCR	1138		
C520*	GE	SCR	1145		
C520G5,G8*	GE	SCR	1145		
C530*	GE	SCR	1149		
C530G5,G8*	GE	SCR	1149		
C600*	GE	SCR	1153		
C601*	GE	SCR	1157		
C602*	GE	SCR	1161		
C764	-	Pwr Tran		D40N1	1237
C1012,13*	GE	SCR	1165		
C1112,13*	GE	SCR	1165		
C1212,13*	GE	SCR	1165		
C3512,13*	GE	SCR	1165		
C4012,13*	GE	SCR	1165		
C5014*	GE	SCR	163		
C6014*	GE	SCR	163		
C15014*	GE	SCR	163		
C15414*	GE	SCR	163		
C15514*	GE	SCR	163		
C15814*	GE	SCR	163		
C18015*	GE	SCR			
C18515*	GE	SCR	163		
CB200	UNI	SCR		C103Y	953
CB201	UNI	SCR		C103YY	953
CB202	UNI	SCR		C103A	953
CB203	UNI	SCR		C103B	953
CD200	UNI	SCR		C103Y	953
CD201	UNI	SCR		C103YY	953
CD202	UNI	SCR		C103A	953
CD203	UNI	SCR		C103B	953
CL-100	CL	SSL		SSL-5A	131
CL-110	CL	SSL		SSL-34	131
CL-110A	CL	SSL		SSL-34	131
CL-110B	CL	SSL		SSL-34	131
CP409	-	Pwr Tran		D40D8	1233
CR02A1	MIT	SCR		C103YY	953
CR02A2	MIT	SCR		C103A	953
CR02A4	MIT	SCR		C103B	953
CR05A1	MIT	SCR		C103YY	953
CR05A2	MIT	SCR		C103A	953
CR05A4	MIT	SCR		C103B	953
CS11B	WES	SCR		C103Y	953
CS11C	WES	SCR		C103YY	953
CS11D	WES	SCR		C103A	953
CS11E	WES	SCR		C103B	953
CS11G	WES	SCR		C103B	953
CS11H	WES	SCR		C103B	953

* = Series
C.F. = Contact Factory

Industry Type	Mfg.	Device Type	Exact Type Page	Suggested GE Replacement	
				Type	Page
D5E37	GE	Unijunction	1176		
D5E43	GE	Unijunction	1177		
D5E44-5	GE	Unijunction	1178		
D5G514-16*	GE	Unijunction	124		
D5K1-2*	GE	Unijunction	1180		
D12A8*	GE	Amplifier	1188		
D12E026/126	GE	Amplifier	1189		
D13H1*	GE	Switch	1190		
D13T1-2*	GE	Unijunction		2N6027,8	702
D13V1-4*	GE	Int Voltage Reg	1192		
D16G6*	GE	Amplifier	1196		
D16P1*	GE	Amplifier	1197		
D26C1-5*	GE	Amplifier	1199		
D26E1-6*	GE	Amplifier	1201		
D26G1*	GE	Amplifier	1203		
D26P*	GE	Amplifier	1206		
D29E1-10*	GE	Amplifier	1209		
D29F1-7*	GE	Amplifier	1217		
D30A1-5*	GE	Amplifier	1219		
D32K*	GE	Amplifier	1221		
D32P*	GE	Amplifier	1223		
D33D21-30*	GE	Amplifier	1209		
D40C1-7*	GE	Pwr Tran	1229		
D40D1-8*	GE	Pwr Tran	1233		
D40N1-4*	GE	Pwr Tran	1237		
D40P	GE	Pwr Tran	1241		
D41D1-7*	GE	Pwr Tran	1243		
D42C1-11*	GE	Pwr Tran	1247		
D43C1-11*	GE	Pwr Tran	1251		
D44C1-11*	GE	Pwr Tran	1255		
D44H	GE	Pwr Tran	1259		
D44R1-4*	GE	Pwr Tran	1261		
D45C1-11*	GE	Pwr Tran	1265		
D45H	GE	Pwr Tran	1269		
D235	TRW	SCR		C280,281	1056
D350	TRW	SCR		C282,283	1056
D400	TRW	SCR		C286,287	1056
D470	TRW	SCR		C290,291	1062
D4912	SYL	Tunnel Diode		TD265	1537
D4912B	SYL	Tunnel Diode		TD265A	1537
D4962	SYL	Tunnel Diode		SMTD941	C.F.
D4962A	SYL	Tunnel Diode		SMTD971	C.F.
D4962B	SYL	Tunnel Diode		SMTD970	C.F.
D4962C	SYL	Tunnel Diode		SMTD968	C.F.
D4963	SYL	Tunnel Diode		TD273	1537
D4963A	SYL	Tunnel Diode		TD273	1537
D4963B	SYL	Tunnel Diode		TD273A	1537
D4963C	SYL	Tunnel Diode		TD263B	1537
D4964	SYL	Tunnel Diode		SMTD976	C.F.
D4964A	SYL	Tunnel Diode		SMTD976	C.F.
D4964B	SYL	Tunnel Diode		SMTD974	C.F.
D4964C	SYL	Tunnel Diode		SMTD973	C.F.
D4965	SYL	Tunnel Diode		TD275	1537
D4965A	SYL	Tunnel Diode		TD275	1537
D4965B	SYL	Tunnel Diode		TD275	1537
D4965C	SYL	Tunnel Diode		TD275A	1537
D4966	SYL	Tunnel Diode		TD276	1537
D4966A	SYL	Tunnel Diode		TD276	1537
D4966B	SYL	Tunnel Diode		TD276A	1537
D4966C	SYL	Tunnel Diode		TD276A	1537
D4972	SYL	Tunnel Diode		SMTD941	C.F.
D4972A	SYL	Tunnel Diode		SMTD971	C.F.
D4972B	SYL	Tunnel Diode		SMTD970	C.F.
D4972C	SYL	Tunnel Diode		SMTD968	C.F.
D4973	SYL	Tunnel Diode		TD273	1537
D4973A	SYL	Tunnel Diode		TD273	1537
D4973B	SYL	Tunnel Diode		TD273A	1537
D4973C	SYL	Tunnel Diode		TD263B	1537
D4974	SYL	Tunnel Diode		SMTD976	C.F.
D4974A	SYL	Tunnel Diode		SMTD976	C.F.
D4974B	SYL	Tunnel Diode		SMTD974	C.F.
D4974C	SYL	Tunnel Diode		SMTD973	C.F.
D4975	SYL	Tunnel Diode		TD275	1537

Industry Type	Mfg.	Device Type	Exact Type Page	Suggested GE Replacement	
				Type	Page
D4975A	SYL	Tunnel Diode		TD275	1537
D4975B	SYL	Tunnel Diode		TD275	1537
D4975C	SYL	Tunnel Diode		TD275A	1537
D4976	SYL	Tunnel Diode		TD276	1537
D4976A	SYL	Tunnel Diode		TD276	1537
D4976B	SYL	Tunnel Diode		TD276A	1537
D4976C	SYL	Tunnel Diode		TD276A	1537
D5062	SYL	Tunnel Diode		STD954	C.F.
D5062A	SYL	Tunnel Diode		SMTD971	C.F.
D5062B	SYL	Tunnel Diode		SMTD969	C.F.
D5062C	SYL	Tunnel Diode		SMTD968	C.F.
D5063	SYL	Tunnel Diode		TD273	1537
D5063A	SYL	Tunnel Diode		TD263	1537
D5063B	SYL	Tunnel Diode		TD263	1537
D5063C	SYL	Tunnel Diode		TD263B	1537
D5064	SYL	Tunnel Diode		SMTD974	C.F.
D5064A	SYL	Tunnel Diode		SMTD976	C.F.
D5064B	SYL	Tunnel Diode		SMTD974	C.F.
D5064C	SYL	Tunnel Diode		SMTD974	C.F.
D5065	SYL	Tunnel Diode		TD265	1537
D5065A	SYL	Tunnel Diode		TD265	1537
D5065B	SYL	Tunnel Diode		TD265	1537
D5065C	SYL	Tunnel Diode		TD275A	1537
D5066	SYL	Tunnel Diode		TD266	1537
D5066A	SYL	Tunnel Diode		TD266	1537
D5066B	SYL	Tunnel Diode		TD266A	1537
D5066C	SYL	Tunnel Diode		TD266A	1537
D5072	SYL	Tunnel Diode		STD954	C.F.
D5072A	SYL	Tunnel Diode		SMTD971	C.F.
D5072B	SYL	Tunnel Diode		SMTD969	C.F.
D5072C	SYL	Tunnel Diode		SMTD968	C.F.
D5073	SYL	Tunnel Diode		TD273	1537
D5073A	SYL	Tunnel Diode		TD263	1537
D5073B	SYL	Tunnel Diode		TD263B	1537
D5073C	SYL	Tunnel Diode		TD263B	1537
D5074	SYL	Tunnel Diode		SMTD974	C.F.
D5074A	SYL	Tunnel Diode		SMTD976	C.F.
D5074B	SYL	Tunnel Diode		SMTD974	C.F.
D5074C	SYL	Tunnel Diode		SMTD974	C.F.
D5075	SYL	Tunnel Diode		TD265	1537
D5075A	SYL	Tunnel Diode		TD265	1537
D5075B	SYL	Tunnel Diode		TD265	1537
D5075C	SYL	Tunnel Diode		TD275A	1537
D5076	SYL	Tunnel Diode		TD275A	1537
D5076A	SYL	Tunnel Diode		TD266	1537
D5076B	SYL	Tunnel Diode		TD276A	1537
D5076C	SYL	Tunnel Diode		TD266A	1537
D5361	SYL	Tunnel Diode		TD401	122
D5361A	SYL	Tunnel Diode		TD404	122
D5561	SYL	Tunnel Diode		TD401	122
D5561A	SYL	Tunnel Diode		TD404	122
D5561B	SYL	Tunnel Diode		TD403	122
D5571	SYL	Tunnel Diode		TD401	122
D5571A	SYL	Tunnel Diode		TD404	122
D5571B	SYL	Tunnel Diode		TD403	122
DA1701-04*	GE	Rectifier	1271		
DATA-LIT	LIT	Numeric R O		SSL-190	130
DT230A*	GE	Rectifier	1274		
DT230B*	GE	Rectifier	1274		
DT230F*	GE	Rectifier	1274		
DT230G*	GE	Rectifier	1274		
DT230H	GE	Rectifier	1274		
DT230H1*	GE	Rectifier	1274		
DT1110	LUC	Pwr Tran		D40D1	1233
DT1111	LUC	Pwr Tran		D40D7	1233
DT1112	LUC	Pwr Tran		D40N1	1237
DT1120	LUC	Pwr Tran		D40D1	1233
DT1121	LUC	Pwr Tran		D40D7	1233
DT1122	LUC	Pwr Tran		D40N1	1237
DT1311	LUC	Pwr Tran		D40D7	1233

* = Series
C.F. = Contact Factory

Industry Type	Mfg.	Device Type	Exact Type Page	Suggested GE Replacement	
				Type	Page
DT1321	LUC	Pwr Tran		D40D7	1233
DT1510	LUC	Pwr Tran		D40D1	1233
DT1511	LUC	Pwr Tran		D40D4	1233
DT1512	LUC	Pwr Tran		D40D8	1233
DT1520	LUC	Pwr Tran		D40D1	1233
DT1521	LUC	Pwr Tran		D40D8	1233
DT1522	LUC	Pwr Tran		D40D8	1233
DTA6001	SYL	Tunnel Diode		TD402	122
DTA6007	SYL	Tunnel Diode		TD402	122
DTA6013	SYL	Tunnel Diode		TD402	122
DTA6019	SYL	Tunnel Diode		TD402	122
DZ800*	GE	Rect Bridge	1273		
DZ805*	GE	Rect Bridge	1273		
DZ806*	GE	Rect Bridge	1273		
E180	PSI	SCR		C350	1067
E220	TRW	SCR		C350	1067
E300	TRW	SCR		C380	1089
E400	TRW	SCR		C380	1089
E500	TRW	SCR		C380	1089
E600	TRW	SCR		C501	1133
EN722	FSC	Transistor		GN722	C.F.
EN870	FSC	Transistor		GN870	C.F.
EN871	FSC	Transistor		GN871	C.F.
EN1132	FSC	Transistor		GN1132	C.F.
F16H1	GE	Transistor	1276		
F180	TRW	SCR		C350	1067
F220	TRW	SCR		C350	1067
F300	TRW	SCR		C380	1089
F500	TRW	SCR		C501	1133
F600	TRW	SCR		C501	1133
FD100	FSC	Diode		DA1702	1271
FD111	FSC	Diode		DA1702	1271
FD300	FSC	Diode		DT230	1274
FD600	FSC	Diode		DA1702	1271
FDH600	FSC	Diode		1N4606	306
FDH666	FSC	Diode		DA1702	1271
FDN600	FSC	Diode		1N4606	306
FDN666	FSC	Diode		MA1702	1429
FLD100	FSC	SSL		SSL-34	131
FLV100	FSC	SSL		SSL-22	130
FLV101	FSC	SSL		SSL-22	130
FLV102	FSC	SSL		SSL-22	130
FLV110	FSC	SSL		SSL-22L	130
FND10A	FSC	Numeric R O		SSL-140	130
FPA700	FSC	Photo Array		J300	1396
FPA700A	FSC	Photo Array		J300A	1396
FPA710	FSC	Photo Array		J300	1396
FPA710A	FSC	Photo Array		J300A	1396
FPF110	FSC	Photo Tran		L14A502	1403
FPF130	FSC	Photo Tran		L14A502	1403
FPM100	FSC	Photo Tran		L15E	1421
FPM200	FSC	Photo Tran		L15E	1421
FPT100	FSC	Photo Tran		L14A502	1403
FPT120	FSC	Photo Tran		L15E	1403
FR3001	TEC	Rectifier		A114C	819
FT34D	FSC	Pwr Tran		D42C8	1247
GBC*		Transistor	800		
G0000.5A	KMC	Tunnel Diode		SMTD977	C.F.
G0000.5B	KMC	Tunnel Diode		SMTD977	C.F.
G0000.5C	KMC	Tunnel Diode		SMTD977	C.F.
G0000.5D	KMC	Tunnel Diode		SMTD977	C.F.
G00005A	KMC	Tunnel Diode		SMTD971	C.F.
G00005B	KMC	Tunnel Diode		SMTD971	C.F.
G00005C	KMC	Tunnel Diode		SMTD971	C.F.
G00005D	KMC	Tunnel Diode		SMTD971	C.F.
G00010A	KMC	Tunnel Diode		TD273	1537
G00010B	KMC	Tunnel Diode		TD273	1537
G00010C	KMC	Tunnel Diode		TD273	1537
G00010D	KMC	Tunnel Diode		TD273	1537
G00020A	KMC	Tunnel Diode		SMTD976	C.F.

Industry Type	Mfg.	Device Type	Exact Type Page	Suggested GE Replacement	
				Type	Page
G00020B	KMC	Tunnel Diode		SMTD976	C.F.
G00020C	KMC	Tunnel Diode		SMTD976	C.F.
G00020D	KMC	Tunnel Diode		SMTD976	C.F.
G00050A	KMC	Tunnel Diode		TD275	1537
G00050B	KMC	Tunnel Diode		TD275	1537
G00050C	KMC	Tunnel Diode		TD275	1537
G00050D	KMC	Tunnel Diode		TD275	1537
G00100A	KMC	Tunnel Diode		TD266	1537
G00100B	KMC	Tunnel Diode		TD276	1537
G00100C	KMC	Tunnel Diode		TD276	1537
G00100D	KMC	Tunnel Diode		TD276	1537
G05005A	KMC	Tunnel Diode		SMTD970	C.F.
G05005B	KMC	Tunnel Diode		SMTD970	C.F.
G05005C	KMC	Tunnel Diode		SMTD970	C.F.
G05005D	KMC	Tunnel Diode		SMTD970	C.F.
G05010A	KMC	Tunnel Diode		TD273A	1537
G05010B	KMC	Tunnel Diode		TD273A	1537
G05010C	KMC	Tunnel Diode		TD273A	1537
G05010D	KMC	Tunnel Diode		TD273A	1537
G05020A	KMC	Tunnel Diode		SMTD975	C.F.
G05020B	KMC	Tunnel Diode		SMTD975	C.F.
G05020C	KMC	Tunnel Diode		SMTD975	C.F.
G05020D	KMC	Tunnel Diode		SMTD975	C.F.
G05050A	KMC	Tunnel Diode		TD275	1537
G05050B	KMC	Tunnel Diode		TD275	1537
G05050C	KMC	Tunnel Diode		TD275	1537
G05050D	KMC	Tunnel Diode		TD275	1537
G5-8*	GE	Heat Sink	1277/82		
G650	TRW	SCR		C501	1133
G850	TRW	SCR		C501	1133
G950	TRW	SCR		C501	1133
G25001A	KMC	Tunnel Diode		1N3713	259
G25001D	KMC	Tunnel Diode		1N3713	259
GA100	UNI	SCR		C103Y	953
GA101	UNI	SCR		C103YY	953
GA102	UNI	SCR		C103A	953
GA2-0	UNI	SCR		C103YY	953
GA200A	UNI	SCR		C103YY	953
GA201	UNI	SCR		C103A	953
GA201A	UNI	SCR		C103A	953
GE-1	GE	Sig Tran		2N394	123
GE-2	GE	Sig Tran		2N1414	442
GE-10	GE	Sig Tran		2N2924	498
GE-11	GE	Sig Tran		2N3663	518
GE-17	GE	Sig Tran		2N6010	686
GE-18	GE	Pwr Tran		D44R1	1261
GE-20	GE	Sig Tran		GET2222A	1366
GE-23	GE	Pwr Tran		D44C8	1255
GE-26	GE	Pwr Tran		D44C8	1255
GE-27	GE	Pwr Tran		D40N8	1237
GE-28	GE	Pwr Tran		D42C8	1247
GE-29	GE	Pwr Tran		D43C8	1251
GE-504A	GE	Rectifier		1N5060	312
GE-509	GE	Rectifier		A14P	312
GEB100*	GE	Rect Bridge	1284		
GEMR-1	GE	Rectifier		1N1204A	219
GEMR-2	GE	Rectifier		1N1188	215
GEMR-3	GE	SCR		C35D	922
GEMR-4	GE	SCR		C20D	910
GEMR-5	GE	SCR		C106B1	957
GEMR-6	GE	Pwr Tran		D42C5	1247
GER4001*	GE	Rectifier	1287		
GET706*	GE	Switch	1288		
GET708*	GE	Switch	1288		
GET914*	GE	Switch	1288		
GET929*	GE	Switch	1292		
GET930*	GE	Switch	1292		
GET2221-2	GE	Switch	1296		
GET2221A-2A	GE	Switch	1298		
GET2369*	GE	Switch	1300		

* = Series
C.F. = Contact Factory

Industry Type	Mfg.	Device Type	Exact Type Page	Suggested GE Replacement	
				Type	Page
GET2484*	GE	Switch	1302		
GET2904/6	GE	Switch	1304		
GET2905/7	GE	Switch	1306		
GET3013-14*	GE	Switch	1308		
GET3563	GE	Amplifier	1310		
GET3646*	GE	Switch	1382		
GET3638,A*	GE	Amplifier	1380		
GET4870-1	GE	Unijunction	1384		
GET5305-8	GE	Transistor	1386		
GS100	GSI	Photo Tran		L15A	1419
GS102	GSI	Photo Tran		L15A	1419
GS300	GSI	Photo Tran		L14A502	1403
GS302	GSI	Photo Tran		L14A502	1403
GS370	GSI	Photo Tran		L14A502	1403
GS372	GSI	Photo Tran		L14E3	1411
GS400	GSI	Photo Tran		L14E1	1411
GS403	GSI	Photo Tran		L14E3	1411
GS420	GSI	Photo Tran		L14A502	1403
GS422	GSI	Photo Tran		L14A502	1403
GS470	GSI	Photo Tran		L14A502	1403
GS606	GSI	Photo Tran		L14A502	1403
GS610	GSI	Photo Tran		L14A502	1403
GS612	GSI	Photo Tran		L14A502	1403
GS614	GSI	Photo Tran		L14A502	1403
GS670	GSI	Photo Tran		L14A502	1403
H10A	GE	Photo Coupler	1390		
H10B	GE	Photo Coupler	1392		
H10C	GE	Photo Coupler	1394		
H1000	TRW	SCR		C530,600,1,2	1149
H1100	TRW	SCR		C530,600,601	1149
H1200	TRW	SCR		C600,520,601	1153
H1300	TRW	SCR		C600	1153
H1400	TRW	SCR		C600	1153
H1500	TRW	SCR		C600	1153
HEP706	MOT	Pwr Tran		D44R3	1261
HEP714	MOT	Pwr Tran		D44R1	1261
HR878A	UNI	SCR		C103YY	953
HR878B	UNI	SCR		C103YY	953
HR879A	UNI	SCR		C103A	953
HR879B	UNI	SCR		C103A	953
HR881A	UNI	SCR		C103B	953
HR881B	UNI	SCR		C103B	953
HR3027	UNI	SCR		C103Y	953
HR3028	UNI	SCR		C103YY	953
HR3029	UNI	SCR		C103A	953
HR3030	UNI	SCR		C103Y	953
HR3031	UNI	SCR		C103YY	953
HR3032	UNI	SCR		C103A	953
HT312	HUN	Triac		SC36/141B	1455
HT322	HUN	Triac		SC36/141B	1455
HT342	HUN	Triac		SC36/141D	1455
HT352	HUN	Triac		SC36/141E	1455
HT412	HUN	Triac		SC41/141B	1459
HT422	HUN	Triac		SC41/141B	1459
HT442	HUN	Triac		SC41/141D	1459
HT452	HUN	Triac		SC41/141E	1459
HT612	HUN	Triac		SC41/141B	1459
HT622	HUN	Triac		SC41/141B	1459
HT642	HUN	Triac		SC41/141D	1459
HT652	HUN	Triac		SC41/141E	1459
HT812	HUN	Triac		SC46/146B	1467
HT822	HUN	Triac		SC46/146B	1467
HT842	HUN	Triac		SC46/146D	1467
HT852	HUN	Triac		SC46/146D	1467
HT1012	HUN	Triac		SC46/146B	1467
HT1022	HUN	Triac		SC46/146B	1467
HT1042	HUN	Triac		SC46/146D	1467
HT1052	HUN	Triac		SC46/146D	1467

Industry Type	Mfg.	Device Type	Exact Type Page	Suggested GE Replacement	
				Type	Page
HT1622	HUN	Triac		SC51B	1475
HT1642	HUN	Triac		SC51D	1475
HT1652	HUN	Triac		SC51E	1475
HT2523	HUN	Triac		SC60B	1483
HT2543	HUN	Triac		SC60D	1483
HT2553	HUN	Triac		SC60E	1483
ID100	UNI	SCR		C103Y	953
ID101	UNI	SCR		C103YY	953
ID102	UNI	SCR		C103A	953
ID103	UNI	SCR		C103B	953
ID104	UNI	SCR		C103B	953
ID200	UNI	SCR		2N2323	880
ID201	UNI	SCR		2N2324	880
ID202	UNI	SCR		2N2325	880
ID203	UNI	SCR		2N2326	880
ID300	UNI	SCR		2N2328	880
ID301	UNI	SCR		2N2329	880
IR106A	IR	SCR		C106A	957
IR106B	IR	SCR		C106B	957
IR106C	IR	SCR		C106C	957
IR106F	IR	SCR		C106F	957
IR106Q	IR	SCR		C106Q	957
IR106Y	IR	SCR		C106Y	957
IR-LIT40	LIT	SSL		SSL-34	131
IR-LIT60	LIT	SSL		SSL-15	131
ISLO-LITI	LIT	SSL		PC15-26	1409
IS1760	NEC	Tunnel Diode		TD262	1537
IS1761	NEC	Tunnel Diode		TD262	1537
IS1764	NEC	Tunnel Diode		TD265A	1537
IS2199	NEC	Tunnel Diode		TD263B	1537
J05	DI	Diode		A14F	801
J1	DI	Diode		A14A	801
J2	DI	Diode		1N5059	312
J4	DI	Diode		1N5060	312
J6	DI	Diode		1N5061	312
J8	DI	Diode		1N5062	312
J10	DI	Diode		A14P	312
J300*	GE	Photo Detector	1396		
KBP005	GI	Rect Bridge		GEB100	1284
KBP02	GI	Rect Bridge		GEB102	1284
KBP04	GI	Rect Bridge		GEB104	1284
KBP06	GI	Rect Bridge		GEB106	1284
KBPS005	GI	Rect Bridge		GEB100	1284
KBPS02	GI	Rect Bridge		GEB102	1284
KBPS04	GI	Rect Bridge		GEB104	1284
GBPS06	GI	Rect Bridge		GEB106	1284
L1V*	GE	Photo Detector	1423		
L8*	GE	Photo Detector	1398		
L9*	GE	Photo Detector	1398		
L14A502*	GE	Photo Detector	1403		
L14D1-4*	GE	Photo Detector	643		
L14E1-4*	GE	Photo Detector	1411		
L14F*	GE	Photo Detector	1415		
L14T*	GE	Photo Detector	1417		
L15A600	GE	Photo Detector	1419		
L15E	GE	Photo Detector	1421		
L811*	GE	Photo Detector	1398		
L911*	GE	Photo Detector	1398		
L4450	PHF	Isolator		H10A	1390
LA700	HEI	Photo Tran		J300	1396
LS400	TI	Photo Tran		L15E	1421
LS600	TI	Photo Tran		L15A600	1419
M73P1	GE	Sig Diode	1428		
MA1701*	GE	Sig Diode	1429		
MA1702*	GE	Sig Diode	1429		
MA1703*	GE	Sig Diode	1429		
MA1704*	GE	Sig Diode	1429		

* = Series
C.F. = Contact Factory

Industry Type	Mfg.	Device Type	Exact Type Page	Suggested GE Replacement	
				Type	Page
MA4607A	MIC	Tunnel Diode		TD263B	1537
MA4607A1	MIC	Tunnel Diode		SMTD972	C.F.
MA4607A2	MIC	Tunnel Diode		SMTD972	C.F.
MA4607B	MIC	Tunnel Diode		TD263B	1537
MA4607C	MIC	Tunnel Diode		TD273A	1537
MA8001	MEH	Pwr Tran		D40D4	1233
MA8003	MEH	Pwr Tran		D40D8	1233
MAC1-2	MOT	Triac		SC46/146D	1491
MAC1-4	MOT	Triac		SC46/146B	1491
MAC1-6	MOT	Triac		SC46/146D	1491
MAC2-2	MOT	Triac		SC45/146D	1467
MAC2-4	MOT	Triac		SC45/146B	1467
MAC2-6	MOT	Triac		SC45/146D	1467
MAC3-2	MOT	Triac		SC46/146D	1491
MAC3-4	MOT	Triac		SC46/146B	1491
MAC3-6	MOT	Triac		SC46/146D	1491
MAC35-1	MOT	Triac		SC61E	1483
MAC35-2	MOT	Triac		SC61E	1483
MAC35-3	MOT	Triac		SC61B	1483
MAC35-4	MOT	Triac		SC61B	1483
MAC35-5	MOT	Triac		SC61C	1483
MAC35-6	MOT	Triac		SC61D	1483
MAC35-7	MOT	Triac		SC61E	1483
MAC36-1	MOT	Triac		SC60E	1483
MAC36-2	MOT	Triac		SC60E	1483
MAC36-3	MOT	Triac		SC60B	1483
MAC36-4	MOT	Triac		SC60B	1483
MAC36-5	MOT	Triac		SC60C	1483
MAC36-6	MOT	Triac		SC60D	1483
MAC36-7	MOT	Triac		SC60E	1483
MAN3A	MON	Numeric RO		SSL-140	130
MAN4A	MON	Numeric RO		SSL-190	130
MBS4991	MOT	Switch		2N4991	578
MBS4992	MOT	Switch		2N4992	582
MCD1	MON	Photo Coupler		H10A	1390
MCH2005F	TSC	Pwr Tran		D40C1	1229
MCR406-1	MOT	SCR		C106Y	957
MCR406-2	MOT	SCR		C106F	957
MC406-3	MOT	SCR		C106A	957
MCR406-4	MOT	SCR		C106B	957
MCR407-1	MOT	SCR		C107Y	965
MCR407-2	MOT	SCR		C107F	965
MCR407-3	MOT	SCR		C107A	965
MCR407-4	MOT	SCR		C107B	965
MCR649-1	MOT	SCR		C32F	913
MCR649-2	MOT	SCR		C32F	913
MCR649-3	MOT	SCR		C32A	913
MCR649-4	MOT	SCR		C32B	913
MCR649-5	MOT	SCR		C32C	913
MCR649-6	MOT	SCR		C32D	913
MCR649-7	MOT	SCR		C32F	913
MCR1907-1	MOT	SCR		C34,40U	918
MCR1907-2	MOT	SCR		C34,40F	918
MCR1907-3	MOT	SCR		C34,40A	918
MCR1407-4	MOT	SCR		C34,40B	918
MCR1407-5	MOT	SCR		C34,40C	918
MCR1407-6	MOT	SCR		C34,40D	918
MCR2315-1	MOT	SCR		C20U	910
MCR2315-2	MOT	SCR		C20F	910
MCR2315-3	MOT	SCR		C20A	910
MCR2315-4	MOT	SCR		C20B	910
MCR2315-5	MOT	SCR		C20C	910
MCR2315-6	MOT	SCR		C20D	910
MCR3818-1	MOT	SCR		C30U	913
MCR381802	MOT	SCR		C30F	913
MCR3818-3	MOT	SCR		C30A	913
MCR3818-4	MOT	SCR		C30B	913
MCR3818-5	MOT	SCR		C30C	913
MCR3818-6	MOT	SCR		C30D	913
MCR3818-7	MOT	SCR		C30E	913
MCR3918-1	MOT	SCR		C32U	913
MCR3918-2	MOT	SCR		C32F	913
MCR3918-3	MOT	SCR		C32A	913
MCR3918-4	MOT	SCR		C32B	913
MCR3918-5	MOT	SCR		C32C	913
MCR3918-6	MOT	SCR		C32D	913
MCR3918-7	MOT	SCR		C32E	913
MCR3935-1	MOT	SCR		C30U	913
MCR3935-2	MOT	SCR		C30F	913
MCR3935-3	MOT	SCR		C30A	913
MCR3935-4	MOT	SCR		C30B	913
MCR3935-5	MOT	SCR		C30C	913
MCR3935-6	MOT	SCR		C30D	913
MCR3935-7	MOT	SCR		C30E	913
MCR3935-8	MOT	SCR		C137M	978
MCT1	MON	Photon Coupler		PC15-26	1409
MCT2	MON	Photon Coupler		H11A	C.F.
MD1	MON	Detector		L14A502	1403
MD2	MON	Detector		L14A502	1403
MDA920-2	MOT	Rect Bridge		GEB100	1284
MDA920-3	MOT	Rect Bridge		GEB101	1284
MDA920-4	MOT	Rect Bridge		GEB102	1284
MDA920-6	MOT	Rect Bridge		GEB104	1284
MDA920-7	MOT	Rect Bridge		GEB106	1284
MDA920A-2	MOT	Rect Bridge		GEB100	1284
MDA920A-3	MOT	Rect Bridge		GEB101	1284
MDA920A-4	MOT	Rect Bridge		GEB102	1284
MDA920A-6	MOT	Rect Bridge		GEB104	1284
MDA920A-7	MOT	Rect Bridge		GEB106	1284
ME1	MON	SSL		SSL-315	131
ME2	MON	SSL		SSL-5C	131
ME2A	MON	SSL		SSL-55B	131
ME3	MON	SSL		SSL-15	131
ME4	MON	SSL		SSL-34	131
ME5	MON	SSL		SSL-35	131
ME60	MON	SSL		SSL-15	131
ME120C	MON	SSL		SSL-5A	131
MEU21	MEH	Unijunction		2N6027	702
MEU22	MEH	Unijunction		2N6028	702
MJ400	MOT	Pwr Tran		D44R4	1261
MJ420	MOT	Pwr Tran		D40N1	1237
MJ421	MOT	Pwr Tran		D40N4	1237
MJ2249	MOT	Pwr Tran		D44C8	1255
MJ2251	MOT	Pwr Tran		D44R1	1261
MJ2252	MOT	Pwr Tran		D44R3	1261
MJ2253	MOT	Pwr Tran		D45C8	1265
MJ3101	MOT	Pwr Tran		D44C5	1255
MJ3201	MOT	Pwr Tran		D44R1	1261
MJ3202	MOT	Pwr Tran		D44R3	1261
MJ3701	MOT	Pwr Tran		D45C5	1265
MJ4101	MOT	Pwr Tran		D44C5	1255
MJ8100	MOT	Pwr Tran		D43C8	1251
MJE101	MOT	Pwr Tran		D45C6	1265
MJE102	MOT	Pwr Tran		D45C8	1265
MJE103	MOT	Pwr Tran		D45C8	1265
MJE105	MOT	Pwr Tran		D45C8	1265
MJE201	MOT	Pwr Tran		D44C6	1255
MJE202	MOT	Pwr Tran		D44C8	1255
MJE203	MOT	Pwr Tran		D44C8	1255
MJE205	MOT	Pwr Tran		D44C8	1255
MJE340	MOT	Pwr Tran		D44R3	1261
MJE341	MOT	Pwr Tran		D44R2	1261
MJE344	MOT	Pwr Tran		D44R2	1261

* = Series
C.F. = Contact Factory

Industry Type	Mfg.	Device Type	Exact Type Page	Suggested GE Replacement	
				Type	Page
MJE370	MOT	Pwr Tran		D45C2	1265
MJE371	MOT	Pwr Tran		D45C5	1265
MJE488	MOT	Pwr Tran		D44C8	1255
MJE520	MOT	Pwr Tran		D44C2	1255
MJE521	MOT	Pwr Tran		D44C5	1255
MJE3440	MOT	Pwr Tran		D44R3	1261
MLED50	MOT	SSL		SSL-12	130
MLED60	MOT	SSL		SSL-15	131
MLED90	MOT	SSL		SSL-315	131
MLED600	MOT	SSL		SSL-22	130
MLED630	MOT	SSL		SSL-22	130
MLED900	MOT	SSL		SSL-34	131
MLED930	MOT	SSL		SSL-4	131
MM1619	MOT	Pwr Tran		D44C1	1255
MM1803	MOT	Pwr Tran		D40D1	1233
MM1812	MOT	Pwr Tran		D40N1	1237
MM2258	MOT	Pwr Tran		D44R2	1261
MM2259	MOT	Pwr Tran		D44R2	1261
MM2260	MOT	Pwr Tran		D44R2	1261
MM2261	MOT	Pwr Tran		D40D7	1233
MM2263	MOT	Pwr Tran		D44R2	1261
MM3001	MOT	Pwr Tran		D44R1	1261
MM3002	MOT	Pwr Tran		D40N1	1237
MM3003	MOT	Pwr Tran		D40N3	1237
MM3004	MOT	Pwr Tran		D40D1	1233
MM3008	MOT	Pwr Tran		D44R2	1261
MM3009	MOT	Pwr Tran		D44R2	1261
MM3724	MOT	Pwr Tran		D40D1	1233
MM3725	MOT	Pwr Tran		D40D7	1233
MM3726	MOT	Pwr Tran		D43C8	1251
MM4019	MOT	Pwr Tran		D41D4	1243
MM4020	MOT	Pwr Tran		D45C3	1265
MM4429	MOT	Pwr Tran		D40D4	1233
MM4430	MOT	Pwr Tran		D40D4	1233
MOC1000	MOT	Photon Coupler		PC15-26	1409
MOR33	MOT	Numeric RO		SSL-140	130
MOV	GE	Varistor	166		
M22P*	GE	Sig Diode	1427		
MP8111	MEH	Pwr Tran		D44C8	1255
MP8112	MEH	Pwr Tran		D44C8	1255
MP8211	MEH	Pwr Tran		D44C5	1255
MP8212	MEH	Pwr Tran		D44C6	1255
MP8221	MEH	Pwr Tran		D44C5	1255
MP8222	MEH	Pwr Tran		D44C6	1255
MPD200*	GE	Sig Diode	284		
MPD300*	GE	Sig Diode	284		
MPD400*	GE	Sig Diode	284		
MP010ABB	WES	Rect Bridge		GEB101	1284
MP010ABD	WES	Rect Bridge		GEB102	1284
MP010ABH	WES	Rect Bridge		GEB104	1284
MP010ABM	WES	Rect Bridge		GEB106	1284
MP010ABS	WES	Rect Bridge		GEB108	1284
MP010ABZ	WES	Rect Bridge		GEB110	1284
MPR10*	GE	Rectifier	1431		
MPR12*	GE	Rectifier	1431		
MPR15*	GE	Rectifier	1431		
MPS918	MOT	Transistor		GPS918	C.F.
MPS3563	MOT	Transistor		GPS3563	C.F.
MPS3693	MOT	Transistor		GPS3693	C.F.
MPS3694	MOT	Transistor		GPS3694	C.F.
MPS3702	MOT	Transistor		2N5447	639
MPS3703	MOT	Transistor		2N5448	639
MPS3704	MOT	Transistor		2N5449	641
MPS3705	MOT	Transistor		2N5450	641
MPS3706	MOT	Transistor		2N5451	641
MPS3707	MOT	Transistor		GPS3707	C.F.
MPS3708	MOT	Transistor		GPS3708	C.F.
MPS3709	MOT	Transistor		GPS3709	C.F.
MPS3710	MOT	Transistor		GPS3710	C.F.
MPS3711	MOT	Transistor		GPS3711	C.F.
MPS6507	MOT	Transistor		GPS6507	C.F.
MPS6511	MOT	Transistor		GPS6511	C.F.
MPS6512	MOT	Transistor		GPS6512	C.F.
MPS6513	MOT	Transistor		GPS6513	C.F.
MPS6514	MOT	Transistor		GPS6514	C.F.
MPS6515	MOT	Transistor		GPS6515	C.F.
MPS6516	MOT	Transistor		GPS6516	C.F.
MPS6517	MOT	Transistor		GPS6517	C.F.
MPS6518	MOT	Transistor		GPS6518	C.F.
MPS6519	MOT	Transistor		GPS6519	C.F.
MPS6520	MOT	Transistor		GPS6520	C.F.
MPS6521	MOT	Transistor		GPS6521	C.F.
MPS6522	MOT	Transistor		GPS6522	C.F.
MPS6530	MOT	Transistor		GPS6520	C.F.
MPS6531	MOT	Transistor		GPS6531	C.F.
MPS6532	MOT	Transistor		GPS6532	C.F.
MPS6533	MOT	Transistor		GPS6533	C.F.
MPS6534	MOT	Transistor		GPS6534	C.F.
MPS6535	MOT	Transistor		GPS6535	C.F.
MPS6539	MOT	Transistor		GPS6539	C.F.
MPS6542	MOT	Transistor		GPS6542	C.F.
MPS6560	MOT	Transistor		GPS6560	C.F.
MPS6561	MOT	Transistor		GPS6561	C.F.
MPS6562	MOT	Transistor		GPS6562	C.F.
MPS6563	MOT	Transistor		GPS6563	C.F.
MPS6565	MOT	Transistor		GPS6565	C.F.
MPS6566	MOT	Transistor		GPS6566	C.F.
MPS6567	MOT	Transistor		GPS6567	C.F.
MPS6571	MOT	Transistor		GPS6571	C.F.
MPSA05	MOT	Transistor		GPSA05	C.F.
MPSA06	MOT	Transistor		GPSA06	C.F.
MPSA09	MOT	Transistor		GPSA09	C.F.
MPSA10	MOT	Transistor		GPSA10	C.F.
MPSA12	MOT	Transistor		GPSA12	C.F.
MPSA13	MOT	Transistor		GPSA13	C.F.
MPSA14	MOT	Transistor		GPSA14	C.F.
MPSA20	MOT	Transistor		GPSA20	C.F.
MPSA55	MOT	Transistor		GPSA55	C.F.
MPSA56	MOT	Transistor		GPSA56	C.F.
MPSA70	MOT	Transistor		GPSA70	C.F.
MPSU01	MOT	Pwr Tran		D40D2	1233
MPSU02	MOT	Pwr Tran		D40D5	1233
MPSU03	MOT	Pwr Tran		D44R1-4	1261
MPSU04	MOT	Pwr Tran		D44R1-4	1261
MPSU05	MOT	Pwr Tran		D40D8	1233
MPSU10	MOT	Pwr Tran		D40N3	1237
MPSU51	MOT	Pwr Tran		D41D2	1243
MPSU52	MOT	Pwr Tran		D41D5	1243
MPSU55	MOT	Pwr Tran		D41D8	1243
MPU131	MOT	Unijunction		2N6027	702
MPU132	MOT	Unijunction		2N6028	702
MPU133	MOT	Unijunction		2N6028	702
MPU231	MOT	Unijunction		D13K1	706
MPU232	MOT	Unijunction		D13K2	706
MPU233	MOT	Unijunction		D13K2	706
M2P/MQ2	GE	Sig Diode	290		
MR22F1	MOT	Rectifier		A114C	819
MR880	MOT	Rectifier		1N3889	271
MR881	MOT	Rectifier		1N3890	271
MR882	MOT	Rectifier		1N3891	271
MR883	MOT	Rectifier		1N3892	271
MR884	MOT	Rectifier		1N3893	271
MR890	MOT	Rectifier		1N3909	273
MR891	MOT	Rectifier		1N3910	273
MR892	MOT	Rectifier		1N3911	273
MR893	MOT	Rectifier		1N3912	273
MR894	MOT	Rectifier		1N3913	273
MR1121	MOT	Rectifier		1N1200A	219
MR1122	MOT	Rectifier		1N1202A	219
MR1124	MOT	Rectifier		1N1204A	219

* = Series
C.F. = Contact Factory

Industry Type	Mfg.	Device Type	Exact Type Page	Suggested GE Replacement	
				Type	Page
MR1126	MOT	Rectifier		1N1206A	219
MR1128	MOT	Rectifier		1N3671A	219
MR1130	MOT	Rectifier		1N3673A	219
MR1366	MOT	Rectifier		A129M	831
MR1376	MOT	Rectifier		A129M	831
MR1386	MOT	Rectifier		A139M	833
MR1396	MOT	Rectifier		A139M	833
MRD14B	MOT	Amplifier		2N5779	643
MRD100	MOT	Photo Tran		L15E,F	1421
MRD150	MOT	Photo Tran		L15E,F	1421
MRD200	MOT	Photo Tran		L15A600	1419
MRD210	MOT	Photo Tran		L15A600	1419
MRD250	MOT	Photo Tran		L15A600	1419
MRD300	MOT	Photo Tran			
MRD310	MOT	Photo Tran		L14A502	1403
MRD450	MOT	Photo Tran			
MRD600	MOT	Photo Tran		L15A600	1419
MRD810	MOT	Photo Tran		L15A600	1419
MRD3050	MOT	Photo Tran		L14A502	1403
MRD3051	MOT	Photo Tran		L14A502	1403
MRD3052	MOT	Photo Tran		L14A502	1403
MRD3053	MOT	Photo Tran		L14A502	1403
MRD3054	MOT	Photo Tran		L14A502	1403
MRD3055	MOT	Photo Tran		L14A502	1403
MRD3056	MOT	Photo Tran		L14A502	1403
MS1052	MS	Tunnel Diode		SMTD971	C.F.
MS1054	MS	Tunnel Diode		TD273	1537
MS1059	MS	Tunnel Diode		SMTD976	C.F.
MS1083	MS	Tunnel Diode		SMTD971	C.F.
MS1083A	MS	Tunnel Diode		SMTD971A	C.F.
MS1085	MS	Tunnel Diode		TD273	1537
MS1085A	MS	Tunnel Diode		TD273	1537
MS1087	MS	Tunnel Diode		SMTD976	C.F.
MS1087A	MS	Tunnel Diode		SMTD976	C.F.
MS1152	MS	Tunnel Diode		SMTD970	C.F.
MS1154	MS	Tunnel Diode		TD273A	1537
MS1159	MS	Tunnel Diode		SMTD975	C.F.
MS1163	MS	Tunnel Diode		SMTD970	C.F.
MS1163A	MS	Tunnel Diode		SMTD970	C.F.
MS1165	MS	Tunnel Diode		TD273A	1537
MS1165A	MS	Tunnel Diode		TD273A	1537
MS1166	MS	Tunnel Diode		SMTD975	C.F.
MS1166A	MS	Tunnel Diode		SMTD975	C.F.
MS1200	MS	Tunnel Diode		SMTD953	C.F.
MS1301	MS	Tunnel Diode		SMTD954	C.F.
MS1302	MS	Tunnel Diode		SMTD955	C.F.
MS1303	MS	Tunnel Diode		SMTD956	C.F.
MS1304	MS	Tunnel Diode		SMTD957	C.F.
MS1305	MS	Tunnel Diode		SMTD958	C.F.
MS1531A	MS	Tunnel Diode		TD273A	1537
MS1550A	MS	Tunnel Diode		SMTD971	C.F.
MS1551A	MS	Tunnel Diode		TD263	1537
MS1553A	MS	Tunnel Diode		TD265	1537
MS1554A	MS	Tunnel Diode		TD266	1537
MSA7505	FSC	Pwr Tran		D44C1	1255
MSA8505	FSC	Pwr Tran		D44C1	1255
MSA8506	FSC	Pwr Tran		D42C1	1247
MSA8508	FSC	Pwr Tran		D42C1	1247
MSP15	MST	Pwr Tran		D44R1	1261
MSP20	MST	Pwr Tran		D44R1	1261
MSP25	MST	Pwr Tran		D44R1	1261
MSP30	MST	Pwr Tran		D44R3	1261
MST105	MST	Pwr Tran		D44R2	1261
MST15	MST	Pwr Tran		D44R1	1261
MST20	MST	Pwr Tran		D44R1	1261
MST20B	MST	Pwr Tran		D44R1	1261
MST20S	MST	Pwr Tran		D44R2	1261
MST25	MST	Pwr Tran		D44R1	1261

Industry Type	Mfg.	Device Type	Exact Type Page	Suggested GE Replacement	
				Type	Page
MST30	MST	Pwr Tran		D44R3	1261
MST30B	MST	Pwr Tran		D44R3	1261
MST30S	MST	Pwr Tran		D44R4	1261
MT1070	-	Pwr Tran		D40D1	1233
MU4891	MOT	Unijunction		2N2646	477
MU4892	MOT	Unijunction		2N2646	477
MU4893	MOT	Unijunction		2N2647	477
MU4894	MOT	Unijunction		2N2647	477
U13T1	UNI	Unijunction		D13K1	706
U13T2	UNI	Unijunction		D13K2	706
MUS4987	MOT	Switch		2N4987	570
MUS4988	MOT	Switch		2N4988	574
MV2	MON	SSL		SSL-3	130
MV10B	MON	SSL		SSL-22	130
MV10B3	MON	SSL		SSL-22	130
MV50	MON	SSL		SSL-12	130
MV5020	MON	SSL		SSL-22L	130
NL511-3	NAT	SCR		C137N	978
NL511-4	NAT	SCR		C137P	978
NL511-6	NAT	SCR		C137PB	978
NL577	NAT	SCR		C145	1006
NLC35A	NAT	SCR		C35A	922
NLC35B	NAT	SCR		C35B	922
NLC35C	NAT	SCR		C35C	922
NLC35D	NAT	SCR		C35D	922
NLC35E	NAT	SCR		C35E	922
NLC35G	NAT	SCR		C35G	922
NLC35H	NAT	SCR		C35H	922
NLC35M	NAT	SCR		C35M	922
NLC35N	NAT	SCR		C35N	922
NLC35S	NAT	SCR		C35S	922
NLC36A	NAT	SCR		C36A	C.F.
NLC36B	NAT	SCR		C36B	C.F.
NLC36C	NAT	SCR		C36C	C.F.
NLC36D	NAT	SCR		C36D	C.F.
NLC36E	NAT	SCR		C36E	C.F.
NLC36G	NAT	SCR		C36G	C.F.
NLC36H	NAT	SCR		C36H	C.F.
NLC36M	NAT	SCR		C36M	C.F.
NLC36N	NAT	SCR		C36N	C.F.
NLC36S	NAT	SCR		C36S	C.F.
NLC37A	NAT	SCR		C37A	926
NLC37B	NAT	SCR		C37B	926
NLC37C	NAT	SCR		C37C	926
NLC37D	NAT	SCR		C37D	926
NLC37E	NAT	SCR		C37E	926
NLC37M	NAT	SCR		C37M	926
NLC37N	NAT	SCR		C37N	926
NLC37S	NAT	SCR		C37S	926
NLC38A	NAT	SCR		C38A	930
NLC38B	NAT	SCR		C38B	930
NLC38C	NAT	SCR		C38C	930
NLC38D	NAT	SCR		C38D	930
NLC38E	NAT	SCR		C38E	930
NLC38G	NAT	SCR		C38G	930
NLC38H	NAT	SCR		C38H	930
NLC40A	NAT	SCR		C40A	C,F.
NLC40B	NAT	SCR		C40B	C.F.
NLC40C	NAT	SCR		C40C	C.F.
NLC40D	NAT	SCR		C40D	C.F.
NLC40G	NAT	SCR		C40G	C.F.
NLC40H	NAT	SCR		C40H	C.F.
NLC45	NAT	SCR		C45	937
NLC46	NAT	SCR		C46	937
NLC50	NAT	SCR		C50	943
NLC52	NAT	SCR		C52	943
NLC60	NAT	SCR		C60	949
NLC62	NAT	SCR		C62	949

* = Series
C.F. = Contact Factory

Industry Type	Mfg.	Device Type	Exact Type Page	Suggested GE Replacement	
				Type	Page
NLC135A	NAT	SCR		C137AX49	978
NLC135B	NAT	SCR		C137BX49	978
NLC135C	NAT	SCR		C137CX49	978
NLC135D	NAT	SCR		C137DX49	978
NLC135E	NAT	SCR		C137EX49	978
NLC135M	NAT	SCR		C137MX49	978
NLC135N	NAT	SCR		C137NX49	978
NLC135S	NAT	SCR		C137SX49	978
NLC137E	NAT	SCR		C137E	978
NLC137M	NAT	SCR		C137M	978
NLC137N	NAT	SCR		C137N	978
NLC137P	NAT	SCR		C137P	978
NLC137PA	NAT	SCR		C137PA	978
NLC137PB	NAT	SCR		C137PB	978
NLC137S	NAT	SCR		C137S	978
NLC137T	NAT	SCR		C137T	978
NLC150	NAT	SCR		C150	1011
NLC151	NAT	SCR		C158	1025
NLC152	NAT	SCR		C152	1011
NLC153	NAT	SCR		C159	1025
NLC154	NAT	SCR		C154	1017
NLC155	NAT	SCR		C155	1017
NLC156	NAT	SCR		C156	1017
NLC157	NAT	SCR		C157	1017
NLC178	NAT	SCR		C178	1035
NLC180	NAT	SCR		C180	1035
NLC181	NAT	SCR		C185,C358	1040
NLC185	NAT	SCR		C185,C358	1040
NLC290	NAT	SCR		C290	1062
NLC291	NAT	SCR		C291	1062
NLC350	NAT	SCR		C350	1067
NLC354	NAT	SCR		C354	1071
NLC355	NAT	SCR		C355	1071
NLC358	NAT	SCR		C358	1079
NLC380	NAT	SCR		C380	1089
NLC501	NAT	SCR		C501	1133
NLF158	NAT	SCR		C158	1025
NLF159	NAT	SCR		C159	1025
NSL701-1	NSC	Photo Diode			C.F.
NSL701-9A	NSC	Photo Diode			C.F.
NSL703	NSC	Photo Diode			C.F.
NSL710P	NSC	Photo Diode			C.F.
NSL720	NSC	Photo Diode			C.F.
NSL820	NSC	Photo Diode			C.F.
OP300	OPT	Photo Darlingtn		2N5777	643
OP400	OPT	Photo Tran		L15E	1421
OP500	OPT	Photo Tran		L15E	1421
OP600	OPT	Photo Tran		L15A600	1419
OP601	OPT	Photo Tran		L15A600	1419
OP602	OPT	Photo Tran		L15A600	1419
OP603	OPT	Photo Tran		L15A600	1419
OP604	OPT	Photo Tran		L15A600	1419
OP611	OPT	Photo Tran		L15F	C.F.
OP612	OPT	Photo Tran			C.F.
OP613	OPT	Photo Tran		L15F	C.F.
OP614	OPT	Photo Tran		L15F	C.F.
OP621	OPT	Photo Tran		L14A502	1403
OP622	OPT	Photo Tran		L14A502	1403
OP623	OPT	Photo Tran			C.F.
OP624	OPT	Photo Tran			C.F.
OP666	OPT	Photo Tran			C.F.
OP1030	OPT	Photon Coupler		PC4-73	1407
OP1063	OPT	Photon Coupler		PC15-26	1409
OSL1	OPC	SSL		SSL-12	130
OSL2	OPC	SSL		SSL-12	130
OSL3	OPC	SSL		SSL-12	130

Industry Type	Mfg.	Device Type	Exact Type Page	Suggested GE Replacement	
				Type	Page
PC15-26	GE	Photon Coupler	1409		
PC4-73	GE	Photon Coupler	1407		
PDH100	ECI	Rect Bridge		GEB110	1284
PPR1006	PPC	Pwr Tran		D42C5	1247
PPR1008	PPC	Pwr Tran		D42C8	1247
PT26	HUT	Triac		SC41B	1459
PT46	HUT	Triac		SC41D	1459
PT210	HUT	Triac		SC46B	1467
PT215	HUT	Triac		SC51B	1475
PT225	HUT	Triac		SC61B	1483
PT410	HUT	Triac		SC46D	1467
PT415	HUT	Triac		SC51D	1475
PT425	HUT	Triac		SC61D	1483
PT600	TRW	Pwr Tran		D42C5	1247
PT601	TRW	Pwr Tran		D42C5	1247
PT612	TRW	Pwr Tran		D42C8	1247
PT665	TRW	Pwr Tran		D44C8	1255
PT896	TRW	Pwr Tran		D40D7	1233
PT1544	TRW	Pwr Tran		D40D7	1233
PT1545	TRW	Pwr Tran		D40D7	1233
PT1558	TRW	Pwr Tran		D40D7	1233
PT1559	TRW	Pwr Tran		D40D7	1233
PT2525A	TRW	Pwr Tran		D44R1	1261
PT2620	TRW	Pwr Tran		D40D4	1233
PT2630	TRW	Pwr Tran		D40D7	1233
PT2635	TRW	Pwr Tran		D42C7	1247
PT2640	TRW	Pwr Tran		D40D4	1233
PT2660	TRW	Pwr Tran		D40D4	1233
PT2670	TRW	Pwr Tran		D40D7	1233
PT3502	TRW	Pwr Tran		D40D4	1233
PT3503	TRW	Pwr Tran		D40D1	1233
PT4690	TRW	Pwr Tran		D42C4	1247
PT4816	TRW	Pwr Tran		D40D1	1233
PT5693	TRW	Pwr Tran		D44C1	1255
PT6618	TRW	Pwr Tran		D40D1	1233
PT6696	TRW	Pwr Tran		D40D4	1233
Q2004	ECC	Triac		SC41B	1459
Q2005	ECC	Triac		SC41B	1459
Q2007	ECC	Triac		SC46B	1467
Q2010	ECC	Triac		SC46B	1467
Q2015	ECC	Triac		SC51B	1475
Q4004	ECC	Triac		SC41D	1459
Q4005	ECC	Triac		SC41D	1459
Q4007	ECC	Triac		SC46D	1467
RA1-3B	GE	Amplifier	1433		
R3020606	WES	Rectifier		A129M	831
R3020612	WES	Rectifier		A129M	831
R3101212	WES	Rectifier		1N5331	219
R3101216	WES	Rectifier		1N5331	219
R4020620	WES	Rectifier		A139M	833
R4020630	WES	Rectifier		A139M	833
R4100070	WES	Rectifier		1N1183A	215
R4100170	WES	Rectifier		1N1184A	215
R4100822	WES	Rectifier		1N3766	215
R4100840	WES	Rectifier		1N3766	215
R4100860	WES	Rectifier		1N3766	215
R4101022	WES	Rectifier		1N3768	215
R4101040	WES	Rectifier		1N5332	215
R4101060	WES	Rectifier		1N5332	215
R4101070	WES	Rectifier		1N3768	215
R4101222	WES	Rectifier		1N5332	215
R4101240	WES	Rectifier		1N5332	215
R4101260	WES	Rectifier		1N5332	215
R4101270	WES	Rectifier		1N5332	215

* = Series
C.F. = Contact Factory

Industry Type	Mfg.	Device Type	Exact Type Page	Suggested GE Replacement	
				Type	Page
R4108070	WES	Rectifier		1N3766	215
RED-LIT2	LIT	SSL		SSL-22L	130
RED-LIT4	LIT	SSL		SSL-22	130
RED-LIT7	LIT	SSL		SSL-22	130
RED-LIT50	LIT	SSL		SSL-12	130
RL005	ED	Rectifier		A114F	819
RL010	ED	Rectifier		A114A	819
FL020	ED	Rectifier		A114B	821
RL040	ED	Rectifier		A114D	821
RL060	ED	Rectifier		A114M	821
RM3005	RAY	Pwr Tran		D40D7	1233
RM3022	RAY	Pwr Tran		D40C4	1229
RT116	RAD	Pwr Tran		D40D4	1233
RTA0101	TEC	SCR		C103Y	953
RTA0103	TEC	SCR		C103Y	953
RTA0106	TEC	SCR		C103YY	953
RTA0110	TEC	SCR		C103A	953
RTA0115	TEC	SCR		C103B	953
RTA0120	TEC	SCR		C103B	953
RTB0101	TEC	SCR		C103Y	953
RTB0103	TEC	SCR		C103Y	953
RTB0106	TEC	SCR		C103YY	953
RTB0110	TEC	SCR		C103A	953
RTB0115	TEC	SCR		C103B	953
RTB0120	TEC	SCR		C103B	953
RTB0201	TEC	SCR		C103Y	953
RTB0203	TEC	SCR		C103Y	953
RTB0206	TEC	SCR		C103YY	953
RTB0210	TEC	SCR		C103A	953
RTB0215	TEC	SCR		C103B	953
RTB0220	TEC	SCR		C103B	953
RTB0301	TEC	SCR		C103Y	953
RTB0303	TEC	SCR		C103Y	953
RTB0306	TEC	SCR		C103YY	953
RTB0310	TEC	SCR		C103A	953
RTB0315	TEC	SCR		C103B	953
RTB0320	TEC	SCR		C103B	953
RTB0401	TEC	SCR		C103Y	953
RTB0403	TEC	SCR		C103Y	953
RTB0406	TEC	SCR		C103YY	953
RTB0410	TEC	SCR		C103A	953
RTB0415	TEC	SCR		C103B	953
RTB0420	TEC	SCR		C103B	953
RTB0501	TEC	SCR		C103Y	953
RTB0503	TEC	SCR		C103Y	953
RTB0506	TEC	SCR		C103YY	953
RTB0510	TEC	SCR		C103A	953
RTB0515	TEC	SCR		C103B	953
RTB0520	TEC	SCR		C103B	953
RTB0601	TEC	SCR		C103Y	953
RTB0603	TEC	SCR		C103Y	953
RTB0606	TEC	SCR		C103YY	953
RTB0610	TEC	SCR		C103A	953
RTB0615	TEC	SCR		C103B	953
RTB0620	TEC	SCR		C103B	953
RTC0101	TEC	SCR		C103Y	953
RTC0103	TEC	SCR		C103Y	953
RTC0106	TEC	SCR		C103YY	953
RTC0110	TEC	SCR		C103A	953
RTC0115	TEC	SCR		C103B	953
RTC0120	TEC	SCR		C103B	953
RTC0201	TEC	SCR		C103Y	953
RTC0203	TEC	SCR		C103Y	953
RTC0206	TEC	SCR		C103YY	953
RTC0210	TEC	SCR		C103A	953
RTC0215	TEC	SCR		C103B	953
RTC0220	TEC	SCR		C103B	953
RTC0301	TEC	SCR		C103Y	953
RTC0303	TEC	SCR		C103Y	953
RTC0306	TEC	SCR		C103YY	953
RTC0310	TEC	SCR		C103A	953
RTC0315	TEC	SCR		C103B	953
RTC0320	TEC	SCR		C103B	953
RTC0401	TEC	SCR		C103Y	953
RTC0403	TEC	SCR		C103Y	953
RTC0406	TEC	SCR		C103YY	953
RTC0410	TEC	SCR		C103A	953
RTC0415	TEC	SCR		C103B	953
RTC0420	TEC	SCR		C103B	953
RTC0501	TEC	SCR		C103Y	953
RTC0503	TEC	SCR		C103Y	953
RTC0506	TEC	SCR		C103YY	953
RTC0510	TEC	SCR		C103A	953
RTC0515	TEC	SCR		C103B	953
RTC0520	TEC	SCR		C103B	953
RTC0601	TEC	SCR		C103Y	953
RTC0603	TEC	SCR		C103Y	953
RTC0606	TEC	SCR		C103YY	953
RTC0610	TEC	SCR		C103A	953
RTC0615	TEC	SCR		C103B	953
RTC0620	TEC	SCR		C103B	953
RTJ0201	TEC	SCR		C103Y	953
RTJ0203	TEC	SCR		C103Y	953
RTJ0206	TEC	SCR		C103YY	953
RTJ0210	TEC	SCR		C103A	953
RTJ0215	TEC	SCR		C103B	953
RTJ0220	TEC	SCR		C103B	953
RTN0202	TEC	SCR		C20U	910
RTN0205	TEC	SCR		C20F	910
RTN0210	TEC	SCR		C20A	910
RTN0220	TEC	SCR		C20B	910
RTN0230	TEC	SCR		C20C	910
RTN0240	TEC	SCR		C20D	910
RTN0250	TEC	SCR		C20E	910
RTN0302	TEC	SCR		C122U	970
RTN0305	TEC	SCR		C122F	970
RTN0310	TEC	SCR		C122A	970
RTN0320	TEC	SCR		C122B	970
RTN0330	TEC	SCR		C122C	970
RTN0340	TEC	SCR		C122D	970
RTN0350	TEC	SCR		C122E	970
RTR0202	TEC	SCR		C122U	970
RTR0205	TEC	SCR		C122F	970
RTR0210	TEC	SCR		C122A	970
RTR0220	TEC	SCR		C122B	970
RTR0230	TEC	SCR		C122C	970
RTR0240	TEC	SCR		C122D	970
RTR0250	TEC	SCR		C122E	970
RTR0302	TEC	SCR		C122U	970
RTR0305	TEC	SCR		C122F	970
RTR0310	TEC	SCR		C122A	970
RTR0320	TEC	SCR		C122B	970
RTR0330	TEC	SCR		C122C	970
RTR0340	TEC	SCR		C122D	970
RTR0350	TEC	SCR		C122E	970
RTR0402	TEC	SCR		C122U	970
RTS0202	TEC	SCR		C22U	910
RTS0205	TEC	SCR		C22F	910
RTS0210	TEC	SCR		C22A	910
RTS0220	TEC	SCR		C22B	910
RTS0230	TEC	SCR		C22C	910
RTS0240	TEC	SCR		C22D	910
RTS0250	TEC	SCR		C22E	910
RTS0302	TEC	SCR		C22U	910
RTS0305	TEC	SCR		C22F	910
RTS0310	TEC	SCR		C22A	910
RTS0320	TEC	SCR		C22B	910
RTS0330	TEC	SCR		C22C	910

* = Series
C.F. = Contact Factory

Industry Type	Mfg.	Device Type	Exact Type Page	Suggested GE Replacement	
				Type	Page
RTS0340	TEC	SCR		C22D	910
RTS0350	TEC	SCR		C22E	910
RTT0102	TEC	SCR		C20U	910
RTT0105	TEC	SCR		C20F	910
RTT0110	TEC	SCR		C20A	910
RTT0120	TEC	SCR		C20B	910
RTT0130	TEC	SCR		C20C	910
RTT0140	TEC	SCR		C30D	913
RTT0150	TEC	SCR		C30E	913
RTT0202	TEC	SCR		C30F	913
RTT0205	TEC	SCR		C30U	913
RTT0210	TEC	SCR		C30A	913
RTT0220	TEC	SCR		C30B	913
RTT0230	TEC	SCR		C30C	913
RTT0240	TEC	SCR		C30D	913
RTT0250	TEC	SCR		C30E	913
RTT0302	TEC	SCR		C30F	913
RTT0305	TEC	SCR		C30F	913
RTT0310	TEC	SCR		C30A	913
RTT0320	TEC	SCR		C30B	913
RTT0330	TEC	SCR		C30C	913
RTT0340	TEC	SCR		C30D	913
RTT0350	TEC	SCR		C30E	913
RTU0102	TEC	SCR		C20U	910
RTU0105	TEC	SCR		C20F	910
RTU0110	TEC	SCR		C20A	910
RTU0120	TEC	SCR		C20B	910
RTU0130	TEC	SCR		C20C	910
RTU0140	TEC	SCR		C20D	910
RTU0150	TEC	SCR		C20E	910
RTU0202	TEC	SCR		C30U	913
RTU0205	TEC	SCR		C30F	913
RTU0210	TEC	SCR		C30A	913
RTU0220	TEC	SCR		C30B	913
RTU0230	TEC	SCR		C30C	913
RTU0240	TEC	SCR		C30D	913
RTU0250	TEC	SCR		C30E	913
RTU0302	TEC	SCR		C30U	913
RTU0305	TEC	SCR		C30F	913
RTU0310	TEC	SCR		C30A	913
RTU0320	TEC	SCR		C30B	913
RTU0330	TEC	SCR		C30C	913
RTU0340	TEC	SCR		C30D	913
RTU0350	TEC	SCR		C30E	913
S26/7	GE	Sig Diode	1437		
S100A-G*	GE	Assembly	1439		
S200A*	GE	Assembly	1447		
S300A*	GE	Assembly	1450		
S0303L	ECC	SCR		C106Y	957
S0308G	ECC	SCR		C222F	1048
S0308H	ECC	SCR		C220F	1048
S0310G	ECC	SCR		C222F	1048
S0310H	ECC	SCR		C220F	1048
S0316G	ECC	SCR		C32F	913
S0316H	ECC	SCR		C30F	913
S0325G	ECC	SCR		C32F	913
S400A*	GE	Assembly	1453		
S500A*	GE	Assembly	C.F.		
S0503L	ECC	SCR		C106F	957
S0508G	ECC	SCR		C222F	1048
S0508H	ECC	SCR		C220F	1048
S0510G	ECC	SCR		C222F	1048
S0510H	ECC	SCR		C220F	1048
S0516G	ECC	SCR		C32F	913
S0516H	ECC	SCR		C30F	913
S0525G	ECC	SCR		C32F	913
S0525H	ECC	SCR		C30F	913
S715	-	Pwr Tran		D40D1	1233
S801	-	Pwr Tran		D42C1	1247
S1000	-	Pwr Tran		D42C1	1247
S1003L	ECC	SCR		C106A	957
S1008G	ECC	SCR		C222A	1048
S1008H	ECC	SCR		C220A	1048
S1010G	ECC	SCR		C222A	1048
S1010H	ECC	SCR		C220A	1048
S1016G	ECC	SCR		C32A	913
S1016H	ECC	SCR		C30A	913
S1025G	ECC	SCR		C32A	913
S1025H	ECC	SCR		C30A	913
S2003L	ECC	SCR		C106B	957
S2008G	ECC	SCR		C222B	1048
S2008H	ECC	SCR		C220B	1048
S2010G	ECC	SCR		C222B	1048
S2010H	ECC	SCR		C220B	1048
S2016G	ECC	SCR		C32B	913
S2016H	ECC	SCR		C30B	913
S2025G	ECC	SCR		C32B	913
S2025H	ECC	SCR		C30B	913
S4003L	ECC	SCR		C106D	957
S4008G	ECC	SCR		C222D	1048
S4008H	ECC	SCR		C220D	1048
S4010G	ECC	SCR		C222D	1048
S4010H	ECC	SCR		C220D	1048
S4016G	ECC	SCR		C32D	913
S4016H	ECC	SCR		C30D	913
S4025G	ECC	SCR		C32D	913
S4025H	ECC	SCR		C30D	913
S4035H	ECC	SCR		C137E	978
S5035H	ECC	SCR		C137E	978
S6010H	ECC	SCR		C37M	926
S6016H	ECC	SCR		C37M	926
S6025H	ECC	SCR		C37M	926
S6035H	ECC	SCR		C137M	978
S8010H	ECC	SCR		C37N	926
S8016H	ECC	SCR		C37N	926
S8025H	ECC	SCR		C37N	926
S8035H	ECC	SCR		C137N	978
S9035H	ECC	SCR		C137T	978
S10035H	ECC	SCR		C137P	978
SC05,E	SM	Rectifier		A14F	801
SC1	SM	Rectifier		A14P	312
SC2	SM	Rectifier		A14A	801
SC4	SM	Rectifier		1N5059	312
SC6	SM	Rectifier		1N5060	312
SC8	SM	Rectifier		1N5062	312
SC40,41*	GE	Triac	1459		
SC45,46*	GE	Triac	1467		
SC50,51*	GE	Triac	1475		
SC60,61*	GE	Triac	1483		
SC141*	GE	Triac	1491		
SC146*	GE	Triac	1491		
SC240/41*	GE	Triac	1499		
SC245/46*	GE	Triac	1507		
SC250/51*	GE	Triac	1515		
SC1484	SPE	Photon Coupler		H10A	1390
SCA05	SM	Rectifier		A14F	801
SCA1	SM	Rectifier		A14A	801
SCA2	SM	Rectifier		1N5059	312
SCA3	SM	Rectifier		A14C	801
SCA4	SM	Rectifier		1N5060	312
SCA6	SM	Rectifier		1N5061	312
SCA8	SM	Rectifier		1N5062	312
SCA10	SM	Rectifier		A14P	801
SCBR05F	SM	Rectifier		A114P	C.F.
SCBR1F	SM	Rectifier		A114A	819
SCBR6F	SM	Rectifier		A14M	801
SCE1	SM	Rectifier		A114A	819
SCE2	SM	Rectifier		1N5059	312
SCE3	SM	Rectifier		A14C	801
SCE4	SM	Rectifier		1N5060	312

* = Series
C.F. = Contact Factory

Industry Type	Mfg.	Device Type	Exact Type Page	Suggested GE Replacement Type	Suggested GE Replacement Page
SCE6	SM	Rectifier		1N5061	312
SCE8	SM	Rectifier		1N5062	312
SCT1	SM	Rectifier		A114A	819
SCT2	SM	Rectifier		A114B	821
SCT3	SM	Rectifier		A114C	819
SCT4	SM	Rectifier		A114D	821
SCT5	SM	Rectifier		A114E	819
SD05	DI	Rectifier		A14F	801
SD1	DI	Rectifier		A14A	801
SD2	DI	Rectifier		1N5059	312
SD4	DI	Rectifier		1N5060	312
SD6	DI	Rectifier		1N5061	312
SD8	DI	Rectifier		1N5062	312
SD1023	-	Pwr Tran		D40D1	1233
SD1410	SPE	Photo Darlingtn		L15C	C.F.
SD1440	SPE	Photo Tran		L15E	1421
SD2410	SPE	Photo Darlingtn			C.F.
SD2440	SPE	Photo Tran		L15A600	1419
SD3410	SPE	Photo Darlingtn			C.F.
SD3440	SPE	Photo Tran		L14A502	1403
SD4410	SPE	Photo Darlingtn		L15C	C.F.
SD5410	SPE	Photo Darlingtn			C.F.
SD5440	SPE	Photo Tran		L14A502	1403
SDI1345	FSC	Pwr Tran		D44C5	1255
SDI445	FSC	Pwr Tran		D45C5	1265
SDJ345	FSC	Pwr Tran		D44C6	1255
SDJ445	FSC	Pwr Tran		D45C6	1265
SDK345	FSC	Pwr Tran		D44C6	1255
SDK445	FSC	Pwr Tran		D45C6	1265
SDL345	FSC	Pwr Tran		D44C8	1255
SDL445	FSC	Pwr Tran		D45C8	1265
SDM345	FSC	Pwr Tran		D44C5	1255
SDM445	FSC	Pwr Tran		D45C5	1265
SDN345	FSC	Pwr Tran		D44C8	1255
SDN445	FSC	Pwr Tran		D45C8	1265
SDT3321	SOD	Pwr Tran		D42C6	1247
SDT3322	SOD	Pwr Tran		D43C8	1251
SDT3325	SOD	Pwr Tran		D43C6	1251
SDT3326	SOD	Pwr Tran		D42C8	1247
SDT3421	SOD	Pwr Tran		D42C6	1247
SDT3422	SOD	Pwr Tran		D42C8	1247
SDT3425	SOD	Pwr Tran		D42C6	1247
SDT3426	SOD	Pwr Tran		D42C5	1247
SDT3501	SOD	Pwr Tran		D43C5	1251
SDT3502	SOD	Pwr Tran		D43C7	1251
SDT3505	SOD	Pwr Tran		D43C6	1251
SDT3506	SOD	Pwr Tran		D43C3	1251
SDT3550	SOD	Pwr Tran		D43C7	1251
SDT3552	SOD	Pwr Tran		D43C4	1251
SDT3553	SOD	Pwr Tran		D43C7	1251
SDT3575	SOD	Pwr Tran		D45C6	1265
SDT3576	SOD	Pwr Tran		D45C8	1265
SDT3578	SOD	Pwr Tran		D45C6	1265
SDT3579	SOD	Pwr Tran		D45C7	1265
SDT3701	SOD	Pwr Tran		D45C6	1265
SDT3702	SOD	Pwr Tran		D45C8	1265
SDT3703	SOD	Pwr Tran		D45C5	1265
SDT3704	SOD	Pwr Tran		D45C8	1265
SDT3706	SOD	Pwr Tran		D45C2	1265
SDT3707	SOD	Pwr Tran		D45C5	1265
SDT3708	SOD	Pwr Tran		D45C8	1265
SDT3709	SOD	Pwr Tran		D45C3	1265
SDT3710	SOD	Pwr Tran		D45C6	1265
SDT3711	SOD	Pwr Tran		D45C8	1265
SDT3712	SOD	Pwr Tran		D45C8	1265
SDT3713	SOD	Pwr Tran		D45C8	1265
SDT3715	SOD	Pwr Tran		D45C6	1265
SDT3716	SOD	Pwr Tran		D45C4	1265
SDT3717	SOD	Pwr Tran		D45C7	1265
SDT3720	SOD	Pwr Tran		D45C6	1265
SDT3721	SOD	Pwr Tran		D45C6	1265
SDT3722	SOD	Pwr Tran		D45C8	1265
SDT3725	SOD	Pwr Tran		D45C6	1265
SDT3726	SOD	Pwr Tran		D45C6	1265
SDT3727	SOD	Pwr Tran		D45C8	1265
SDT3729	SOD	Pwr Tran		D45C6	1265
SDT3730	SOD	Pwr Tran		D45C8	1265
SDT3733	SOD	Pwr Tran		D45C6	1265
SDT3775	SOD	Pwr Tran		D43C6	1251
SDT3776	SOD	Pwr Tran		D43C8	1251
SDT3778	SOD	Pwr Tran		D43C6	1251
SDT4301	SOD	Pwr Tran		D42C5	1247
SDT4302	SOD	Pwr Tran		D42C8	1247
SDT4304	SOD	Pwr Tran		D42C6	1247
SDT4305	SOD	Pwr Tran		D42C8	1247
SDT4307	SOD	Pwr Tran		D42C6	1247
SDT4308	SOD	Pwr Tran		D42C8	1247
SDT4310	SOD	Pwr Tran		D42C6	1247
SDT4311	SOD	Pwr Tran		D42C8	1247
SDT4455	SOD	Pwr Tran		D40D5	1233
SDT4483	SOD	Pwr Tran		D40D4	1233
SDT4551	SOD	Pwr Tran		D42C4	1247
SDT4553	SOD	Pwr Tran		D42C4	1247
SDT4583	SOD	Pwr Tran		D42C4	1247
SDT4611	SOD	Pwr Tran		D42C5	1247
SDT4612	SOD	Pwr Tran		D42C8	1247
SDT4614	SOD	Pwr Tran		D42C5	1247
SDT4615	SOD	Pwr Tran		D42C8	1247
SDT5001	SOD	Pwr Tran		D40D4	1233
SDT5002	SOD	Pwr Tran		D40D7	1233
SDT5006	SOD	Pwr Tran		D40D4	1233
SDT5007	SOD	Pwr Tran		D40D7	1233
SDT5011	SOD	Pwr Tran		D40D5	1233
SDT5012	SOD	Pwr Tran		D40D8	1233
SDT5501	SOD	Pwr Tran		D40D5	1233
SDT5502	SOD	Pwr Tran		D40D8	1233
SDT5506	SOD	Pwr Tran		D40D4	1233
SDT5507	SOD	Pwr Tran		D40D7	1233
SDT5511	SOD	Pwr Tran		D40D5	1233
SDT5512	SOD	Pwr Tran		D40D8	1233
SDT5901	SOD	Pwr Tran		D42C6	1247
SDT5902	SOD	Pwr Tran		D42C8	1247
SDT5906	SOD	Pwr Tran		D42C5	1247
SDT5907	SOD	Pwr Tran		D42C7	1247
SDT6001	SOD	Pwr Tran		D44C7	1255
SDT6011	SOD	Pwr Tran		D44C5	1255
SDT6013	SOD	Pwr Tran		D44C6	1255
SDT6031	SOD	Pwr Tran		D44C5	1255
SDT6101	SOD	Pwr Tran		D42C2	1247
SDT6102	SOD	Pwr Tran		D42C4	1247
SDT6103	SOD	Pwr Tran		D42C7	1247
SDT6104	SOD	Pwr Tran		D42C2	1247
SDT6105	SOD	Pwr Tran		D42C4	1247
SDT6106	SOD	Pwr Tran		D42C4	1247
SDT7401	SOD	Pwr Tran		D42C6	1247
SDT7402	SOD	Pwr Tran		D42C8	1247

* = Series
C.F. = Contact Factory

Industry Type	Mfg.	Device Type	Exact Type Page	Suggested GE Replacement	
				Type	Page
SDT7411	SOD	Pwr Tran		D42C6	1247
SDT7412	SOD	Pwr Tran		D42C8	1247
SDT7414	SOD	Pwr Tran		D42C6	1247
SDT7415	SOD	Pwr Tran		D42C8	1247
SDT7511	SOD	Pwr Tran		D42C6	1247
SDT7512	SOD	Pwr Tran		D44C8	1255
SDT7514	SOD	Pwr Tran		D44C6	1255
SDT7515	SOD	Pwr Tran		D44C8	1255
SDT9001	SOD	Pwr Tran		D42C3	1247
SDT9002	SOD	Pwr Tran		D42C5	1247
SDT9003	SOD	Pwr Tran		D42C8	1247
SDT9004	SOD	Pwr Tran		D42C3	1247
SDT9005	SOD	Pwr Tran		D42C5	1247
SDT9006	SOD	Pwr Tran		D42C8	1247
SDT9007	SOD	Pwr Tran		D42C3	1247
SDT9008	SOD	Pwr Tran		D42C5	1247
SDT9009	SOD	Pwr Tran		D42C8	1247
Sel Components	GE		164		
SE708*	GE	Sig Diode	1523		
SE1001	FSC	Transistor		GSE1001	C.F.
SE1002	FSC	Transistor		GSE1002	C.F.
SE1010	FSC	Transistor		GSE1010	C.F.
SE1450	SPE	SSL		SSL-15	131
SE2001	FSC	Transistor		GSE2001	C.F.
SE2002	FSC	Transistor		GSE2002	C.F.
SE3001	FSC	Transistor		GSE3001	C.F.
SE3450	SPE	SSL		SSL-5A	131
SE4001	FSC	Transistor		GSE4001	C.F.
SE4002	FSC	Transistor		GSE4002	C.F.
SE5450	SPE	SSL		SSL-5A	131
SE6001	FSC	Transistor		GSE6001	C.F.
SE6002	FSC	Transistor		GSE6002	C.F.
SE7001	FSC	Pwr Tran		D40N1	1237
SE7002	FSC	Pwr Tran		D40N1	1237
SE7006	FSC	Pwr Tran		D44R1	1261
GE7020	FSC	Pwr Tran		D44R4	1261
SE7055	FSC	Pwr Tran		D40N1	1237
SE7056	FSC	Pwr Tran		D40N3	1237
SE8001	FSC	Pwr Tran		D40D1	1233
SE8002	FSC	Pwr Tran		D40D4	1233
SE8040	FSC	Transistor		GSE8040	C.F.
SE8042	FSC	Pwr Tran		D40D1	1233
SE8540	FSC	TRansistor		GSE8540	C.F.
SE8542	FSC	Pwr Tran		D41D1	1243
SF1CN1	WES	Rectifier		A114A	819
SF2CN1	WES	Rectifier		A114B	821
SF3CN1	WES	Rectifier		A114C	819
SF4	SM	Rectifier		A114D	821
SF4CN1	WES	Rectifier		A114D	821
SF5	SM	Rectifier		A114E	819
SF5CN1	WES	Rectifier		A114E	819
SF6	SM	Rectifier		A114M	821
SFT186	FSC	Pwr Tran		D40N1	1237
SFT187	FSC	Pwr Tran		D44R1	1261
SFT445	FSC	Pwr Tran		D40D7	1233
SPT26	HUT	Triac		SC40B	1459
SPT46	HUT	Triac		SC40D	1459
SPT210	HUT	Triac		SC45B	1467
SPT215	HUT	Triac		SC50B	1475
SPT225	HUT	Triac		SC60B	1483
SPT410	HUT	Triac		SC45D	1467
SPT415	HUT	Triac		SC50D	1475
SPT425	HUT	Triac		SC60D	1483
SPT3440	SSI	Pwr Tran		D44R2	1261
SR500	SPE	Card/Tape Rdr		SR500	C.F.
SS321*	GE	Sig Diode	1452		
SS322*	GE	Sig Diode	1452		
SS324*	GE	Sig Diode	1452		
SS325*	GE	Sig Diode	1452		
SS334*	GE	Sig Diode	1452		
SS337*	GE	Sig Diode	1452		
SSL-3	GE	SSL	130		
SSL-12	GE	SSL	130		
SSL-22	GE	SSL	130		
SSL-22L	GE	SSL	130		
SSL-4	GE	SSL	131		
SSL-5A	GE	SSL	131		
SSL-5B	GE	SSL	131		
SSL-5C	GE	SSL	131		
SSL-34	GE	SSL	131		
SSL-35	GE	SSL	131		
SSL-54	GE	SSL	131		
SSL-55B	GE	SSL	131		
SSL-55C	GE	SSL	131		
SSL-15	GE	SSL	131		
SSL-315	GE	SSL	131		
SSL-140	GE	SSL	130		
SSL-190	GE	SSL	130		
ST2*	GE	Triac	1524		
ST4*	GE	Triac	1525		
ST84027	TEC	Pwr Tran		D44R2	1261
ST84028	TEC	Pwr Tran		D44R2	1261
ST84029	TEC	Pwr Tran		D44R2	1261
STB567*	GE	Sig Diode	1529		
STB568*	GE	Sig Diode	1529		
STB569*	GE	Sig Diode	1529		
STC1300	SIL	Pwr Tran		D44C5	1255
STC1336	SIL	Pwr Tran		D44C5	1255
STC1800	SIL	Pwr Tran		D42C5	1247
STC1850	SIL	Pwr Tran		D42C7	1247
STC1860	SIL	Pwr Tran		D42C8	1247
STC1862	SIL	Pwr Tran		D42C5	1247
STC4401	SIL	Pwr Tran		D44C6	1255
STC5202	SIL	Pwr Tran		D45C5	1265
STC5203	SIL	Pwr Tran		D45C8	1265
STC5205	SIL	Pwr Tran		D45C4	1265
STC5206	SIL	Pwr Tran		D45C7	1265
STC5802	SIL	Pwr Tran		D45C5	1265
STC5803	SIL	Pwr Tran		D45C8	1265
STC5805	SIL	Pwr Tran		D45C4	1265
STC5806	SIL	Pwr Tran		D45C7	1265
STT4451	SIL	Pwr Tran		D42C5	1247

* = Series
C.F. = Contact Factory

Industry Type	Mfg.	Device Type	Exact Type Page	Suggested GE Replacement	
				Type	Page
SW10	TEC	SCR		C103Y	953
SW11	TEC	SCR		C103Y	953
SYL4224	SYL	SCR		C103YY	953
SYL4225	SYL	SCR		C103Y	953
SYL4312	SYL	SCR		C103Y	953
T151	TI	Rectifier		1N4450	280
T152	TI	Rectifier		1N4450	280
T153	TI	Rectifier		1N4450	280
T154	TI	Rectifier		1N4454	242
T155	TI	Rectifier		1N4606	306
T156	TI	Rectifier		A14A	801
T157	TI	Rectifier		A14B	801
T158	TI	Rectifier		A14D	801
T159	TI	Rectifier		A14D	801
T160	TI	Rectifier		A14D	801
T206	PIR	Triac		SC41B	1459
T206S	PIR	Triac		SC40B	1459
T210	PIR	Triac		SC46B	1467
T210S	PIR	Triac		SC45B	1467
T215	PIR	Triac		SC51B	1475
T215S	PIR	Triac		SC50B	1475
T225	PIR	Triac		SC61B	1483
T225S	PIR	Triac		SC60B	1483
T406	PIR	Triac		SC41D	1459
T406S	PIR	Triac		SC40D	1459
T410	PIR	Triac		SC46D	1467
T410S	PIR	Triac		SC45D	1467
T415	PIR	Triac		SC51D	1475
T415S	PIR	Triac		SC50D	1475
T425	PIR	Triac		SC61D	1483
T425S	PIR	Triac		SC60D	1483
T507	WES	SCR		C158,159	1025
T727	WES	SCR		C397,398	1123
TA7494	RCA	SCR		C140B	990
TA7394	RCA	SCR		C140D	990
TA7395	RCA	SCR		C139M	982
TA7554	-	Pwr Tran		D44C8	1255
TA7555	-	Pwr Tran		D44C6	1255
TA7556	-	Pwr Tran		D45C8	1265
TA7557	-	Pwr Tran		D45C6	1265
TA7739	-	Pwr Tran		D40N1	1237
TA7740	-	Pwr Tran		D40N3	1237
TAG06-30	TAG	SCR		C103Y	953
TAG06-80	TAG	SCR		C103YY	953
TAG06-90	TAG	SCR		C103A	953
TC106A	TEC	SCR		C106A	957
TC106B	TEC	SCR		C106B	957
TC106C	TEC	SCR		C106C	957
TC106D	TEC	SCR		C106D	957
TC106F	TEC	SCR		C106F	957
TC106Q	TEC	SCR		C106Q	957
TC106Y	TEC	SCR		C106A	957
TD9*	GE	Tunnel Diode	1534		
TD251-56*	GE	Tunnel Diode	1535		
TD251A-56A*	GE	Tunnel Diode	1535		
TD261-66*	GE	Tunnel Diode	1537		
TD261A-66A*	GE	Tunnel Diode	1537		
TD201-206*	GE	Tunnel Diode	120		
TD201A-206A*	GE	Tunnel Diode	120		
TD271-76*	GE	Tunnel Diode	1537		
TD271A-76A*	GE	Tunnel Diode	1537		
TD401-39*	GE	Tunnel Diode	122		
TFR105	TEC	Rectifier		A114F	819
TFR110	TEC	Rectifier		A114A	819
TFR120	TEC	Rectifier		A114C	819

Industry Type	Mfg.	Device Type	Exact Type Page	Suggested GE Replacement	
				Type	Page
TFR140	TEC	Rectifier		A114D	821
TI486	TI	Pwr Tran		D42C8	1247
TI487	TI	Pwr Tran		D42C8	1247
TI3010	TI	SCR		C22/122F	910/970
TI3011	TI	SCR		C22/122A	910/970
TI3012	TI	SCR		C22/122B	910/970
TI3013	TI	SCR		C22/122C	910/970
TI3014	TI	SCR		C22/122D	910/970
TI40A0	TI	SCR		C22/122F	910/970
TI40A1	TI	SCR		C22/122A	910/970
TI40A2	TI	SCR		C22/122B	910/970
TI40A3	TI	SCR		C22/122C	910/970
TI40A4	TI	SCR		C22/122D	910/970
TIC35	TI	SCR		C103Y	953
TIC36	TI	SCR		C103YY	953
TIC44	TI	SCR		C103Y	953
TIC45	TI	SCR		C103YY	953
TIC46	TI	SCR		C103A	953
TIC47	TI	SCR		C103B	953
TIC220B	TI	Triac		SC40B	1459
TIC220D	TI	Triac		SC40D	1459
TIC220E	TI	Triac		SC40E	1459
TIC221B	TI	Triac		SC40B	1459
TIC221D	TI	Triac		SC40D	1459
TIC221E	TI	Triac		SC40E	1459
TIC222B	TI	Triac		SC40B	1459
TIC222D	TI	Triac		SC40D	1459
TIC222E	TI	Triac		SC40E	1459
TIC230B	TI	Triac		SC46B	1467
TIC230D	TI	Triac		SC46D	1467
TIC230E	TI	Triac		SC46E	1467
TIC231B	TI	Triac		SC45B	1467
TIC231D	TI	Triac		SC45D	1467
TIC231E	TI	Triac		SC45E	1467
TIC232B	TI	Triac		SC45B	1467
TIC232D	TI	Triac		SC45D	1467
TIC232E	TI	Triac		SC45E	1467
TIC240B	TI	Triac		SC51B	1475
TIC240D	TI	Triac		SC51D	1475
TIC240E	TI	Triac		SC51E	1475
TIL107	TI	Photon Coupler		H10A	1390
TIL108	TI	Photon Coupler		H10B	1392
TIL204	TI	SSL		SSL-22	130
TIL206	TI	SSL		SSL-12	130
TIL208	TI	SSL		SSL-22	130
TIL209	TI	SSL		SSL-22	130
TIL210	TI	SSL		SSL-22L	130
TIL601	TI	Photo Tran		L15A600	1419
TIL602	TI	Photo Tran		L15A600	1419
TIL603	TI	Photo Tran		L15A600	1419
TIL604	TI	Photo Tran		L15A600	1419
TIL605	TI	Photo Tran		L15A600	1419
TIL606	TI	Photo Tran		L15A600	1419
TIL607	TI	Photo Tran		L15A600	1419
TIL608	TI	Photo Tran		L15A600	1419
TIL609	TI	Photo Tran		L15F	C.F.
TIL610	TI	Photo Tran		L15F	C.F.
TIL611	TI	Photo Tran		L15F	C.F.
TIL612	TI	Photo Tran		L15E	C.F.
TIL613	TI	Photo Tran		L15F	C.F.
TIL614	TI	Photo Tran		L15F	C.F.
TIL615	TI	Photo Tran		L15F	C.F.
TIL616	TI	Photo Tran		L15F	C.F.
TIP29	TI	Pwr Tran		D44C5	1255
TIP29A	TI	Pwr Tran		D44C8	1255
TIP29B	TI	Pwr Tran		D44R1	1261
TIP29C	TI	Pwr Tran		D44R1	1261
TIP30	TI	Pwr Tran		D45C5	1265
TIP20A	TI	Pwr Tran		D45C8	1265
TIP31	TI	Pwr Tran		D44C5	1255

* = Series
C.F. = Contact Factory

Industry Type	Mfg.	Device Type	Exact Type Page	Suggested GE Replacement	
				Type	Page
TIP31A	TI	Pwr Tran		D44C8	1255
TIP32	TI	Pwr Tran		D45C5	1255
TIP32A	TI	Pwr Tran		D45C8	1265
TIS62	TI	Transistor		GS62	1378
TIS63	TI	Transistor		GS63	1378
TIS64	TI	Transistor		GS64	1378
TIS82	TI	Pwr Tran		D40D4	1233
TIS92	TI	Transistor		GS92	C.F.
TIS93	TI	Transistor		GS93	C.F.
TIS97	TI	Transistor		GS97	C.F.
TIS98	TI	Transistor		GS98	C.F.
TIXL26	TI	SSL		SSL-5A	131
TIXL27	TI	SSL		SSL-35	131
TIXL101	TI	Photon Coupler		H10A	1390
TIXL102	TI	Photon Coupler		H10B	1392
TIXL103	TI	Photon Coupler		H10B	1392
TIXL109	TI	Photon Coupler		PC15-26	1409
TIXL302	TI	SSL		SSL-190	130
TN53	SPR	Pwr Tran		D40D5	1233
TN59	SPR	Pwr Tran		D40D2	1233
TN61	SPR	Pwr Tran		D40D2	1233
TN63	SPR	Pwr Tran		D40D1	1233
TN79	SPR	Pwr Tran		D40D1	1233
TRS140HP	ITC	Pwr Tran		D40N1	1237
TRS140MP	ITC	Pwr Tran		D44R1	1261
TRS160HP	ITC	Pwr Tran		D40N1	1237
TRS160MP	ITC	Pwr Tran		D44R1	1261
TRS180HP	ITC	Pwr Tran		D40N1	1237
TRS180MP	ITC	Pwr Tran		D44R1	1261
TRS200HP	ITC	Pwr Tran		D40N1	1237
TRS200MP	ITC	Pwr Tran		D44R1	1261
TRS225HP	ITC	Pwr Tran		D40N1	1237
TRS225MP	ITC	Pwr Tran		D44R1	1261
TRS250HP	ITC	Pwr Tran		D40N1	1237
TRS250MP	ITC	Pwr Tran		D44R1	1261
TRS275HP	ITC	Pwr Tran		D40N1	1237
TRS275MP	ITC	Pwr Tran		D44R3	1261
TRS301HP	ITC	Pwr Tran		D40N3	1237
TRS301LC	ITC	Pwr Tran		D44R3	1261
TRS301MP	ITC	Pwr Tran		D44R3	1261
TRS325MP	ITC	Pwr Tran		D44R3	1261
TRS1204	ITC	Pwr Tran		D44R1	1261
TRS1205	ITC	Pwr Tran		D44R1	1261
TRS1404	ITC	Pwr Tran		D44R1	1261
TRS1405	ITC	Pwr Tran		D44R1	1261
TRS1604	ITC	Pwr Tran		D44R1	1261
TRS1605	ITC	Pwr Tran		D44R1	1261
TRS1804	ITC	Pwr Tran		D44R1	1261
TRS1805	ITC	Pwr Tran		D44R1	1261
TRS2004	ITC	Pwr Tran		D44R1	1261
TRS2005	ITC	Pwr Tran		D44R1	1261
TRS2006	ITC	Pwr Tran		D44R2	1261
TRS2254	ITC	Pwr Tran		D44R1	1261
TRS2255	ITC	Pwr Tran		D44R2	1261
TRS2504	ITC	Pwr Tran		D44R1	1261
TRS2505	ITC	Pwr Tran		D44R2	1261
TRS2754	ITC	Pwr Tran		D44R3	1261
TRS2755	ITC	Pwr Tran		D44R3	1261
TRS2804S	ITC	Pwr Tran		D44R3	1261
TRS2805S	ITC	Pwr Tran		D44R3	1261
TRS3006	ITC	Pwr Tran		D44R4	1261
TRS3014	ITC	Pwr Tran		D44R3	1261
TRS3015	ITC	Pwr Tran		D44R3	1261
TRS3204S	ITC	Pwr Tran		D44R3	1261
TRS3205S	ITC	Pwr Tran		D44R3	1261
TRS3254	ITC	Pwr Tran		D44R3	1261
TRS3255	ITC	Pwr Tran		D44R4	1261
TRS3742	ITC	Pwr Tran		D44R4	1261
TRS4926	ITC	Pwr Tran		D44R2	1261
TRS4927	ITC	Pwr Tran		D44R2	1261
TS05	DI	Rectifier		A14F	801
TS1	DI	Rectifier		A14A	801
TS2	DI	Rectifier		1N5059	312
TS4	DI	Rectifier		1N5060	312
TS6	DI	Rectifier		1N5061	312

Industry Type	Mfg.	Device Type	Exact Type Page	Suggested GE Replacement	
				Type	Page
TS8	DI	Rectifier		1N5062	312
TU10/1	SHW	Tunnel Diode		1N3713	259
TU10/2	SHW	Tunnel Diode		1N3713	259
TU12/1	SHW	Tunnel Diode		STD957	C.F.
TU12/2	SHW	Tunnel Diode		STD957	C.F.
TU13/1	SHW	Tunnel Diode		TD263	1537
TU13/2	SHW	Tunnel Diode		TD263	1537
TU14/1	SHW	Tunnel Diode		SMTD974	C.F.
TU14/2	SHW	Tunnel Diode		SMTD974	C.F.
TU101	SHW	Tunnel Diode		1N3712	259
TU105	SHW	Tunnel Diode		STD957	C.F.
TU110	SHW	Tunnel Diode		TD263	1537
U13T1	UNI	Unijunction		D13K1	706
U13T2	UNI	Unijunction		D13K2	706
UPI2217	UPI	Pwr Tran		D40D1	1233
UPI2218	UPI	Pwr Tran		D40D1	1233
UPI4046	UPI	Pwr Tran		D40D5	1233
UPI4047	UPI	Pwr Tran		D40D5	1233
UTR02	UNI	Rectifier		A114F	819
UTR12	UNI	Rectifier		A114A	819
V409	-	Pwr Tran		D44C5	1255
VE18	VAR	Rect Bridge		GEB101	1284
VE18X	VAR	Rect Bridge		GEB101	1284
VE27	VAR	Rect Bridge		GEB102	1284
VE28	VAR	Rect Bridge		GEB102	1284
VE47	VAR	Rect Bridge		GEB104	1284
VE48	VAR	Rect Bridge		GEB104	1284
VE48X	VAR	Rect Bridge		GEB104	1284
VE67	VAR	Rect Bridge		GEB106	1284
VE68	VAR	Rect Bridge		GEB106	1284
VX3375	ECD	Pwr Tran		D42C5	1247
VX3733	ECD	Pwr Tran		D44C4	1255
W005	GI	Rect Bridge		GEB100	1284
W02	GI	Rect Bridge		GEB102	1284
W04	GI	Rect Bridge		GEB104	1284
W06	GI	Rect Bridge		GEB106	1284
W111	VAR	Rect Bridge		GEB100	1284
XB401	TI	Pwr Tran		D40D4	1233
XB404	TI	Pwr Tran		D44C4	1255
XB408	TI	Pwr Tran		D44C4	1255
XB476	TI	Pwr Tran		D44C1	1255
Z4X5.1B*	GE	Zener	167		
Z4X14B*	GE	Zener	167		
Z4XL*	GE	Zener	167		
ZT90	FER	Pwr Tran		D40D7	1233
ZT94	FER	Pwr Tran		D40D4	1233
ZT95	FER	Pwr Tran		D40D7	1233
ZT210	FER	Pwr Tran		D40D7	1233
ZT600	FER	Pwr Tran		D40D1	1233
ZT1479	FER	Pwr Tran		D40D4	1233
ZT1480	FER	Pwr Tran		D40D7	1233
ZT1481	FER	Pwr Tran		D40D4	1233
ZT1482	FER	Pwr Tran		D40D7	1233
ZT1483	FER	Pwr Tran		D44C5	1255
ZT1484	FER	Pwr Tran		D44C8	1255
ZT1485	FER	Pwr Tran		D44C5	1255
ZT1486	FER	Pwr Tran		D44C8	1255
ZT1613	FER	Pwr Tran		D40D4	1233
ZT1700	FER	Pwr Tran		D40D4	1233
ZT1701	FER	Pwr Tran		D44C4	1255
ZT1711	FER	Pwr Tran		D40D8	1233
ZT2102	FER	Pwr Tran		D40D1	1233
ZT2270	FER	Pwr Tran		D40D4	1233
ZT2876	FER	Pwr Tran		D42C7	1247
ZT3375	FER	Pwr Tran		D42C5	1247
ZT3440	FER	Pwr Tran		D44R2	1261
904	ELN	Photo Tran		L14A502	1403
916E	ELN	Photo Tran		L14F	1415
916L	ELN	Photo Tran		L14A502	1403
916W	ELN	Photo Tran		L14F/L14A	1415/1403
917E	ELN	Photo Tran		L14A502	1403
918E	ELN	Photo Tran		L14A502	1403
918L	ELN	Photo Tran		L14A502	1403
919W	ELN	Photo Tran		L14E3	1411

* = Series
C.F. = Contact Factory

(Pages 78-102 revised for future use)

PUBLICATION NUMBER TO PAGE NUMBER

For Specifications not included in this Handbook, contact either your franchised General Electric distributor or any General Electric Electronic Components Sales Office.

Publication No.	Page
20.30	417
20.35	434
20.70	442
20.80	458
25.27	401
25.65	436
35.11	432
35.12	433
35.14	465
35.20	471
35.24	1189
35.25	473
35.27	1188
35.31	517
35.32	481
35.33	490
35.34	494
35.35	1433
35.36	496
35.42	462
35.50	1201
35.51	1202
35.52	1203
35.54	1199
35.56	1219
35.57	1204
35.59	1206
35.61	475
35.65	1192
35.70	1427
35.71	464
35.72	554
35.73	555
35.74	449
35.75	474
35.76	431
35.77	546
35.78	601
35.79	430
35.80	593
35.81	547
35.82	535
35.83	536
35.84	513
35.85	515
35.86	516
35.87	514
35.88	213
35.89	246
35.90	214
35.91	258
35.92	429
35.93	493
35.94	1428
35.95	608
35.96	306
35.97	257
35.98	424
40.13	592
40.19	558
40.31	518
40.32	613
40.33	1292
40.34	711
40.35	1302
40.36	657
40.37	523
40.38	527
40.39	537
40.40	542
40.45	1196
40.46	594
40.58	599
40.59	602
40.60	482
40.61	498
40.62	499
40.63	502
40.64	501
40.65	504
40.68	507
40.69	509
40.74	550
40.75	552
40.76	522
40.77	666
40.78	604
40.79	609
40.80	1386
40.82	1197
40.83	590
40.84	1223
40.85	1209
40.86	1211
40.87	1215
40.88	647
40.89	649
40.90	653
40.91	662
40.92	664
40.93	670
40.94	674
40.95	678
40.96	682
40.97	686
40.98	637
40.99	690
40.100	694
40.101	698
40.103	639
40.104	641
40.105	633
40.106	635
40.107	1310
40.108	1221
40.109	708
41.11	617
41.12	625
41.15	1217
41.22	1380
45.16	1288
45.17	1296
45.18	1308
45.19	1300
45.20	1382
45.22	1298
45.23	1302
45.46	556
45.60	484
45.63	548
45.67	1304
45.68	1306
50.60	1229
50.61	1247
50.62	1251
50.63	1233
50.64	1243
50.66	1237
50.68	1255
50.69	1265
50.70	1261
50.71	1259
50.72	1269
50.73	1241
55.41	1423
55.45	1403
55.46	643
55.47	1411
55.49	1415
55.54	1417
55.56	1421
55.58	1419
55.60	1396
55.61	1390
55.62	1392
55.63	1394
55.66	1407
55.67	1409
60.10	405
60.11	411
60.12	1177
60.13	1178
60.14	1179
60.15	1180
60.16	1184
60.20	702
60.21	706
60.50	450
60.53	463
60.56	491
60.61	1384
60.62	477
60.64	1176
65.16	715
65.17	720
65.18	724
65.19	728
65.25	562
65.26	570
65.27	566
65.28	574
65.30	586
65.31	578
65.32	582
65.34	1190
70.20	259
70.22	1534
70.26	1535
70.28	1537
70.32	279
70.51	879
75.20	241
75.21	1271
75.22	1429
75.25	242
75.28	209
75.36	280
75.38	292
75.40	309
75.42	284
75.44	294
75.45	307
75.46	1529
75.50	290
75.51	311
75.54	1276
75.57	1273
75.58	1523
75.63	1452
80.28	413
120.5	201
130.25	1274
130.53	1431
130.54	801
130.55	312
130.56	288
130.58	825
130.59	316
130.63	819
130.64	821
130.66	1287
130.67	825
130.68	827
130.69	803
130.95	231
130.96	1284
140.10	223
140.12	269
140.15	227
140.20	219
140.22	271
140.23	807
140.24	298
140.25	831
140.26	833
140.28	205
140.30	207
140.32	247
140.33	811
140.37	302
140.40	237
140.43	255
140.47	273
140.48	271
140.50	215
140.76	865
140.80	859
140.85	853
145.15	251
145.28	249
145.30	263
145.32	277
145.50	871
145.55	813
145.58	835
145.60	837
145.70	839
145.71	842
145.78	844
145.80	847
145.85	850
150.2	902
150.5	425
150.7	953
150.8	886
150.9	957
150.10	880
150.11	467
150.13	965
150.15	446
150.20	890
150.21	894
150.22	906
150.25	900
150.30	910
150.35	970
150.36	1048
155.10	1437
155.20	1439
155.21	1441
155.22	1442
155.23	1443
155.24	1444
155.25	1445
155.26	1446
155.40	1447
155.50	1450
155.60	1453
160.19	454
160.20	922
160.22	420
160.23	926
160.27	913
160.28	918
160.30	930
160.35	990
160.45	978
160.46	595
160.47	982
160.49	998
170.17	937
170.18	1006
170.19	1010
170.20	943
170.23	1011
170.26	949
170.35	1017
170.36	1025
170.37	1071
170.38	1079
170.42	1111
170.44	1101
170.45	1123
170.48	1530
170.49	1532
170.52	1035
170.53	1040
170.54	1067
170.56	1089
170.57	1093
170.58	1056
170.60	1062
170.70	1133
170.72	1277
170.80	1138
170.81	1145
170.82	1149
170.84	1153
170.85	1157
170.86	1161
175.15	1491
175.16	1499
175.17	1507
175.18	1514
175.19	1455
175.25	1459
175.26	1467
175.27	1475
175.28	1483
175.30	1524
175.32	1525
175.46	1491
190.10	1398
195.10	1165
195.10.1	1165

SIGNAL TRANSISTORS

The General Electric Company introduced the first epoxy encapsulated small signal transistor in 1962. At this time, the concept of continuous, automated techniques used in the mass production of small signal transistors revolutionized the semiconductor industry. Thus General Electric has had nearly a decade's experience in supplying small signal epoxy transistors to the industrial and consumer markets. Many refinements and additions to the original process have resulted in the most reliable and economical small signal transistors available today. These epoxy encapsulated transistors are capable of functioning in virtually any conceivable small signal application.

APPLICATION

COMPLEMENTARY PAIRS	PAGE 107,108
GENERAL PURPOSE AMPLIFIERS	PAGE 109,110,111
GENERAL PURPOSE SWITCHES	PAGE 112
DARLINGTON AMPLIFIERS	PAGE 112
HIGH VOLTAGE AMPLIFIERS	PAGE 112
HIGH SPEED SWITCHES	PAGE 113
LOW NOISE AMPLIFIERS	PAGE 113

RELIABILITY

The key to the success of the General Electric small signal transistor is its proven reliability. Reliability has been designed into the product and is insured by strict control of input materials, processing and the repeatability of manufacturing steps. Patented production techniques makes reliability an inherent feature of General Electric small signal transistors.

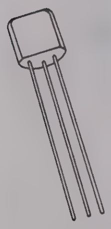
Electrically the transistor parameters are controlled from the sand up at General Electric. Starting with the growth of the Silicon crystals and continuing with the diffusions, oxidations and metalization of the wafers, processes are based on work conducted at General Electric dating back to the early fifties, the pioneering era of semiconductors. Mechanically, the epoxy package offers improved performance under conditions of vibration and shock. Recent strides in passivation of the silicon chip, improved epoxy and lead materials have made 150°C junction temperatures possible.

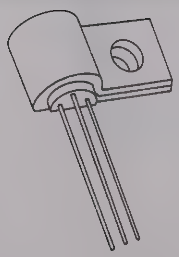
General Electric epoxy encapsulated transistors have demonstrated superior reliability performance as documented by extensive testing showing device capabilities of 800 cycles of −65 to +150°C temperature cycling, 10,000 hours of 850°C/85% RH temperature humidity storage.

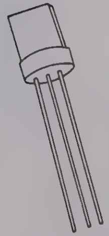
SELECTOR GUIDES

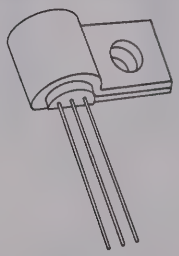
BY VOLTAGE & CURRENT	PAGE 106
BY INDUSTRY TYPE OR JEDEC— SEE INDEX & CROSS REFERENCE	

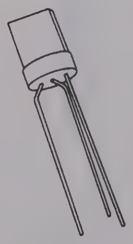
PACKAGES

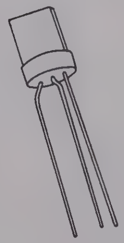

TO-18

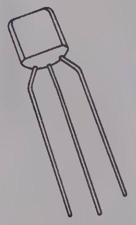

TO-18 with heatsink


TO-98

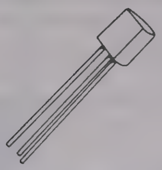

TO-98 with heatsink


TO-98 lead formed to TO-5

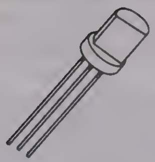

TO-98 lead formed to TO-18


TO-18 lead formed to TO-5

RECOMMENDED STOCKING TYPES



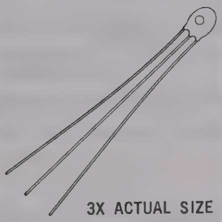
TO-18



TO-98

	TO-18 PNP	TO-18 NPN	TO-98 PNP	TO-98 NPN
COMPLEMENTARY PAIRS	2N6011	2N6010	D29E5	D33D25
GENERAL PURPOSE AMPLIFIERS	2N6011	2N6010	2N6076	2N5172
GENERAL PURPOSE SWITCH	2N6001	2N6000		
HIGH SPEED SWITCH		GET3646		
HIGH VOLTAGE AMPLIFIER		2N6218		2N5174
LOW NOISE AMPLIFIER	2N6003	2N6002	2N5999	2N5998
DARLINGTON AMPLIFIER		GET5306		2N5306

MICRO MINIATURE EPOXY TRANSISTORS



3X ACTUAL SIZE

I_C mA / V_{CEO} (Volts)	To 5mA		5mA to 25mA		25mA to 75mA	
	NPN	PNP	NPN	PNP	NPN	PNP
0 to 19	D26G1 D26P1		D26P1		D26P1	
20 to 29	D26C1 D26C2 D26C3 D26C4 D26C5 D26P2 D26P3	D30A1 D30A2 D30A3 D30A4 D30A5	D26C1 D26C2 D26C3 D26C4 D26C5 D26P2 D26P3	D30A1 D30A2 D30A3 D30A4 D30A5	D26C1 D26C2 D26C3 D26C4 D26C5 D26P2 D26P3	D30A1 D30A2 D30A3 D30A4 D30A5
30 to 39						
40 to 49	D26E1 D26E2 D26E3 D26E4 D26E5 D26E6		D26E1 D26E2 D26E3 D26E4 D26E5 D26E6		D26E1 D26E2 D26E3 D26E4 D26E5 D26E6	

SMALL SIGNAL EPOXY TRANSISTORS

TO-18 OUTLINE

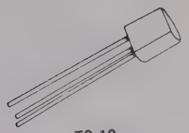
I_C mA / V_{CEO} (Volts)	50μA to 5mA		5mA to 25mA		25mA to 75mA		75mA to 800mA	
	NPN	PNP	NPN	PNP	NPN	PNP	NPN	PNP
10 to 19			GET706 GET3013 GET708 GET3563 GET914 GET3646 GET2369		GET706 GET2369 GET708 GET3013 GET914 GET3646		GET2369	
20 to 29	2N5810 2N6000 2N5812 2N6002	GET3638 2N5813 GET3638A 2N6001 2N5811 2N6003	GET3014 2N6002 2N6000 D32K1	GET3638 2N6001 GET3638A 2N6003	GET3014 2N6002 2N5451 D32K1 2N6000	GET3638 2N6001 GET3638A 2N6003 2N5447	2N5810 2N6002 2N5812 D32K1 2N6000	2N5811 2N5001 2N5813 2N6003
30 to 39	2N5368 D32P1 2N5369 D32P2 2N5370 D32P3 2N5371 D32P4	2N5372 2N5374 2N5373 2N5375	GET2221 2N5369 GET2222 2N5370 2N5368 2N5371	2N5372 2N5374 2N5373 2N5375	GET2221 2N5370 GET2222 2N5371 2N5368 2N5449 2N5369 2N5450	2N5372 2N5375 2N5373 2N5448 2N5374	2N5368 2N5370 2N5369 2N5371	2N5372 2N5374 2N5373 2N5375
40 to 49	2N5814 2N5827A 2N5816 2N5828 2N5818 2N5828A 2N5824 2N6004 2N5825 2N6006 2N5826 2N6010 2N5827 2N6012	GET2904 2N5819 GET2905 2N6005 GET2906 2N6007 GET2907 2N6011 2N5815 2N6013 2N5817	GET2221A 2N6006 GET2222A 2N6010 2N4994 2N6012 2N4995 D32K2 2N6004	GET2904 2N6005 GET2905 2N6007 GET2906 2N6011 GET2907 2N6013	GET2221A 2N6010 GET2222A 2N6012 2N6004 D32K2 2N6006	GET2904 2N6005 GET2905 2N6007 GET2906 2N6011 GET2907 2N6013	2N5814 2N6006 2N5816 2N6010 2N5818 2N6012 2N6004 D32K2	GET2904 2N5819 GET2905 2N6005 GET2906 2N6007 GET2907 2N6011 2N5815 2N6013 2N5817
50 to 59	GET929 GET930		GET929 GET930					
60 to 79	GET2484 2N6016 2N5820 2N6222 2N5822 2N6224 2N6014	2N5821 2N6017 2N5823 2N6223 2N6015 2N6225	GET2484 2N6222 2N6014 2N6224 2N6016	2N6015 2N6223 2N6017 2N6225	2N6014 2N6016	2N6015 2N6017	2N5820 2N6014 2N5821 2N6016 2N5822 2N5823	2N6015 2N6017
80 to 300	2N6218 2N6221 2N6219 2N6220		2N6218 2N6221 2N6219 2N6220					

SMALL SIGNAL EPOXY TRANSISTORS

TO-98 OUTLINE

I_C (mA) / V_{CEO} (Volts)	50μA to 5mA		5mA to 25mA		25mA to 75mA		75mA to 800mA	
	NPN	PNP	NPN	PNP	NPN	PNP	NPN	PNP
to 19	2N2926 2N3662 2N3900 2N3663 2N3900A D16G6 2N3901		2N2926 2N3662 2N3900 2N3663 2N3900A D16G6 2N3901					
20 to 29	2N3390 2N3396 2N3391 2N3397 2N3391A 2N3398 2N3392 2N5172 2N3393 2N5998 2N3394 2N6008 2N3395	2N5354 2N6076 2N5355 2N5999 2N5356 2N6009	2N3390 2N5420 2N3391 2N5172 2N3391A 2N5998 2N3392 2N6008 2N3393 2N3402 2N3394 2N3403 2N3395 2N3414 2N1396 2N3415 2N3397 2N5305 2N3398 2N5306 2N5418 2N5306A 2N5419	2N5354 2N6076 2N5355 2N5999 2N5356 2N6009	2N5418 2N5305 2N5419 2N5306 2N5420 2N5306A 2N3402 2N5998 2N3403 2N6008 2N3414 D33D21 2N3415 D33D22	2N5354 2N6009 2N5355 D29E1 2N5356 D29E2 2N5999	D33D21 D33D22	D29E1 D29E2
30 to 39			2N3843 2N3854 2N3843A 2N3854A 2N3844 2N3855 2N3844A 2N3855A 2N3845 2N3856 2N3845A 2N3856A		2N3843 2N3854 2N3843A 2N3854A 2N3844 2N3855 2N3844A 2N3855A 2N3845 2N3856 2N3845A 2N3856A			
40 to 49	2N3858 2N3859 2N3860	D29F1 2N5365 D29F2 2N5366 D29F3 2N5367 D29F4	2N3858 2N4425 2N3859 2N5307 2N3860 2N5308 2N4424 2N5308A	D29F1 2N5365 D29F2 2N5366 D29F3 2N5367 D29F4	2N4424 D33D24 2N4425 D33D25 2N5307 D33D26 2N5308 D33D27 2N5308A	2N5365 D29E5 2N5366 D29E6 2N5367 D29E7 D29E4	D33D24 D33D25 D33D26 D33D27	D29E4 D29E5 D29E6 D2957
50 to 59	2N5232 2N5309 2N5232A 2N5310 2N5249 2N5311 2N5249A		2N5232 2N5311 2N5232A 2N3404 2N5249 2N3405 2N5249A 2N3416 2N5309 2N3417 2N5310		2N3404 2N3405 2N3416 2N3417			
60 to 69	2N3858A 2N3859A 2N3860A	D29F5 D29F6 D29F7	2N3858A 2N3859A 2N3860A	D29F5 D29F6 D29F7	D33D29 D33D30	D29E9 D29E10	D33D29 D33D30	D29E9 D29E10
70 to 100	2N3877 2N5175 2N3877A 2N5176 2N5174		2N3877 2N5175 2N3877A 2N5176 2N5174					

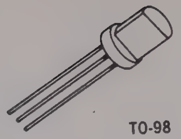
COMPLEMENTARY PAIRS
TO-18 PACKAGE


TO-18

Device		BV_{CEO} (V)	h_{FE} Min.-Max. @ I_C, V_{CE} (V)		$V_{CE(SAT)}$ (V) Max. @ I_C, I_B		Complement	Specification Sheet Page	
NPN	PNP							NPN	PNP
2N5368		30	60-200	150mA,10	0.3	150mA,15mA	2N5372	633	635
2N5369		30	100-300	150mA,10	0.3	150mA,15mA	2N5373	633	635
2N5370		30	200-600	150mA,10	0.3	150mA,15mA	2N5374	633	635
2N5371		30	60-600	150mA,10	0.3	150mA,15mA	2N5375	633	635
	2N5372	30	40-120	150mA,10	0.3	150mA,15mA	2N5368	633	635
	2N5373	30	100-300	150mA,10	0.3	150mA,15mA	2N5369	633	635
	2N5374	30	200-400	150mA,10	0.3	150mA,15mA	2N5370	633	635
	2N5375	30	40-400	150mA,10	0.3	150mA,15mA	2N5371	633	635
	2N5447	25	60-300	50mA,5	0.25	50mA,5mA	2N5449	641	639
	2N5448	30	30-150	50mA,5	0.25	50mA,5mA	2N5450	641	639
2N5449		30	100-300	50mA,2	0.6	100mA,5mA	2N5447	641	639
2N5450		30	50-150	50mA,2	0.8	100mA,5mA	2N5448	641	639
2N5451		20	30-600	50mA,2	1.0	100mA,5mA	2N5447	641	639
2N5810		25	60-200	2mA,2	0.75	500mA,50mA	2N5811	647	647
	2N5811	25	60-200	2mA,2	0.75	500mA,50mA	2N5810	647	647
2N5812		25	150-500	2mA,2	0.75	500mA,50mA	2N5813	647	647
	2N5813	25	150-500	2mA,2	0.75	500mA,50mA	2N5812	647	647
2N5814		40	60-120	2mA,2	0.75	500mA,50mA	2N5815	649	649
	2N5815	40	60-120	2mA,2	0.75	500mA,50mA	2N5814	649	649
2N5816		40	100-200	2mA,2	0.75	500mA,50mA	2N5817	649	649
	2N5817	40	100-200	2mA,2	0.75	500mA,50mA	2N5816	649	649
2N5818		40	150-300	2mA,2	0.75	500mA,50mA	2N5819	649	649
	2N5819	40	150-300	2mA,2	0.75	500mA,50mA	2N5818	649	649
2N5820		60	60-120	2mA,2	0.75	500mA,50mA	2N5821	653	653
	2N5821	60	60-120	2mA,2	0.75	500mA,50mA	2N5820	653	653
2N5822		60	100-200	2mA,2	0.75	500mA,50mA	2N5823	653	653
	2N5823	60	100-200	2mA,2	0.75	500mA,50mA	2N5822	653	653
2N6000		25	100-300	10mA,1	0.4	300mA,30mA	2N6001	670	674
	2N6001	25	100-300	10mA,1	0.75	300mA,30mA	2N6000	670	674
2N6002		25	250-500	10mA,1	0.4	300mA,30mA	2N6003	670	674
	2N6003	25	250-500	10mA,1	0.75	300mA,30mA	2N6002	670	674
2N6004		40	100-300	10mA,1	0.4	300mA,30mA	2N6005	678	682
	2N6005	40	100-300	10mA,1	0.75	300mA,30mA	2N6004	678	682
2N6006		40	250-500	10mA,1	0.4	300mA,30mA	2N6007	678	682
	2N6007	40	250-500	10mA,1	0.75	300mA,30mA	2N6006	678	682
2N6010		40	100-300	10mA,1	0.25	300mA,30mA	2N6011	686	690
	2N6011	40	100-300	10mA,1	0.6	300mA,30mA	2N6010	686	690
2N6012		40	250-500	10mA,1	0.25	300mA,30mA	2N6013	686	690
	2N6013	40	250-500	10mA,1	0.6	300mA,30mA	2N6012	686	690
2N6014		60	100-300	10mA,1	0.25	300mA,30mA	2N6015	694	698
	2N6015	60	100-300	10mA,1	0.6	300mA,30mA	2N6014	694	698
2N6016		60	250-500	10mA,1	0.25	300mA,30mA	2N6017	694	698
	2N6017	60	250-500	10mA,1	0.6	300mA,30mA	2N6016	694	698
2N6222		60	75-200	2mA,5	0.125	10mA,1mA	2N6223	711	711
	2N6223	60	75-200	2mA,5	0.250	10mA,1mA	2N6222	711	711
2N6224		60	150-300	2mA,5	0.125	10mA,1mA	2N6225	711	711
	2N6225	60	150-300	2mA,5	0.250	10mA,1mA	2N6224	711	711
GET2221		30	40-120	150mA,10	0.3	150mA,15mA	GET2904	1364	1296
GET2221A		40	40-120	150mA,10	0.3	150mA,15mA	GET2904	1366	1296
GET2222		30	100-300	150mA,10	0.3	150mA,15mA	GET2905	1364	1306
GET2222A		40	100-300	150mA,10	0.3	150mA,15mA	GET2905	1366	1306
	GET2904	40	40-120	150mA,10	0.4	150mA,15mA	GET2221A	1366	1296
	GET2905	40	100-300	150mA,10	0.4	150mA,15mA	GET2222A	1366	1296

COMPLEMENTARY PAIRS

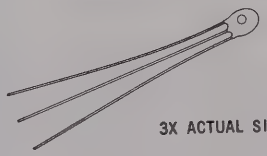
TO-98 OUTLINE


TO-98

Device		BV_{CEO} (V)	h_{FE} Min.-Max. @ I_C, V_{CE} (V)		$V_{CE(SAT)}$ (V) Max. @ I_C, I_B		Complement	Specification Sheet Page	
NPN	PNP							NPN	PNP
2N3858		40	60-120	2mA,5	0.125	10mA,1mA	D29F1	537	1215
2N3859		40	100-200	2mA,5	0.125	10mA,1mA	D29F2	537	1217
2N3860		40	150-300	2mA,5	0.125	10mA,1mA	D29F3	537	1217
2N3858A		60	60-120	2mA,5	0.125	10mA,1mA	D29F5	542	1217
2N3859A		60	100-200	2mA,5	0.125	10mA,1mA	D29F6	542	1217
2N3860A		60	150-300	2mA,5	0.125	10mA,1mA	D29F7	542	1217
2N5172		25	100-500	10mA,10	0.25	10mA,1mA	2N6076	592	592
2N5232		50	250-500	2mA,5	0.125	10mA,1mA	D29F4	599	1217
	2N5354	25	40-120	50mA,1	0.25	50mA,2.5mA	2N5418	637	617
	2N5355	25	100-300	50mA,1	0.25	50mA,2.5mA	2N5419	637	617
	2N5356	25	250-500	50mA,1	0.25	50mA,2.5mA	2N5420	637	617
2N5418		25	40-120	50mA,1	0.25	50mA,2.5mA	2N5354	637	617
2N5419		25	100-300	50mA,1	0.25	50mA,2.5mA	2N5355	637	617
2N5420		25	250-500	50mA,1	0.25	50mA,2.5mA	2N5356	637	617
2N5998		25	150-300	10mA,2	0.25	50mA,2.5mA	2N5999	666	666
	2N5999	25	150-300	10mA,2	0.25	50mA,2.5mA	2N5998	666	666
2N6008		25	250-500	10mA,2	0.25	50mA,2.5mA	2N6009	666	666
	2N6009	25	250-500	10mA,2	0.25	50mA,2.5mA	2N6008	666	666
	2N6076	25	100-500	10mA,10	0.25	10mA,1mA	2N5172	592	592
	D29E1	25	60-200	2mA,2	0.75	500mA,50mA	D33D21	1209	1209
	D29E2	25	150-500	2mA,2	0.75	500mA,50mA	D33D22	1209	1209
	D29E4	40	60-120	2mA,2	0.75	500mA,50mA	D33D24	1211	1211
	D29E5	40	100-200	2mA,2	0.75	500mA,50mA	D33D25	1211	1211
	D29E6	40	150-300	2mA,2	0.75	500mA,50mA	D33D26	1211	1211
	D29E7	40	250-500	2mA,2	0.75	500mA,50mA	D33D27	1211	1211
	D29E9	60	60-120	2mA,2	0.75	500mA,50mA	D33D29	1215	1215
	D29E10	60	100-200	2mA,2	0.75	500mA,50mA	D33D30	1215	1215
	D29F1	40	60-120	2mA,5	0.25	10mA,1mA	2N3858	537	1215
	D29F2	40	100-200	2mA,5	0.25	10mA,1mA	2N3859	537	1217
	D29F3	40	150-300	2mA,5	0.25	10mA,1mA	2N3560	537	1217
	D29F4	40	250-500	2mA,5	0.25	10mA,1mA	2N5232	599	1217
	D29F5	60	60-120	2mA,5	0.25	10mA,1mA	2N3858A	542	1217
	D29F6	60	100-200	2mA,5	0.25	10mA,1mA	2N3859A	592	1217
	D29F7	60	150-300	2mA,5	0.25	10mA,1mA	2N3860A	537	1217
D33D21		25	60-200	2mA,2	0.75	500mA,50mA	D29E1	1209	1209
D33D22		25	150-500	2mA,2	0.75	500mA,50mA	D29E2	1209	1209
D33D24		40	60-120	2mA,2	0.75	500mA,50mA	D29E4	1211	1211
D33D25		40	100-200	2mA,2	0.75	500mA,50mA	D29E5	1211	1211
D33D26		40	150-300	2mA,2	0.75	500mA,50mA	D29E6	1211	1211
D33D27		40	250-500	2mA,2	0.75	500mA,50mA	D29E7	1211	1211
D33D29		60	60-120	2mA,2	0.75	500mA,50mA	D29E9	1215	1215
D33D30		60	100-200	2mA,2	0.75	500mA,50mA	D29E10	1215	1215

COMPLEMENTARY PAIRS

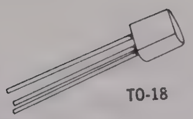
MICRO TAB PACKAGE


3X ACTUAL SIZE

Device		BV_{CEO} (V)	h_{FE} Min.-Max. @ I_C, V_{CE} (V)		$V_{CE(SAT)}$ (V) Max. @ I_C, I_B		Complement	Specification Sheet Page	
NPN	PNP							NPN	PNP
D26C1		25	30-90	10mA,5	0.25	10mA,1mA	D30A1	1199	1219
D26C2		25	60-180	10mA,5	0.25	10mA,1mA	D30A2	1199	1219
D26C3		25	140-300	10mA,5	0.25	10mA,1mA	D30A3	1199	1219
D26C4		25	250-500	10mA,5	0.25	10mA,1mA	D30A4	1199	1219
D26C5		25	400-800	10mA,5	0.25	10mA,1mA	D30A5	1199	1219
	D30A1	25	30-90	10mA,5	0.25	10mA,1mA	D26C1	1219	1199
	D30A2	25	60-180	10mA,5	0.25	10mA,1mA	D26C2	1219	1199
	D30A3	25	140-300	10mA,5	0.25	10mA,1mA	D26C3	1219	1199
	D30A4	25	250-500	10mA,5	0.25	10mA,1mA	D26C4	1219	1199
	D30A5	25	400-800	10mA,5	0.25	10mA,1mA	D26C5	1219	1199

GENERAL PURPOSE AMPLIFIERS

TO-18 OUTLINE

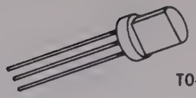


Device	Type	BV$_{CEO}$ @ 10mA (V)	h_{FE} Min.-Max.	@ I_C, V_{CE} (V)	$V_{CE(SAT)}$ (V) Max.	@ I_C, I_B	f_T Typical (MHz)	C_{ob} @ 10V, 1MHz Typical (Pf)	P_T @ 25°C (mw)	Specification Sheet Page
2N4994	NPN	45	40-160	10mA,10			400	1	360	590
2N4995	NPN	45	100-400	10mA,10			400	1	360	590
2N5368	NPN	30	60-200	150mA,10	.30	150mA,15mA	300	5	360	633
2N5369	NPN	30	100-300	150mA,10	.30	150mA,15mA	300	5	360	633
2N5370	NPN	30	200-600	150mA,10	.30	150mA,15mA	300	5	360	633
2N5371	NPN	30	60-600	150mA,10	.30	150mA,15mA	300	5	360	633
2N5372	PNP	30	40-120	150mA,10	.30	150mA,15mA	250	6	360	635
2N5373	PNP	30	100-300	150mA,10	.30	150mA,15mA	250	6	360	635
2N5374	PNP	30	200-400	150mA,10	.30	150mA,15mA	250	6	360	635
2N5375	PNP	30	40-400	150mA,10	.30	150mA,15mA	250	6	360	635
2N5447	PNP	25	60-300	50mA,5	.25	50mA,5mA	150	8	360	639
2N5448	PNP	30	30-150	50mA,5	.25	50mA,5mA	150	8	360	639
2N5449	NPN	30	100-300	50mA,2	.6	100mA,5mA	150	7	625	641
2N5450	NPN	30	50-150	50mA,2	.8	100mA,5mA	150	7	625	641
2N5451	NPN	20	30-600	50mA,2	1.0	100mA,5mA	150	7	625	641
2N5810	NPN	25	60-200	2mA,2	.75	500mA,50mA	150	7	625	647
2N5811	PNP	25	60-200	2mA,2	.75	500mA,50mA	150	8	500	647
2N5812	NPN	25	150-500	2mA,2	.75	500mA,50mA	150	7	625	647
2N5813	PNP	25	150-500	2mA,2	.75	500mA,50mA	150	7	500	647
2N5814	NPN	40	60-120	2mA,2	.75	500mA,50mA	150	7	625	649
2N5815	PNP	40	60-120	2mA,2	.75	500mA,50mA	150	7	500	649
2N5816	NPN	40	100-200	2mA,2	.75	500mA,50mA	150	7	625	649
2N5817	PNP	40	100-200	2mA,2	.75	500mA,50mA	150	7	500	649
2N5818	NPN	40	150-300	2mA,2	.75	500mA,50mA	150	7	625	649
2N5819	PNP	40	150-300	2mA,2	.75	500mA,50mA	150	7	500	649
2N5820	NPN	60	60-120	2mA,2	.75	500mA,50mA	150	7	625	653
2N5821	PNP	60	60-120	2mA,2	.75	500mA,50mA	150	7	500	653
2N5822	NPN	60	100-200	2mA,2	.75	500mA,50mA	150	7	625	653
2N5823	PNP	60	100-200	2mA,2	.75	500mA,50mA	150	7	500	653
2N5824	NPN	40	60-120	2mA,5	.125	10mA,1mA	200	2	360	657
2N5825	NPN	40	100-200	2mA,5	.125	10mA,1mA	200	2	360	657
2N5826	NPN	40	150-300	2mA,5	.125	10mA,1mA	200	2	360	657
2N5827	NPN	40	250-500	2mA,5	.125	10mA,1mA	200	2	360	662
2N5827A	NPN	40	250-500	2mA,5	.125	10mA,1mA	200	2	360	662
2N5828	NPN	40	400-800	2mA,5	.125	10mA,1mA	200	2	360	664
2N5828A	NPN	40	400-800	2mA,5	.125	10mA,1mA	200	2	360	664
2N6000	NPN	25	100-300	10mA,1	.175	100mA,10mA	200	5	400	670
2N6001	PNP	25	100-300	10mA,1	.175	100mA,10mA	250	7	400	674
2N6002	NPN	25	250-500	10mA,1	.175	100mA,10mA	200	5	400	670
2N6003	PNP	25	250-500	10mA,1	.175	100mA,10mA	250	7	400	674
2N6004	NPN	40	100-300	10mA,1	.175	100mA,10mA	200	5	400	678
2N6005	PNP	40	100-300	10mA,1	.175	100mA,10mA	250	7	400	682
2N6006	NPN	40	250-500	10mA,1	.175	100mA,10mA	200	5	400	678
2N6007	PNP	40	250-500	10mA,1	.175	100mA,10mA	250	7	400	682
2N6010	NPN	40	100-300	10mA,1	.25	300mA,30mA	150	7	625	686
2N6011	PNP	40	100-300	10mA,1	.60	300mA,30mA	150	8	500	690
2N6012	NPN	40	250-500	10mA,1	.25	300mA,30mA	150	7	625	686
2N6013	PNP	40	250-500	10mA,1	.60	300mA,30mA	150	8	500	690
2N6014	NPN	60	100-300	10mA,1	.25	300mA,30mA	150	7	625	694
2N6015	PNP	60	100-300	10mA,1	.60	300mA,30mA	150	8	500	698
2N6016	NPN	60	250-500	10mA,1	.25	300mA,30mA	150	7	625	694
2N6017	PNP	60	250-500	10mA,1	.60	300mA,30mA	150	8	500	698
2N6218	NPN	300	20-	20mA,10	1.0	10mA,1mA	80	3	500	708
2N6219	NPN	250	20-	20mA,10	1.0	10mA,1mA	80	3	500	708
2N6220	NPN	200	20-	20mA,10	2.0	20mA,2mA	80	3	500	708
2N6221	NPN	150	20-	20mA,10	2.0	20mA,2mA	80	3	500	708
2N6222	NPN	60	75-200	2mA,5	.125	10mA,1mA	200	2	360	711
2N6223	PNP	60	75-200	2mA,5	.25	10mA,1mA	200	2	360	711
2N6224	NPN	60	150-300	2mA,5	.125	10mA,1mA	250	2	360	711
2N6225	PNP	60	150-300	2mA,5	.25	10mA,1mA	250	2	360	711
D32P1	NPN	30	40-80	2mA,5	.150	10mA,1mA	250	.9	360	1223
D32P2	NPN	30	60-120	2mA,5	.150	10mA,1mA	250	.9	360	1223
D32P3	NPN	30	100-200	2mA,5	.150	10mA,1mA	300	.9	360	1223
D32P4	NPN	30	150-300	2mA,5	.150	10mA,1mA	300	.9	360	1223
GET929	NPN	50	60-120	10uA,5	.125	10mA,1mA	200	2	360	1292
GET930	NPN	50	100-300	10uA,5	.125	10mA,1mA	200	2	360	1292
GET2221	NPN	30	40-120	150mA,10	.30	150mA,15mA	300	5	360	1296
GET2221A	NPN	40	40-120	150mA,10	.30	150mA,15mA	300	5	360	1298
GET2222	NPN	30	100-300	150mA,10	.30	150mA,15mA	300	5	360	1296
GET2222A	NPN	40	100-300	150mA,10	.30	150mA,15mA	300	5	360	1298
GET2484	NPN	60	150-900	2mA,5*	.35	1mA,.1mA	100	2	360	1302
GET2904	PNP	40	40-120	150mA,10	.40	150mA,15mA	150	5	360	1304
GET2905	PNP	40	40-120	150mA,10	.40	150mA,15mA	150	5	360	1306
GET2906	PNP	40	100-300	150mA,10	.40	150mA,15mA	150	5	360	1304
GET2907	PNP	40	100-300	150mA,10	.40	150mA,15mA	150	5	360	1306
GET3563	NPN	12	20-200	8mA,10			750	0.9	200	1310
GET3638	PNP	25	30-800	50mA,1	.25	50mA,2.5mA	200	5	360	
GET3638A	PNP	25	100-800	50mA,1	.25	50mA,2.5mA	200	5	360	

* hfe at 1KHz

GENERAL PURPOSE AMPLIFIERS

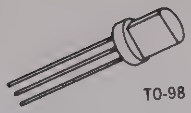
TO-98 OUTLINE



TO-98

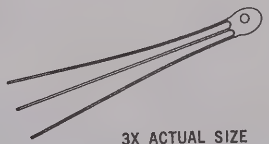
Device	Type	BV_{CEO} @ 10mA (V)	h_{FE} Min.-Max. @ I_C, V_{CE} (V)		$V_{CE\,(SAT)}$ (V) Max. @ I_C, I_B		f_T Typical (MHz)	C_{cb} @ 10V, 1MHz Typical (Pf)	P_T @ 25°C (mw)	Specification Sheet Page
2N2711	NPN	18	30-90	2mA,5	1.6	50mA,3mA	120	7	360	482
2N2712	NPN	18	75-225	2mA,5	1.6	50mA,3mA	120	7	360	482
2N2713	NPN	18	30-90	2mA,5	0.3	50mA,3mA	120	5	360	484
2N2714	NPN	18	75-225	2mA,5	0.3	50mA,3mA	120	5	360	484
2N2923	NPN	25	90-180*	2mA,10	1.6	50mA,3mA	120	7	360	498
2N2924	NPN	25	150-300*	2mA,10	1.6	50mA,3mA	120	7	360	498
2N2925	NPN	25	235-470*	2mA,10	1.6	50mA,3mA	120	7	360	498
2N2926	NPN	18	35-470*	2mA,10	1.6	50mA,3mA	120	7	360	499
2N3390	NPN	25	400-800	2mA,5	1.6	50mA,3mA	120	7	360	501
2N3391	NPN	25	250-500	2mA,5	1.6	50mA,3mA	120	7	360	502
2N3391A	NPN	25	250-500	2mA,5	1.6	50mA,3mA	120	7	360	502
2N3392	NPN	25	150-300	2mA,5	1.6	50mA,3mA	120	7	360	504
2N3393	NPN	25	90-180	2mA,5	1.6	50mA,3mA	120	7	360	504
2N3394	NPN	25	55-110	2mA,5	1.6	50mA,3mA	120	7	360	504
2N3395	NPN	25	150-500	2mA,5	1.6	50mA,3mA	120	7	360	507
2N3396	NPN	25	90-500	2mA,5	1.6	50mA,3mA	120	7	360	507
2N3397	NPN	25	55-500	2mA,5	1.6	50mA,3mA	120	7	360	507
2N3398	NPN	25	55-800	2mA,5	1.6	50mA,3mA	120	7	360	507
2N3402	NPN	25	75-225	2mA,5	0.3	50mA,3mA	150	5	560	509
2N3403	NPN	25	180-540	2mA,5	0.3	50mA,3mA	150	5	560	509
2N3404	NPN	50	75-225	2mA,5	0.3	50mA,3mA	150	5	560	509
2N3405	NPN	50	180-540	2mA,5	0.3	50mA,3mA	150	5	560	509
2N3414	NPN	25	75-225	2mA,5	0.3	50mA,3mA	150	5	360	509
2N3415	NPN	25	180-540	2mA,5	0.3	50mA,3mA	150	5	360	509
2N3416	NPN	50	75-225	2mA,5	0.3	50mA,3mA	150	5	360	509
2N3417	NPN	50	180-540	2mA,5	0.3	50mA,3mA	150	5	360	509
2N3662	NPN	12	20-	8mA,10	0.6	10mA,1mA	1000	.9	200	518
2N3663	NPN	12	20-	8mA,10	0.6	10mA,1mA	1000	.9	200	518
2N3843	NPN	30	20-40	2mA,5	0.2	10mA,1mA	150	2	360	523
2N3843A	NPN	30	20-40	2mA,5	0.2	10mA,1mA	150	2	360	523
2N3844	NPN	30	35-70	2mA,5	0.2	10mA,1mA	150	2	360	523
2N3844A	NPN	30	35-70	2mA,5	0.2	10mA,1mA	150	2	360	523
2N3845	NPN	25	60-120	2mA,5	0.2	10mA,1mA	150	2	360	523
2N3845A	NPN	25	60-120	2mA,5	0.2	10mA,1mA	150	2	360	523
2N3854	NPN	36	35-70	2mA,5	0.2	10mA,1mA	200	1.7	360	527
2N3854A	NPN	36	35-70	2mA,5	0.2	10mA,1mA	200	1.7	360	527
2N3855	NPN	36	60-120	2mA,5	0.2	10mA,1mA	200	1.7	360	527
2N3855A	NPN	36	60-120	2mA,5	0.2	10mA,1mA	200	1.7	360	527
2N3856	NPN	36	100-200	2mA,5	0.2	10mA,1mA	200	1.7	360	527
2N3856A	NPN	36	100-200	2mA,5	0.2	10mA,1mA	200	1.7	360	527
2N3858	NPN	40	60-120	2mA,5	.125	10mA,1mA	150	2	360	537
2N3858A	NPN	60	60-120	2mA,5	.125	10mA,1mA	150	2	360	542
2N3859	NPN	40	100-200	2mA,5	.125	10mA,1mA	150	2	360	537
2N3859A	NPN	60	100-200	2mA,5	.125	10mA,1mA	150	2	360	542
2N3860	NPN	40	150-300	2mA,5	.125	10mA,1mA	150	2	360	537
2N3900	NPN	18	250-500	2mA,5	1.6	50mA,3mA	120	7	360	550
2N3900A	NPN	18	250-500	2mA,5	1.6	50mA,3mA	120	7	360	550
2N3901	NPN	25	350-700	2mA,5	1.6	50mA,3mA	120	7	360	552
2N4424	NPN	40	180-540	2mA,5	0.3	50mA,3mA	150	5	360	558
2N4425	NPN	40	180-540	2mA,5	0.3	50mA,3mA	150	5	360	558
2N5172	NPN	25	100-500	10mA,10	0.25	10mA,1mA	100	2	360	592
2N5232	NPN	50	250-500	2mA,5	.125	10mA,1mA	150	2	360	599
2N5232A	NPN	50	250-500	2mA,5	.125	10mA,1mA	150	2	360	599
2N5249	NPN	50	400-800	2mA,5	.125	10mA,1mA	150	2	360	602
2N5249A	NPN	50	400-800	2mA,5	.125	10mA,1mA	150	2	360	602
2N5309	NPN	50	60-120	10uA,5	.125	10mA,1mA	150	2	360	613
2N5310	NPN	50	100-300	10uA,5	.125	10mA,1mA	150	2	360	613
2N5311	NPN	50	250-500	10uA,5	.125	10mA,1mA	150	2	360	613
2N5354	PNP	25	40-120	50mA,1	0.25	50mA,2.5mA	350	5	360	617
2N5355	PNP	25	100-300	50mA,1	0.25	50mA,2.5mA	350	5	360	617
2N5356	PNP	25	250-500	50mA,1	0.25	50mA,2.5mA	350	5	360	617
2N5365	PNP	40	40-120	50mA,1	0.25	50mA,2.5mA	350	5	360	625
2N5366	PNP	40	100-300	50mA,1	0.25	50mA,2.5mA	350	5	360	625
2N5367	PNP	40	250-500	50mA,1	0.25	50mA,2.5mA	350	5	360	625

GENERAL PURPOSE AMPLIFIERS
TO-98 OUTLINE



Device	Type	BV_{CEO} @ 10mA (V)	h_{FE} Min.-Max. @ I_C, V_{CE} (V)		$V_{CE(SAT)}$ (V) Max. @ I_C, I_B		f_T Typical (MHz)	C_{cb} @ 10V, 1MHz Typical (Pf)	P_T @ 25°C (mw)	Specification Sheet Page
2N5418	NPN	25	40-120	50mA,1	0.25	50mA,2.5mA	250	4	400	637
2N5419	NPN	25	100-300	50mA,1	0.25	50mA,2.5mA	250	4	400	637
2N5420	NPN	25	250-500	50mA,1	0.25	50mA,2.5mA	250	4	400	637
2N5998	NPN	25	150-300	10mA,2	0.25	50mA,2.5mA	250	4	400	666
2N5999	PNP	25	150-300	10mA,2	0.25	50mA,2.5mA	350	5	400	666
2N6008	NPN	25	250-500	10mA,2	0.25	50mA,2.5mA	250	4	400	666
2N6009	PNP	25	250-500	10mA,2	0.25	50mA,2.5mA	350	5	400	666
2N6076	PNP	25	100-500	10mA,10	0.25	10mA,1mA	300	5	360	592
D16G6	NPN	12	20-	8mA,10	0.6	10mA,1mA	1000	0.9	200	1196
D29E1	PNP	25	60-200	2mA,2	0.75	500mA,50mA	150	9.4	500	1209
D29E2	PNP	25	150-500	2mA,2	0.75	500mA,50mA	165	9.4	500	1209
D29E4	PNP	40	60-120	2mA,2	0.75	500mA,50mA	120	9.4	500	1211
D29E5	PNP	40	100-200	2mA,2	0.75	500mA,50mA	135	9.4	500	1211
D29E6	PNP	40	150-300	2mA,2	0.75	500mA,50mA	150	9.4	500	1211
D29E7	PNP	40	250-500	2mA,2	0.75	500mA,50mA	165	9.4	500	1211
D29E9	PNP	60	60-120	2mA,2	0.75	500mA,50mA	120	9.4	500	1215
D29E10	PNP	60	100-200	2mA,2	0.75	500mA,50mA	135	9.4	500	1215
D29F1	PNP	40	60-120	2mA,5	0.25	10mA,1mA	150	2.1	360	1217
D29F2	PNP	40	100-200	2mA,5	0.25	10mA,1mA	150	2.1	360	1217
D29F3	PNP	40	150-300	2mA,5	0.25	10mA,1mA	150	2.1	360	1217
D29F4	PNP	40	250-500	2mA,5	0.25	10mA,1mA	150	2.1	360	1217
D29F5	PNP	60	60-120	2mA,5	0.25	10mA,1mA	150	2.1	360	1217
D29F6	PNP	60	100-200	2mA,5	0.25	10mA,1mA	150	2.1	360	1217
D29F7	PNP	60	150-300	2mA,5	0.25	10mA,1mA	150	2.1	360	1217
D33D21	NPN	25	60-200	2mA,2	0.75	500mA,50mA	150	9.4	625	1209
D33D22	NPN	25	150-500	2mA,2	0.75	500mA,50mA	165	9.4	625	1209
D33D24	NPN	40	60-120	2mA,2	0.75	500mA,50mA	120	9.4	625	1211
D33D25	NPN	40	100-200	2mA,2	0.75	500mA,50mA	135	9.4	625	1211
D33D26	NPN	40	150-300	2mA,2	0.75	500mA,50mA	150	9.4	625	1211
D33D27	NPN	40	250-500	2mA,2	0.75	500mA,50mA	165	9.4	625	1211
D33D29	NPN	60	60-120	2mA,2	0.75	500mA,50mA	120	9.4	625	1215
D33D30	NPN	60	100-200	2mA,2	0.75	500mA,50mA	135	9.4	625	1215

GENERAL PURPOSE AMPLIFIERS
MICRO MINIATURE PACKAGE

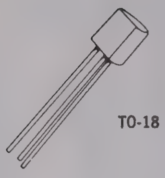


3X ACTUAL SIZE

Device	Type	BV_{CEO} (V)	h_{FE} Min.-Max. @ I_C, V_{CE} (V)		$V_{CE(SAT)}$ (V) Max. @ I_C, I_B		f_T Typical (MHz)	C_{cb} @ 10V, 1MHz Typical (Pf)	P_T @ 25°C (mw)	Specification Sheet Page
D26C1	NPN	25	30-90	10mA,5	0.25	10mA,1mA	250	5	90	1199
D26C2	NPN	25	60-180	10mA,5	0.25	10mA,1mA	250	5	90	1199
D26C3	NPN	25	140-300	10mA,5	0.25	10mA,1mA	250	5	90	1199
D26C4	NPN	25	250-500	10mA,5	0.25	10mA,1mA	250	5	90	1199
D26C5	NPN	25	400-800	10mA,5	0.25	10mA,1mA	250	5	90	1199
D26E1	NPN	45	100-300	10uA,5	1.0	10mA,0.5mA	150	2	90	1201
D26E2	NPN	40	40-90	100uA,2.5	0.25	10mA,1mA	150	2	90	1202
D26E3	NPN	40	70-145	100uA,2.5	0.25	10mA,1mA	150	2	90	1202
D26E4	NPN	40	115-220	100uA,2.5	0.25	10mA,1mA	150	2	90	1202
D26E5	NPN	40	180-330	100uA,2.5	0.25	10mA,1mA	150	2	90	1202
D26E6	NPN	40	40-330	100uA,2.5	0.25	10mA,1mA	150	2	90	1202
D26G1	NPN	15	20-	3mA,1	0.4	10mA,1mA	1000	0.9	90	1203
D30A1	PNP	25	30-90	10mA,5	0.25	10mA,1mA	250	5	90	1219
D30A2	PNP	25	60-180	10mA,5	0.25	10mA,1mA	250	5	90	1219
D30A3	PNP	25	140-300	10mA,5	0.25	10mA,1mA	250	5	90	1219
D30A4	PNP	25	250-500	10mA,5	0.25	10mA,1mA	250	5	90	1219
D30A5	PNP	25	400-800	10mA,5	0.25	10mA,1mA	250	5	90	1219
D26P1	NPN	12	2000-	2mA,5	1.0	50mA,50uA	60	7.6	90	1204
D26P2	NPN	25	2000-20000	2mA,5	1.0	50mA,50uA	60	7.6	90	1206
D26P3	NPN	25	7000-70000	2mA,5	1.0	50mA,50uA	60	7.6	90	1206

GENERAL PURPOSE SWITCHES

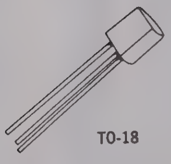
TO-18 OUTLINE


TO-18

Device	Type	BV_{CEO} (V)	t_{ON}	t_{OFF}	Conditions	Specification Sheet Page
2N5368	NPN	30	40nsec	350nsec	I_C=150mA,I_B=15mA,V_{CC}=30V	633
2N5369	NPN	30	40nsec	350nsec	I_C=150mA,I_B=15mA,V_{CC}=30V	633
2N5370	NPN	30	40nsec	400nsec	I_C=150mA,I_B=15mA,V_{CC}=30V	633
2N5371	NPN	30	40nsec	400nsec	I_C=150mA,I_B=15mA,V_{CC}=30V	633
2N5372	PNP	30	50nsec	150nsec	I_C=150mA,I_B=15mA,V_{CC}=30V	635
2N5373	PNP	30	50nsec	150nsec	I_C=150mA,I_B=15mA,V_{CC}=30V	635
2N5374	PNP	30	50nsec	175nsec	I_C=150mA,I_B=15mA,V_{CC}=30V	635
2N5375	PNP	30	50nsec	175nsec	I_C=150mA,I_B=15mA,V_{CC}=30V	635
2N6000	NPN	25	25nsec	320nsec	I_C=150mA,I_{B1}=-I_{B2}=15mA,V_{CC}=30V	670
2N6001	PNP	25	23nsec	230nsec	I_C=150mA,I_{B1}=-I_{B2}=15mA,V_{CC}=30V	674
2N6002	NPN	25	25nsec	410nsec	I_C=150mA,I_{B1}=-I_{B2}=15mA,V_{CC}=30V	670
2N6003	PNP	25	23nsec	300nsec	I_C=150mA,I_{B1}=-I_{B2}=15mA,V_{CC}=30V	674
2N6004	NPN	40	25nsec	320nsec	I_C=150mA,I_{B1}=-I_{B2}=15mA,V_{CC}=30V	678
2N6005	PNP	40	23nsec	230nsec	I_C=150mA,I_{B1}=-I_{B2}=15mA,V_{CC}=30V	682
2N6006	NPN	40	25nsec	410nsec	I_C=150mA,I_{B1}=-I_{B2}=15mA,V_{CC}=30V	678
2N6007	PNP	40	23nsec	300nsec	I_C=150mA,I_{B1}=-I_{B2}=15mA,V_{CC}=30V	682
2N6010	NPN	40	37nsec	400nsec	I_C=150mA,I_{B1}=-I_{B2}=15mA,V_{CC}=30V	686
2N6011	PNP	40	45nsec	425nsec	I_C=150mA,I_{B1}=-I_{B2}=15mA,V_{CC}=30V	690
2N6012	NPN	40	37nsec	500nsec	I_C=150mA,I_{B1}=-I_{B2}=15mA,V_{CC}=30V	686
2N6013	PNP	40	45nsec	525nsec	I_C=150mA,I_{B1}=-I_{B2}=15mA,V_{CC}=30V	690
2N6014	NPN	60	37nsec	400nsec	I_C=150mA,I_{B1}=-I_{B2}=15mA,V_{CC}=30V	694
2N6015	PNP	60	45nsec	425nsec	I_C=150mA,I_{B1}=-I_{B2}=15mA,V_{CC}=30V	698
2N6016	NPN	60	37nsec	500nsec	I_C=150mA,I_{B1}=-I_{B2}=15mA,V_{CC}=30V	694
2N6017	PNP	60	45nsec	525nsec	I_C=150mA,I_{B1}=-I_{B2}=15mA,V_{CC}=30V	698
GET2221A	NPN	40	35nsec	285nsec	I_{CC}=150mA,I_{B1}=I_{B2}=15mA,V_{CC}=30V	1298
GET2222A	NPN	40	35nsec	285nsec	I_{CC}=150mA,I_{B1}=I_{B2}=15mA,V_{CC}=30V	1298
GET2904	PNP	40	50nsec	110nsec	I_{CC}=150mA,I_{B1}=I_{B2}=15mA,V_{CC}=30V	1304
GET2905	PNP	40	50nsec	110nsec	I_{CC}=150mA,I_{B1}=I_{B2}=15mA,V_{CC}=30V	1306
GET2906	PNP	40	50nsec	110nsec	I_{CC}=150mA,I_{B1}=I_{B2}=15mA,V_{CC}=30V	1304
GET2907	PNP	40	50nsec	110nsec	I_C=150mA,I_{B1}=I_{B2}=15mA,V_{CC}=30V	1306
GET3638	PNP	25	75nsec	170nsec	I_C=300mA,I_{B1}=-I_{B2}=30mA,V_{CC}=10V	1380
GET3638A	PNP	25	75nsec	170nsec	I_C=300mA,I_{B1}=-I_{B2}=30mA,V_{CC}=10V	1380

DARLINGTON AMPLIFIERS

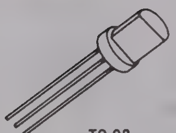
TO-18 OUTLINE


TO-18

Device NPN	BV_{CEO} (V)	h_{FE} Min.-Max. @ I_C, V_{CE} (V)	$V_{CE(SAT)}$ (V) Max. @ I_C, I_B	Specification Sheet Page
GET5305	25	2K-20K 2mA,5	1.4 200mA,200uA	1386
GET5306	25	7K-70K 2mA,5	1.4 200mA,200uA	1386
GET5306A	25	7K-70K 2mA,5	1.4 200mA,200uA	1386
GET5307	40	2K-20K 2mA,5	1.4 200mA,200uA	1386
GET5308	40	7K-70K 2mA,5	1.4 200mA,200uA	1386
GET5308A	40	7K-70K 2mA,5	1.4 200mA,200uA	1386

DARLINGTON AMPLIFIERS

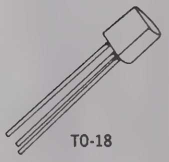
TO-98 OUTLINE


TO-98

Device NPN	BV_{CEO} (V)	h_{FE} Min.-Max. @ I_C, V_{CE} (V)	$V_{CE(SAT)}$ (V) Max. @ I_C, I_B	Specification Sheet Page
2N5305	25	2K-20K 2mA,5	1.4 200mA,200uA	604
2N5306	25	7K-70K 2mA,5	1.4 200mA,200uA	604
2N5306A	25	7K-70K 2mA,5	1.4 200mA,200uA	604
2N5307	40	2K-20K 2mA,5	1.4 200mA,200uA	609
2N5308	40	7K-70K 2mA,5	1.4 200mA,200uA	609
2N5308A	40	7K-70K 2mA,5	1.4 200mA,200uA	609
D16P1	12	2K- 2mA,5	1.4 200mA,200uA	1197

HIGH VOLTAGE TYPES

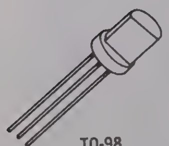
TO-18 OUTLINE


TO-18

Device NPN	BV_{CEO} (V)	h_{FE} Min.-Max. @ I_C, V_{CE} (V)	I_{CBO} Max. @ V_{CB} (V)	$V_{CE(SAT)}$ (V) Max. @ I_C, I_B	Specification Sheet Page
2N6218	300	20 20mA,10	500nA 250	1.0 10mA,1mA	708
2N6219	250	20 20mA,10	1uA 200	1.0 10mA,1mA	708
2N6220	200	20 20mA,10	1uA 150	2.0 20mA,2mA	708
2N6221	150	20 20mA,10	10uA 100	2.3 20mA,2mA	708

HIGH VOLTAGE TYPES

TO-98 OUTLINE


TO-98

Device NPN	BV_{CEO} (V)	h_{FE} Min.-Max. @ I_C, V_{CE} (V)	I_{CBO} Max. @ V_{CB} (V)	$V_{CE(SAT)}$ (V) Max. @ I_C, I_B	Specification Sheet Page
2N3877	70	20 2mA,5	100nA * 40	.125 10mA,1mA	548
2N3877A	85	20 2mA,5	100nA * 40	.125 10mA,1mA	548
2N5174	75	40-600 10mA,5	500nA 60	.950 10mA,1mA	594
2N5175	100	55-160 10mA,5	500nA 60	.950 10mA,1mA	594
2N5176	100	140-300 10mA,5	500nA 60	.950 10mA,1mA	594

* ICES

HIGH SPEED SWITCHES

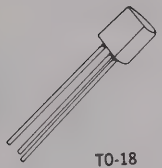
TO-18 OUTLINE

TO-18

Device NPN	BV$_{CEO}$ (V)	t$_{ON}$	t$_{OFF}$	Conditions	Specification Sheet Page
D32K1	25	45	100	I_C=500mA,I_{B1}=-I_{B2}=50mA,V_{CC}=30V	1221
D32K2	40	45	100	I_C=500mA,I_{B1}=-I_{B2}=50mA,V_{CC}=30V	1221
GET706	15	40	75	I_C=10mA,I_{B1}=3mA,I_{B2}=1mA,V_{CC}=3V	1288
GET708	15	40	75	I_C=10mA,I_{B1}=3mA,I_{B2}=1mA,V_{CC}=3V	1288
GET914	15	40	40	I_C=200mA,I_{B1}=40mA,I_{B2}=-20mA,V_{CC}=5V	1288
GET2369	15	15	22	I_C=10mA,I_{B1}=3mA,I_{B2}=-15mA	1300
GET3013	15	15	25	I_C=300mA,I_{B1}=-I_{B2}=30mA,V_{CC}=15V	1308
GET3014	20	16	25	I_C=30mA,I_{B1}=-I_{B2}=3mA,V_{CC}=2V	1308
GET3646	15	18	28	I_C=300mA,I_{B1}=-I_{B2}=30mA,V_{CC}=10V	1382

LOW NOISE AMPLIFIERS

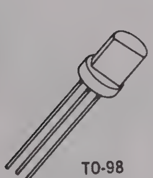
TO-18 OUTLINE


TO-18

Device	Type	BV$_{CEO}$ (V)	h$_{FE}$ Min.-Max. @ I_C V_{CE} (V)		NF (db)	Conditions	Specification Sheet Page
2N5827A	NPN	40	250-500	2mA,5	5	V_{CE}=5V,I_C=100uA,Rg=5K ,BW=15.7KHz	662
2N5828A	PNP	40	400-800	2mA,5	5	V_{CE}=5V,I_C=100uA,Rq=5K .BW=15.7KHz	664
2N6000	NPN	25	100-300	10mA,1	3	V_{CE}=5V,I_E=100uA,Rs=5K ,BW=15.7KHz	670
2N6001	PNP	25	100-300	10mA,1	3	V_{CE}=5V,I_E=100uA,Rs=5K ,BW=15.7KHz	674
2N6002	NPN	25	250-500	10mA,1	2	V_{CE}=5V,I_E=100uA,Rs=5K ,BW=15.7KHz	670
2N6003	PNP	25	250-500	10mA,1	1.5	V_{CE}=5V,I_E=100uA,Rs=5K ,BW=15.7KHz	674
2N6004	NPN	40	100-300	10mA,1	3	V_{CE}=5V,I_E=100uA,Rs=5K ,BW=15.7KHz	678
2N6005	PNP	40	100-300	10mA,1	3	V_{CE}=5V,I_E=100uA,Rs=5K ,BW=15.7KHz	682
2N6006	NPN	40	250-500	10mA,1	2	V_{CE}=5V,I_E=100uA,Rs=5K ,BW=15.7KHz	678
2N6007	PNP	40	250-500	10mA,1	1.5	V_{CE}=5V,I_E=100uA,Rs=5K ,BW=15.7KHz	682
2N6010	NPN	40	100-300	10mA,1	5	V_{CE}=5V,I_E=100uA,Rs=5K ,BW=15.7KHz	686
2N6011	PNP	40	100-300	10mA,1	3	V_{CE}=5V,I_E=100uA,Rs=5K ,BW=15.7KHz	690
2N6012	NPN	40	250-500	10mA,1	3	V_{CE}=5V,I_E=100uA,Rs=5K ,BW=15.7KHz	686
2N6013	PNP	40	250-500	10mA,1	2	V_{CE}=5V,I_E=100uA,Rs=5K ,BW=15.7KHz	690
2N6014	NPN	60	100-300	10mA,1	5	V_{CE}=5V,I_E=100uA,Rs=5K ,BW=15.7KHz	694
2N6015	PNP	60	100-300	10mA,1	3	V_{CE}=5V,I_E=100uA,Rs=5K ,BW=15.7KHz	698
2N6016	NPN	60	250-500	10mA,1	3	V_{CE}=5V,I_E=100uA,Rs=5K ,BW=15.7KHz	694
2N6017	PNP	60	250-500	10mA,1	2	BW=15.7KHz,f=10Hz to 10KHz	698
GET929	NPN	50	60-120	10uA,5	4	V_{CE}=5V,I_C=10uA,Rs=10K ,BW=15.7KHz,f=10Hz to 10KHz	1292
GET930	NPN	50	100-300	10uA,5	3	V_{CE}=5V,I_C=10uA,Rs=10K ,BW=15.7KHz,f=10Hz to 10KHz	1292
GET2484	NPN	60	100 min	10uA,5	3	V_{CE}=5V,I_C=10uA,Rs=10K ,BW=15.7KHz,f=10Hz to 10KHz	1302
GET5306A	NPN	25	7K-70K	2mA,5	5	V_{CE}=5V,I_C=600uA,Rg=160K ,BW=15.7KHz,f=10Hz to 10KHz	1386
GET5308A	NPN	40	7K-70K	2mA,5	5	V_{CE}=5V,I_C=600uA,Rg=160K ,BW=15.7KHz,f=10Hz to 10KHz	1386

LOW NOISE AMPLIFIERS

(TO-98 OUTLINE)


TO-98

Device	Type	BV$_{CEO}$ (V)	h$_{FE}$ Min.-Max. @ I_C V_{CE} (V)		NF (db)	Conditions	Specification Sheet Page
2N3391A	NPN	25	250-500	2mA,5	5	V_{CE}=5V,I_C=10 uA,Rs=5K ,BW=15.7KHz, f=10Hz to 15.7KHz	502
2N3844	NPN	30	35-70	2mA,5	10.2	V_{CE}=10V,I_C=1mA,Rs=20 ,f=2MHz, BW 100KHz	523
2N3844A	NPN	30	35-70	2mA,5	8.5	V_{CE}=10V,I_C=1mA,Rs=20 ,f=2MHz, BW 100KHz	523
2N3845	NPN	30	60-120	2mA,5	10.2	V_{CE}=10V,I_C=1mA,Rs=20 ,f=2MHz, BW 100KHz	523
2N3845A	NPN	30	60-120	2mA,5	8.5	V_{CE}=10V,I_C=1mA,Rs=20 ,f=2MHz, BW 100KHz	523
2N3900A	NPN	18	250-500	2mA,5	5	V_{CE}=5V,I_C=100uA,Rs=5K ,BW=15.7KHz, f=10Hz to 15.7KHz	550
2N3901	NPN	18	350-700	2mA,5	5	V_{CE}=5V,I_C=10 uA,Rs=5K ,BW=15.7KHz, f=10Hz to 15.7KHz	552
2N5232A	NPN	50	250-500	2mA,5	5	V_{CE}=5V,I_C=10 uA,Rs=5K ,BW=15.7KHz, f=10KHz to 15.7 KHz	599
2N5249A	NPN	50	400-800	2mA,5	3	V_{CE}=5V,I_C=100uA,Rs=5K ,BW=15.7KHz, f=10KHz to 15.7 KHz	602
2N5306A	NPN	25	7K-70K	2mA,5	5	V_{CE}=5V,I_C=600uA,Rs=160K ,BW=15.7KHz f=10Hz to 10KHz	604
2N5308A	NPN	40	7K-70K	2mA,5	5	V_{CE}=5V,I_C=600uA,Rs=160K ,BW=15.7KHz f=10Hz to 10KHz	609
2N5309	NPN	50	60-120	10uA,5	4	V_{CE}=5V,I_C=20uA,Rs=5K ,f=1KHz,BW=15.7KHz	613
2N5310	NPN	50	100-300	10uA,5	3	V_{CE}=5V,I_C=20uA,Rs=5K ,f=1KHz,BW=15.7KHz	613
2N5311	NPN	50	250-500	10uA,5	3	V_{CE}=5V,I_C=20uA,Rs=5K ,f=1KHz,BW=15.7KHz	
2N5998	NPN	25	150-300	10mA,2	1.5	V_{CE}=5V,I_C=100uA,Rs=5K ,BW=15.7KHz, f=10Hz to 10KHz	666
2N5999	PNP	25	150-300	10mA,2	1.5	V_{CE}=5V,I_C=100uA,Rs=5K ,BW=15.7KHz, f=10Hz to 10KHz	666
2N6008	NPN	25	250-500	10mA,2	1.5	V_{CE}=5V,I_C=100uA,Rs=5K ,BW=15.7KHz, f=10Hz to 10KHz	666
2N6009	PNP	25	250-500	10mA,2	1.5	V_{CE}=5V,I_C=100uA,Rs=5K ,BW=15.7KHz, f=10Hz to 10KHz	666

SILICON POWER TRANSISTORS

GE silicon power transistors are fabricated with plannar and **POWER-GLAS**™ passivated pellets. They are encapsulated in color coded silicone packages featuring hard solder pellet mountdown and optional factory formed lead configurations.

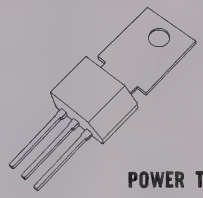
TYPES AVAILABLE INCLUDE:

- **DARLINGTONS**
- **HIGH VOLTAGE TYPES**
- **COMPLIMENTARY PAIRS—1, 3, 4, AND 10 AMPERES**

NPN DARLINGTON—HIGH GAIN

TYPICAL APPLICATIONS

- Audio Output
- Touch Switch
- Oscillator
- Buffer
- High Power Transistor Driver
- Relay Replacement



FEATURES

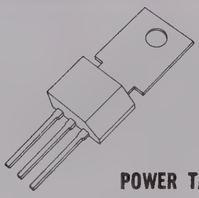
- Very High Gain: 60k typical
- High Input Impedance: 50k ohm typ.
- 1.2 watts
- 1.33Watts@50°C Ambient

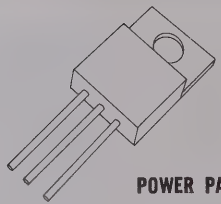
GE Type	P_T $T_C = 25°C$ Max. (W)	V_{CEO} Min. (V)	I_C Cont. (A)	h_{FE} @ 5V, 200mA Min.	Max.	f_T Typical (MHz)	Package Type	Specification Page No.
D40C1	6.25	30	.5	10,000	60,000	75	BROWN Encapsulated Power Tab	1229
D40C2	6.25	30	.5	40,000	—	75		
D40C4	6.25	40	.5	10,000	60,000	75		
D40C5	6.25	40	.5	40,000	—	75		
D40C7	6.25	50	.5	10,000	60,000	75		

NPN HIGH VOLTAGE

TYPICAL APPLICATIONS

- 120V AC Line Operated Amplifiers
- Regulators
- TV Video and Chroma Output
- Inverters/Converters





FEATURES

- **POWER-GLAS**™ Passivated MESA
- Fast Switching
- High Voltage

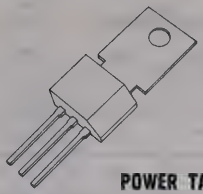
GE Type	P_T $T_C = 25°C$ Max. (W)	V_{CEO} Min. (V)	I_C Cont. (A)	h_{FE} @ 10V, 20mA Min.	Max.	h_{FE} @ 10V, 50mA Min.	Max.	f_T Typical (MHz)	Package Type	Specification Page No.
D40N1	6.25	250	.1	30	90	—	—	80	BROWN Encapsulated Power Tab	1237/ 1241
D40N2	6.25	250	.1	60	180	—	—	80		
D40N3	6.25	300	.1	30	90	—	—	80		
D40N4	6.25	300	.1	60	180	—	—	80		
D40P1	6.25	120	.5	20[1]	—	40[2]	—	—		
D40P3	6.25	180	.5	20[1]	—	40[2]	—	—		
D40P5	6.25	225	.5	20[1]	—	40[2]	—	—		
D44R1	31.25	250	1.0	—	—	30	90	20	RED Encapsulated Power Pac	1261
D44R2	31.25	250	1.0	—	—	75	175	20		
D44R3	31.25	300	1.0	—	—	30	90	20		
D44R4	31.25	300	1.0	—	—	75	175	20		

[1] Measured at Ic = 2mA

[2] Measured at Ic = 80mA

TM Trademark of General Electric Company

COMPLEMENTARY—1 AMPERE



POWER TAB

TYPICAL APPLICATIONS

- Amplifier Output and Driver Stages
- Regulators Series, Shunt, and Switching
- Inverters/Converters

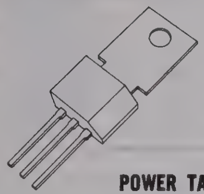
FEATURES

- High Free Air Dissipation (1.33 Watts @ 50°C)
- Low Collector Saturation Voltage (0.5V Typ. @ 1.0A)
- Excellent Linearity
- Fast Switching
- TO-5 Compatible
- Typical f_T, 150 MHz

SPECIFICATION SHEETS
D40D1-11—PAGE NO. 1233
D41D1-11—PAGE NO. 1243

GE Type NPN	GE Type PNP	P_T T_C = 25°C Max. (W)	V_{CEO} Min. (V)	I_C Cont. (A)	h_{FE} @ 2V, 100mA Min.	h_{FE} @ 2V, 100mA Max.	h_{FE} @ 2V, 1A Min.	Package Type
D40D1	—	6.25	30	1.0	50	150	10	BROWN Power Tab
—	D41D1	6.25	—30	—1.0	50	150	10	BLACK Power Tab
D40D2	—	6.25	30	1.0	120	360	20	BROWN Power Tab
—	D41D2	6.25	—30	—1.0	120	360	20	BLACK Power Tab
D40D4	—	6.25	45	1.0	50	150	10	BROWN Power Tab
—	D41D4	6.25	—45	—1.0	50	150	10	BLACK Power Tab
D40D5	—	6.25	45	1.0	120	360	10	BROWN Power Tab
—	D41D5	6.25	—45	—1.0	120	360	10	BLACK Power Tab
D40D7	—	6.25	60	1.0	50	150	10	BROWN Power Tab
—	D41D7	6.25	—60	—1.0	50	150	10	BLACK Power Tab
D40D8	—	6.25	60	1.0	120	360	10	BROWN Power Tab
—	D41D8	6.25	—60	—1.0	120	360	10	BLACK Power Tab
D40D10	—	6.25	75	1.0	50	150	10	BROWN Power Tab
—	D41D10	6.25	—75	—1.0	50	150	10	BLACK Power Tab
D40D11	—	6.25	75	1.0	120	360	10	BROWN Power Tab
—	D41D11	6.25	—75	—1.0	120	360	10	BLACK Power Tab

COMPLEMENTARY—3 AMPERE



POWER TAB

TYPICAL APPLICATIONS

- Amplifier Output and Driver Stages
- Regulators; Series, Shunt, and Switching
- Inverters/Converters

FEATURES

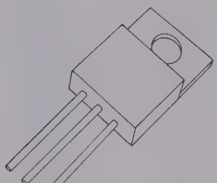
- High Free Air Dissipation (2.1 Watts @ 25°C)
- Very Low Collector Saturation Voltage (0.5V Typ. @ 3.0A I_C)
- Excellent Linearity
- Fast Switching
- TO-5 or TO-66 Compatible
- Typical f_T, 50 MHz

SPECIFICATION SHEETS
D42C1-11—PAGE NO. 1247
D43C1-11—PAGE NO. 1251

GE Type NPN	GE Type PNP	P_T T_C = 25°C Max. (W)	V_{CEO} Min. (V)	I_C Cont. (A)	h_{FE} @ 1V, 200mA Min.	h_{FE} @ 1V, 200mA Max.	h_{FE} @ 1V, 1A Min.	Package Type
D42C1	—	12.5	30	3.0	25	—	10	RED Power Tab
—	D43C1	12.5	—30	—3.0	25	—	10	GREEN Power Tab
D42C2	—	12.5	30	3.0	40	120	20	RED Power Tab
—	D43C2	12.5	—30	—3.0	40	120	20	GREEN Power Tab
D42C3	—	12.5	30	3.0	40	—	20[1]	RED Power Tab
—	D43C3	12.5	—30	—3.0	40	—	20[1]	GREEN Power Tab
D42C4	—	12.5	45	3.0	25	—	10	RED Power Tab
—	D43C4	12.5	—45	—3.0	25	—	10	GREEN Power Tab
D42C5	—	12.5	45	3.0	40	120	20	RED Power Tab
—	D43C5	12.5	—45	—3.0	40	120	20	GREEN Power Tab
D42C6	—	12.5	45	3.0	40	—	20[1]	RED Power Tab
—	D43C6	12.5	—45	—3.0	40	—	20[1]	GREEN Power Tab
D42C7	—	12.5	60	3.0	25	—	10	RED Power Tab
—	D43C7	12.5	—60	—3.0	25	—	10	GREEN Power Tab
D42C8	—	12.5	60	3.0	40	120	20	RED Power Tab
—	D43C8	12.5	—60	—3.0	40	120	20	GREEN Power Tab
D42C9	—	12.5	60	3.0	40	—	20[1]	RED Power Tab
—	D43C9	12.5	—60	—3.0	40	—	20[1]	GREEN Power Tab
D42C10	—	12.5	80	3.0	25	—	10	RED Power Tab
—	D43C10	12.5	—80	—3.0	25	—	10	GREEN Power Tab
D42C11	—	12.5	80	3.0	40	120	20	RED Power Tab
—	D43C11	12.5	—80	—3.0	40	120	20	GREEN Power Tab

[1] h_{FE} measured at I_C = 2A.

COMPLEMENTARY—4 AMPERE



POWER PAC

TYPICAL APPLICATIONS

- Amplifier Outputs
- Regulators; Series, Shunt, and Switching
- Inverters/Converters

FEATURES

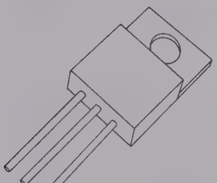
- Low Collector Saturation Voltage (0.5V Typ. @ 3.0A I_C)
- Excellent Linearity
- Fast Switching
- Round Leads
- TO-66 Compatible
- Typical f_T, 50 MHz

SPECIFICATION SHEETS
D44C1-11—PAGE NO. 1255
D45C1-11—PAGE NO. 1265

GE Type		P_T $T_C = 25°C$ Max. (W)	V_{CEO} Min. (V)	I_C Cont. (A)	h_{FE} @ 1V, 200mA		h_{FE} @ 1V, 1A	Package Type
NPN	PNP				Min.	Max.	Min.	
D44C1	—	30	30	4.0	25	—	10	RED Power Pa
—	D45C1	30	−30	−4.0	25	—	10	GREEN Power Pa
D44C2	—	30	30	4.0	40	120	20	RED Power Pa
—	D45C2	30	−30	−4.0	40	120	20	GREEN Power Pa
D44C3	—	30	30	4.0	40	—	20 [1]	RED Power Pa
—	D45C3	30	−30	−4.0	40	—	20 [1]	GREEN Power Pa
D44C4	—	30	45	4.0	25	—	10	RED Power Pa
—	D45C4	30	−45	−4.0	25	—	10	GREEN Power Pa
D44C5	—	30	45	4.0	40	120	20	RED Power Pa
—	D45C5	30	−45	−4.0	40	120	20	GREEN Power Pa
D44C6	—	30	45	4.0	40	—	20 [1]	RED Power Pa
—	D45C6	30	−45	−4.0	40	—	20 [1]	GREEN Power Pa
D44C7	—	30	60	4.0	25	—	10	RED Power Pa
—	D45C7	30	−60	−4.0	25	—	10	GREEN Power Pa
D44C8	—	30	60	4.0	40	120	20	RED Power Pa
—	D45C8	30	−60	−4.0	40	120	20	GREEN Power Pa
D44C9	—	30	60	4.0	40	—	20	RED Power Pa
—	D45C9	30	−60	−4.0	40	—	20	GREEN Power Pa
D44C10	—	30	80	4.0	25	—	10	RED Power Pa
—	D45C10	30	−80	−4.0	25	—	10	GREEN Power Pa
D44C11	—	30	80	4.0	40	120	20	RED Power Pa
—	D45C11	30	−80	−4.0	40	120	20	GREEN Power Pa

[1] h_{FE} measured at $I_C = 2A$.

COMPLEMENTARY—10 AMPERE



POWER PAC

TYPICAL APPLICATIONS

- Amplifier Outputs
- Regulators; Series, Shunt and Switching
- Inverters/Converters

FEATURES

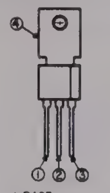
- Low Collector Saturation Voltage (0.24V Typ. @ 3.0A I_C
- Excellent Linearity
- Fast Switching
- Round Leads
- TO-66 Compatible
- Typical f_T, 50 MHz

SPECIFICATION SHEETS
D44H1-11—PAGE NO. 1259
D45H1-11—PAGE NO. 1269

GE Type		P_T $T_C = 25°C$ Max. (W)	V_{CEO} Min. (V)	I_C Cont. (A)	h_{FE} @ 1V, 2A Min.	h_{FE} @ 1V, 4A Min.	Package Type
NPN	PNP						
D44H1	—	50	30	10	35	20	RED Power Ta
—	D45H1	50	−30	−10	35	20	GREEN Power Ta
D44H2	—	50	30	10	60	40	RED Power Ta
—	D45H2	50	−30	−10	60	40	GREEN Power Ta
D44H4	—	50	45	10	35	20	RED Power Ta
—	D45H4	50	−45	−10	35	20	GREEN Power Ta
D44H5	—	50	45	10	60	40	RED Power Ta
—	D45H5	50	−45	−10	60	40	GREEN Power Ta
D44H7	—	50	60	10	35	20	RED Power Ta
—	D45H7	50	−60	−10	35	20	GREEN Power Ta
D44H8	—	50	60	10	60	40	RED Power Ta
—	D45H8	50	−60	−10	60	40	GREEN Power Ta
D44H10	—	50	80	10	35	20	RED Power Ta
—	D45H10	50	−80	−10	35	20	GREEN Power Ta
D44H11	—	50	80	10	60	40	RED Power Ta
—	D45H11	50	−80	−10	60	40	GREEN Power Ta

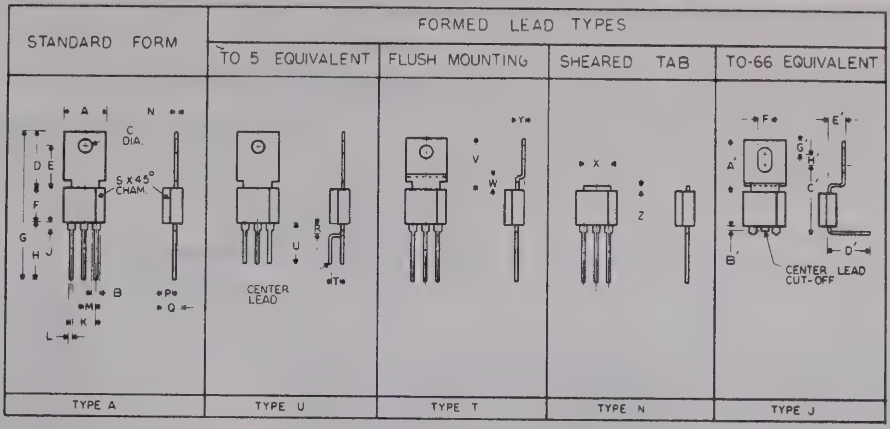
POWER TAB LEAD CONFIGURATIONS

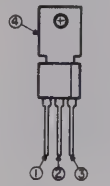
SUFFIX (A, U, T, N, J) DESIGNATES CONFIGURATION



1. BASE
2. COLLECTOR
3. EMITTER
4. MOUNTING TAB (ELECTRICALLY COMMON TO COLLECTOR)

COLOR: RED/GREEN
DEVICES: D42C, D43C


STANDARD FORM
FORMED LEAD TYPES
TO 5 EQUIVALENT
FLUSH MOUNTING
SHEARED TAB
TO-66 EQUIVALENT
A
N
C DIA.
D
E
S X 45° CHAM.
F
G
H
J
B
M
K
L
P
Q
CENTER LEAD
R
U
T
Y
V
W
X
Z
F'
E'
G'
H'
A'
C'
B'
D'
CENTER LEAD CUT-OFF
TYPE A
TYPE U
TYPE T
TYPE N
TYPE J



1. EMITTER
2. BASE
3. COLLECTOR
4. MOUNTING TAB (ELECTRICALLY COMMON TO COLLECTOR)

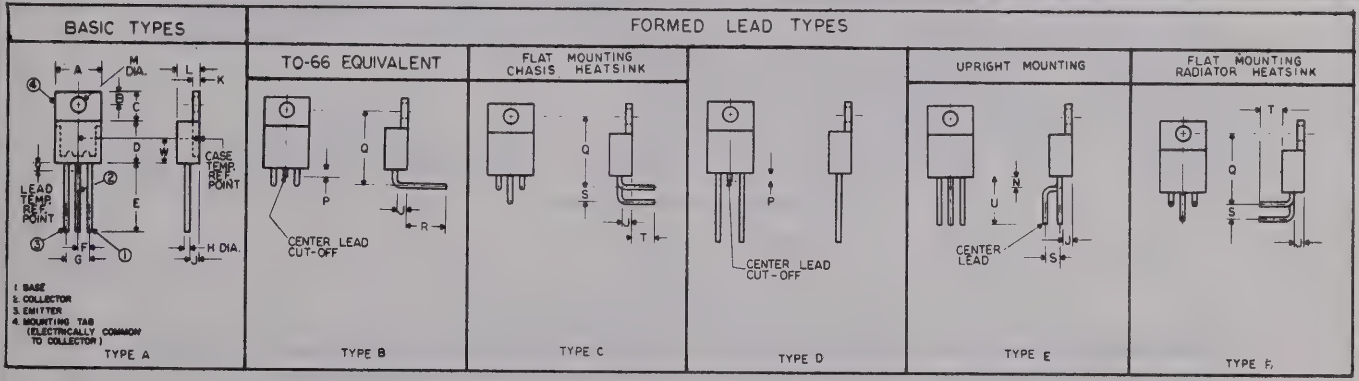
COLOR: BROWN/BLACK
DEVICES: D40C, D40D, D40N, D40P, D41D

SYM.	DEC. IN.		METRIC MM		SYM.	DEC. IN.		METRIC MM	
	MIN.	MAX.	MIN.	MAX.		MIN.	MAX.	MIN.	MAX.
A	.360	.400	9.144	10.160	S	.065	.075	1.651	1.905
B	.047	.053	1.194	1.346	T	.070	.090	1.778	2.286
C	.123	.127	3.124	3.226	U	.300	.365	7.620	9.271
D	.480	.520	12.192	13.208	V	.465 REF.		11.811 REF.	
E	.365	.385	9.271	9.779	W	.105	.135	2.667	3.429
F	.285	.315	7.239	8.001	X	.250 REF.		6.350 REF.	
G	1.207 REF.		30.658 REF.		Y	.080 REF.		2.032 REF.	
H	.395	.420	10.033	10.668	Z	.030	.050	.762	1.270
J	.045	.065	1.143	1.651	A'	.425 REF.		10.795 REF.	
K	.190	.210	4.826	5.334	B'	.030	.050	.762	1.270
L	.024	.028	.610	.711	C'	.580	.590	14.732	14.986
M	.095	.105	2.413	2.667	D'	.370 REF.		9.398 REF.	
N	.019	.026	.483	.660	E'	.110	.130	2.794	3.302
P	.095	.105	2.413	2.667	F'	.120	.135	3.048	3.429
Q	.170	.190	4.318	4.826	G'	.115	.135	2.921	3.429
R	.070	.090	1.778	2.286	H'	.085	.095	2.159	2.413

NOTE: TYPE J NOT APPLICABLE TO DEVICES WITH EBC LEAD CONFIGURATION.

POWER PAC LEAD CONFIGURATIONS

SUFFIX (A, B, C, D, E, F) DESIGNATES CONFIGURATION


BASIC TYPES
FORMED LEAD TYPES
TO-66 EQUIVALENT
FLAT MOUNTING CHASIS HEATSINK
UPRIGHT MOUNTING
FLAT MOUNTING RADIATOR HEATSINK
A
M DIA.
L
K
B
C
D
W
E
CASE TEMP. REF. POINT
LEAD TEMP. REF. POINT
F
G
J
H DIA.
①②③④
1. BASE
2. COLLECTOR
3. EMITTER
4. MOUNTING TAB (ELECTRICALLY COMMON TO COLLECTOR)
Q
P
R
S
T
U
N
CENTER LEAD CUT-OFF
CENTER LEAD
TYPE A
TYPE B
TYPE C
TYPE D
TYPE E
TYPE F

SYM.	DEC. IN.		METRIC MM		SYM.	DEC. IN.		METRIC MM	
	MIN.	MAX.	MIN.	MAX.		MIN.	MAX.	MIN.	MAX.
A	.390	.420	9.906	10.668	L	.160	.190	4.064	4.826
B	.110	.120	2.794	3.048	M	.141	.145	3.581	3.683
C	.240	.260	6.096	6.604	N	.065	.095	1.651	2.413
D	.325	.355	8.255	9.017	P	.035	.065	.889	1.651
E	.500	——	12.700	——	Q	.570	.590	14.478	14.986
F	.095	.105	2.413	2.667	R	.360	——	9.144	——
G	.190	.210	4.826	5.334	S	.120	.130	3.048	3.302
H	.029	.035	.737	.889	T	.172	.202	4.369	5.131
J	.085	.115	2.159	2.921	U	.353	.433	8.966	10.998
K	.040	.060	1.016	1.524	V	——	.065	——	1.651
					W	——	.220	——	5.588

SIGNAL DIODES

APPLICATIONS

0–100 MA	100–200 MA	200–500 MA
Low Level Limiters Computer Logic	Core Driver	Hammer Drive & Core Driver

TYPES

Recommended stocking items in bold

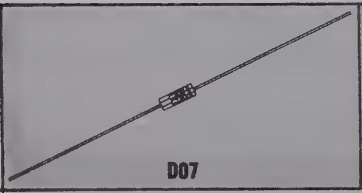
BREAKDOWN VOLTAGE BV (V) \ FORWARD CURRENT I_F (MA)	0–25	25–50	50–100	100–200	200–500
125–250					**DT230H** DT230B DT230G
100–125	1N914 1N914A 1N914B 1N916 1N916A 1N916B	**1N4148** **1N4446** 1N4448 1N4149 1N4447 **1N4449** 1N4864 **DA1701**	1N4531		**DT230A**
75–100	1N3062 1N3063 1N3064 1N3065 1N3066 1N3604 1N3606	1N4305 **1N4454** 1N4151 **1N4153** **DA1702**	1N4532 1N4534 MA1702	1N4606	
50–75	1N626 1N3069 1N3873 1N4087	1N4444 1N4863		1N4150	1N4607 1N4608
25–50	1N251 1N252 1N461 1N625 1N814 1N903, A 1N904 1N3067 1N3605	1N4727 **DA1703** **DA1704** DZ800 DZ805 DZ807 **1N4152**	MA1703 MA1704 1N4533	1N4450	1N4151
0–25	1N4009 SS321 SS334 SE708	**1N4154**	1N4536		

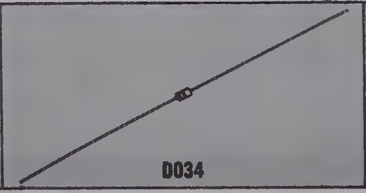
SEE INDEX FOR PAGE NUMBER OF SPECIFICATION SHEET.

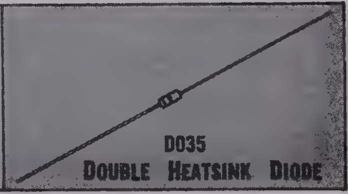
FEATURES

0–100 MA	100–500 MA
Silicon Planar Epitaxial Passivated	Silicon Planar Epitaxial Passivated
Controlled Conductance	Controlled Conductance
Ultra Fast Switching Speed (under 4 nanosec for gold doped)	Nanosec Switching Speed (under 50 nanosec for gold doped)
High Voltage-Low Capacitance Nano Amp Leakage	Moderate Capacitance Low Leakage

PACKAGES

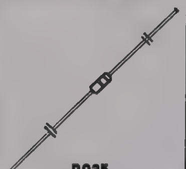

DO7


DO34


DO35
DOUBLE HEATSINK DIODE

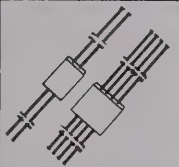
SPECIAL SIGNAL DIODES

MULTIPELLET TYPES

	BV @ 5μA (V)	I_R @ 25°C Max.		V_F Max.		C_O @ 0V Max. (pf)	t_{rr} (nsec)
D035		(nA)	@ V_R(V)	(V)	@ I_F(mA)		
1N4156	30	50	20	1.58	10	25	—
1N4157	30	50	20	2.32	10	20	—
1N4453	30	50	20	.800	10	30	—
1N4828	30	100	20	.830	10	35	—
1N4829	30 [1]	100	20	1.61	10	25	—
1N4830	30 [1]	100	20	2.35	10	20	—
1N5179	30	50	20	3.20	10	20	—
MPD200	30	30	30	1.54	10	20	—
MPD300	60	30	30	2.33	10	15	—
MPD400	90	30	30	3.07	10	10	—
STB567	12	5000	12	1.61	10	—	—
STB568	12	5000	12	2.31	10	—	—
STB569	12	5000	12	3.01	10	—	—

[1] Measured @ 100μA.

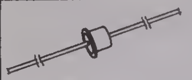
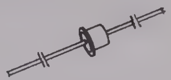
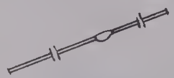
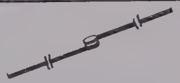
MATCHED PAIRS AND QUADS

	BV @ 5μA (V)	I_R @25°C Max.		V_F Max.	C_O @ 0V Max. (pf)	t_{rr} (nsec)
		(nA)	@ V_R(V)	(V)		
1N4306	75	50	50	10mV Match	2	2
MP-2	40	100	30	10mV Match	2	2
1N4307	75	50	50	10mV Match	2	2
MQ-2	40	100	30	10mV Match	2	2

SEE INDEX FOR PAGE NUMBER OF SPECIFICATION SHEET.

TUNNEL DIODES

PACKAGES

APPLICATIONS

UHF Oscillator Level Detector Peak Sensing Frequency Divider Converter High Speed Logic Sampling Circuits	Detectors Mixers Limiters Compressors Power Monitors	Fast rise time pulse generators Amplitude Discriminator Sampling Circuits Fast threshold detectors Ultra High Speed Logic Level Sensing	Oscillators through X band at low functional cost Mixers Modulated oscillators Pulse code modulators & demodulators	Amplifiers and self oscillating mixers through X band Phase array radar Frequency converters Low level digital phase shifters Pulse position modulators	Doppler mixers Detectors Limiters Compressors

TYPES AVAILABLE

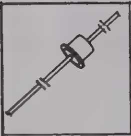
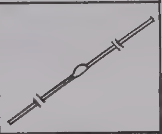
FREQUENCY IN GHz (F_{RO})						
65					**TD400** **Tunnel Diodes** **Microwave**	**BD400** **Back Diodes** **Microwave**
40				**TD270** **Tunnel Diodes** **Low Inductance** **Oscillator**		
20			**TD250/260** **Tunnel Diodes** **Ultra High Speed** **Switch**			
3.4 DC	**1N3712** **Tunnel Diodes** **General Purpose**	**BDI** **Back Diodes** **General Purpose**				

FEATURES

● Low Cost ● Hermetically Sealed ● Electrically & Mechanically Rugged ● Available in subminiature packages—TD 200 Series ● Mil. Versions Available	● Low Cost ● Hermetically Sealed ● Electrically & Mechanically Rugged	● Very fast switching. ● Very stable at elevated operating temperatures. ● Low functional cost. ● TD260 Series has same electrical specs, features, and applications as TD250 except TD260 has 100°C operating capability.	● Package inductance of .15 mh typ. temperatures ● Very fast switching ● Stable at elevated operating temperatures ● Low functional cost ● TD270 Series is the TD250 in the Pill Package which results in a .15 mmh typical inductance and a F_{xo} up to 40 GHZ.	● Controlled negative conductance ● Controlled cutoff frequencies ● Low noise ● Low package inductance ● Stable at elevated operating temperatures	● Low capacitance ● Low inductance ● Low "on" voltage ● Very high frequency capability ● Low I/F noise ratio

TUNNEL DIODES
GENERAL PURPOSE

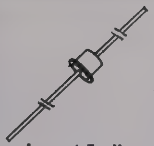
See page 259, 1534 for specifications

 +100°C Operation TD-1	 +100°C Subminiature Package TD-200	I_P Peak Point Current (mA)	I_V Valley Point Current Max. (mA)	C Capacitance Max. (pF)	V_P Peak Point Voltage Typ. (mV)	V_V Valley Voltage Typ. (mV)	V_{FP} Forward Peak Voltage Typ. (mV)	R_S Series Resist. Max. (Ohms)	—G Negative Conductance (mhos × 10^{-3})	f_{RO} Resistive Cutoff Frequency Typical (GHz)
1N3712	TD-201	1.0 ± 10%	0.18	10	65	350	500	4.0	8 Typ.	2.3
1N3713 [1]	TD-201A	1.0 ± 2.5%	0.14	5	65	350	510	4.0	8.5 ± 1	3.2
1N3714	TD-202	2.2 ± 10%	0.48	25	65	350	500	3.0	18 Typ.	2.2
1N3715 [1]	TD-202A	2.2 ± 2.5%	0.31	10	65	350	510	3.0	19 ± 3	3.0
1N3716	TD-203	4.7 ± 10%	1.04	50	65	350	500	2.0	40 Typ.	1.8
1N3717 [1]	TD-203A	4.7 ± 2.5%	0.60	25	65	350	510	2.0	41 ± 5	3.4
1N3718	TD-204	10.0 ± 10%	2.20	90	65	350	500	1.5	80 Typ.	1.6
1N3719 [1]	TD-204A	10.0 ± 2.5%	1.40	50	65	350	510	1.5	85 ± 10	2.8
1N3720	TD-205	22.0 ± 10%	4.80	150	65	350	500	1.0	180 Typ.	1.6
1N3721 [1]	TD-205A	22.0 ± 2.5%	3.10	100	65	350	510	1.0	190 ± 30	2.6
TD-9	TD-206	0.5 ± 10%	0.10	5	60	—	—	6.0	4.0 Typ.	1.3

[1] Mil. Versions Available.

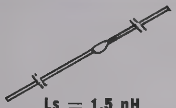
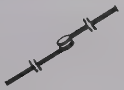
BACK DIODES
GENERAL PURPOSE

See page 879 for specifications

 Ls = 1.5 nH	I_P Peak Point Current Max. (mA)	C Total Capacitance Max. (pF)	Reverse Voltage Min.		I_{F1} Forward Current @ $V_{F1} = 90 \pm 10$ mV (mA)	V_{F2} Forward Voltage @ $I_{F2} = 3\ I_{F1}$ Typical (mV)	t_r Rise Time Typical (psec.)
GE Type			V_{R1} @ $I_R = I_P$ max (mV)	V_{R2} @ 1 mA (mV)			
BD-1	1.0	20	440	440	10.0	120	1.0
BD-2	0.5	10	420	465	5.0	130	0.7
BD-3	0.2	10	400	465	2.0	170	0.5
BD-4	0.1	10	380	465	1.0	170	0.4
BD-5	0.05	10	350	465	0.5	160	0.4
BD-6	0.02	10	330	465	0.2	160	0.4
BD-7	0.01	10	300	465	0.1	160	0.4

TUNNEL DIODES
ULTRA HIGH SPEED SWITCHING

See page 1535 for specifications

 Ls = 1.5 nH		 Ls = .15 nh								
+ 75°C Operation TD-250 (1)	**+ 100°C Operation TD-260 (1)**	**+ 100°C Low Inductance TD-270**	I_P Peak Point (mA) Current	I_V Valley Point Current Max. (mA)	C Capacitance Max. (pF)	V_P Peak Point Voltage Typical (mV)	V_V Valley Voltage Typical (mV)	V_{FP} Forward Voltage @ $I_F = I_P$ Typ. (mV)	R_S Series Resist. Typical (Ω)	t_r Rise Time Typical (psec.)
TD-251	**TD-261**	**TD-271**	2.2 ± 10%	0.31	3.0	70	390	500-700	5.0	430
TD-251A	**TD-261A**	**TD-271A**	2.2 ± 10%	0.31	1.0	80	390	500-700	7.0	160
TD-252	**TD-262**	**TD-272**	4.7 ± 10%	0.60	6.0	80	390	500-700	3.5	320
TD-252A	**TD-262A**	**TD-272A**	4.7 ± 10%	0.60	1.0	90	400	500-700	4.0	74
TD-253	**TD-263**	**TD-273**	10.0 ± 10%	1.40	9.0	75	400	500-700	1.7	350
TD-253A	**TD-263A**	**TD-273A**	10.0 ± 10%	1.40	5.0	80	410	520-700	2.0	190
TD-253B	**TD-263B**	**TD-273B**	10.0 ± 10%	1.40	2.0	90	420	550-700	2.5	68
TD-254	**TD-264**	**TD-274**	22.0 ± 10%	3.80	18.0	90	425	600 Typ.	1.8	185
TD-254A	**TD-264A**	**TD-274A**	22.0 ± 10%	3.80	4.0	100	425	550-700	2.0	64
TD-255	**TD-265**	**TD-275**	50.0 ± 10%	8.50	25.0	110	425	625 Typ.	1.4	100
TD-255A	**TD-265A**	**TD-275A**	50.0 ± 10%	8.50	5.0	130	425	640 Typ.	1.5	35
TD-256	**TD-266**	**TD-276**	100 ± 10%	17.50	35.0	150	450	650 Typ.	1.1	57
TD-256A	**TD-266A**	**TD-276A**	100 ± 10%	17.50	6.0	180	450	660 Typ.	1.2	22

BACK DIODES
MICROWAVE

Ls = 0.1 nH	I_P Peak Point Current Max. (mA)	C Total Capacitance Max. (pF)	Reverse Voltage Min.		I_{F1} Forward Current @ $V_{F1} = 90 \pm 10$ mV (mA)	V_{F2} Forward Voltage Typical @ $I_{F2} = 3\ I_{F1}$ (mV)
GE Type			V_{R1} @ $I_R = I_P$ max (mV)	V_{R2} @ $I_R = 1$ mA (mV)		
BD-402	0.5	3	420	465	5.0	138
BD-403	0.2	1	400	465	2.0	170
BD-404	0.1	1	380	465	1.0	170
BD-405	0.05	1	350	465	0.5	160
BD-406	0.02	1	330	465	0.2	160
BD-407	0.01	1	330	465	0.1	160

TUNNEL DIODES
MICROWAVE

Ls = .15 nH

Type[1]	I_P Peak Current Typ. (mA)	V_P Peak Voltage Typ. (mV)	V_V Valley Voltage Typ. (mV)	V_{FP} Forward Peak Voltage Typ. (mV)	(I_P/I_V) Peak to Valley Ratio Typ.	—R Negative Resistance (Ω)	R_S Series Resistance Max. (Ω)	C_J Junction Capacitance @ —R[1] Typ. (pF)	f_{RO} Resistive Cutoff Freq. Min. (GHz)
TD-401	1.85	65	350	520	8	60-80	3	2.0	5
TD-402	1.85	67	360	540	8	60-80	4	1.0	10
TD-403	1.85	70	380	550	8	60-80	5	0.65	15
TD-404	1.85	72	380	560	8	60-80	5	0.46	20
TD-405	1.85	74	390	570	8	60-80	6	0.36	25
TD-406	1.85	75	390	570	8	60-80	6	0.25	30
TD-407	1.85	76	400	580	8	60-80	6	0.18	40
TD-408	1.85	77	400	580	8	60-80	7	0.13	50
TD-409	1.85	78	400	580	8	60-80	8	0.09	65
TD-411	2.35	65	350	520	8	50-60	3	2.3	5
TD-412	2.35	67	360	540	8	50-60	4	1.2	10
TD-413	2.35	70	380	550	8	50-60	5	0.75	15
TD-414	2.35	72	380	560	8	50-60	5	0.53	20
TD-415	2.35	74	390	570	8	50-60	6	0.41	25
TD-416	2.35	75	390	570	8	50-60	6	0.30	30
TD-417	2.35	76	400	580	8	50-60	6	0.22	40
TD-418	2.35	77	400	580	8	50-60	7	0.15	50
TD-419	2.35	78	400	580	8	50-60	8	0.11	65
TD-421	2.85	65	350	520	8	40-50	3	2.6	5
TD-422	2.85	67	360	540	8	40-50	4	1.3	10
TD-423	2.85	70	380	550	8	40-50	5	0.84	15
TD-424	2.85	72	380	560	8	40-50	5	0.58	20
TD-425	2.85	74	390	570	8	40-50	6	0.46	25
TD-426	2.85	75	390	570	8	40-50	6	0.34	30
TD-427	2.85	76	400	580	8	40-50	6	0.24	40
TD-428	2.85	77	400	580	8	40-50	7	0.16	50
TD-429	2.85	78	400	580	8	40-50	8	0.12	65
TD-431	3.7	65	350	520	8	30-40	3	0.32	5
TD-432	3.7	67	360	540	8	30-40	4	1.6	10
TD-433	3.7	70	380	550	8	30-40	4	1.0	15
TD-434	3.7	72	380	560	8	30-40	5	0.70	20
TD-435	3.7	74	390	570	8	30-40	5	0.55	25
TD-436	3.7	75	390	570	8	30-40	5	0.38	30
TD-437	3.7	76	400	580	8	30-40	6	0.27	40
TD-438	3.7	77	400	580	8	30-40	6	0.18	50
TD-439	3.7	78	400	580	8	30-40	7	0.13	65

[1] C_J @ —R = 0.75 of the junction capacitance measured at V_V.

PUBLICATIONS AVAILABLE

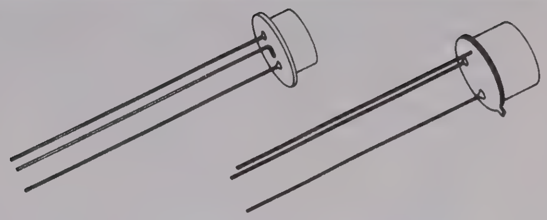
Application Notes

90.32 Tunnel Diodes as Amplifiers & Switches
90.42 Tunnel Diode UHF-TV Tuner
90.43 A Tunnel Diode R.F. Radiation Detector
90.44 Practical Tunnel Diode Converter Circuit Considerations
90.45 Tunnel Diode Sinewave Oscillators
90.66 Application for the Low Cost 1N3712 Series Tunnel Diodes

Specifications

1N3712-3721 General Purpose Tunnel Diodes .... Page 259
TD-9 General Purpose Tunnel Diodes .... Page 1534
TD251-256, 251A-256A, 253B Ultra High Speed
Switching Tunnel Diodes .... Page 1535
TD261/270 Ultra High Speed Switching Tunnel Diodes .... Page 1537
1N4090 Mixer Tunnel Diode .... Page 279
BD1-7 General Purpose Back Diodes .... Page 879

GERMANIUM SIGNAL TRANSISTORS



	GE Type	h_{FE} @ 1V, 20mA	f_{hfb} Typical (MHz)	BV_{CER} Min. @ 600μA 10KΩ (V)	I_{CBO} Max. @ V_{CB} (μA)	I_{CBO} Max. @ V_{CB} (V)	P_T Max. (mW)	Comments	Specification Sheet No.
PNP Alloy	2N43A [1]	34-65	1.3	30	16	45	240	See 2N525.	*
	2N44A [1]	18-43	1.0	30	16	45	240	See 2N524.	*
	2N188A	34-65	1.2	25	16	25	200	See 2N508, 2N1175 and 2N1413 series.	*
	2N241A	50-125	1.3	25	16	25	200	Audio driver and audio output.	*
	2N319	25-42	2.0	20	16	25	225		*
	2N320	34-65	2.5	20	16	25	225		*
	2N321	53-121	3.0	20	16	25	225		*
	2N322	34-65	3.0	18	16	16	200		*
	2N323	53-121	3.5	18	16	16	200		*
	2N324	72-198	4.0	18	16	16	200		*
	2N396	30-150 [2]	8.0	20	6	20	200	Industrial/Military-medium beta, medium speed switch.	*
	2N396A [1]	30-150 [2]	8.0	20 [4]	6	20	200	Same as 2N396.	*
	2N397	40-150 [2]	12.0	15	6	15	200	Industrial/Military-medium speed switch.	*
	2N404	—	8.0	24 [5]	5	12	150	Medium speed switch—wide beta spread.	401
	2N404A	—	8.0	35 [5]	5	12	150	Same as 2N404.	401
	2N413	20-100 [2]	6.0	18 [4]	5	12	150	General purpose medium speed switch.	*
	2N414	30-120 [2]	7.0	15 [4]	5	12	150	Same as 2N413.	*
	2N461	32-199 [3]	4.0	35	15	45	200	General purpose—2N525 recommended.	*
	2N508	100-200	4.5	18	7	16	200	High gain, low noise preamplifiers.	413
	2N508A	100-200	4.5	25	7	25	200		413
	2N524	25-42	2.5	30	10	30	225	Military/industrial—Audio amplifiers and medium speed switch. Specified h_{FE} hold-up, high temperature I_{CO}, and low temperature h_{FE}. Guaranteed reliability index.	417
	2N525	34-65	3.0	30	10	30	225		417
	2N526 [1]	53-90	3.5	30	10	30	225		417
	2N527	72-121	4.0	30	10	30	225		417
	2N1175	70-140	4.0	25	12	30	200	General purpose industrial and consumers preamplifier.	434
	2N1175A	70-140	4.0	25	12	30	200	General purpose industrial and consumer, high gain, low noise preamplifiers. Guaranteed noise figure.	434
	2N1303 [1]	20 Min.[2]	7.0	25 [5]	6	25	150	Medium speed switch.	436
	2N1305 [1]	40-200 [2]	8.0	20 [5]	6	25	150		436
	2N1307 [1]	60-300 [2]	12.0	15 [5]	6	25	150		436
	2N1413	25-42	3.2	25	12	30	200	General purpose industrial and consumer audio amplifier and medium speed switch.	442
	2N1414	34-65	3.6	25	12	30	200		442
	2N1415	53-90	4.0	25	12	30	200		442
	2N1924	34-65	3.0	40	10	45	225	Military/industrial audio amplifier and medium speed switch. High voltage, specified h_{FE} hold-up, low temperature h_{FE}, and high temperature I_{CO}. Guaranteed reliability index.	458
	2N1925	53-90	3.5	40	10	45	225		458
	2N1926	72-121	4.0	40	10	45	225		458

[1] Also available as military types.

[2] $V_{CE} = 1V$, $I_C = 10mA$.

[3] $V_{CB} = 5V$, $I_E = 1mA$, $f = 1$ KHz

[4] BV_{CEO}.

[5] V_{RT}

[6] $V_{RT} = 60V$

* CONTACT FACTORY

UNIJUNCTIONS, TRIGGERS AND SWITCHES

Since the introduction of the commercial silicon unijunction transistor in 1956, General Electric has continued developing an extensive line of negative resistance threshold and four-layer switch devices. Each of these devices can be used as a power thyristor trigger, and each offers a special advantage for a particular trigger function. In addition, each can be used for various non-trigger applications.

The features—both in design and characteristics—which you receive with these products are concisely defined for each series:

TYPES

CONVENTIONAL UNIJUNCTIONS 2N489-494—proved reliability, MIL spec version.
2N2646-47—low cost, proved hermetic sealed device.

PROGRAMMABLE UNIJUNCTION TRANSISTOR (PUT)—variable threshold, low cost, fast switching speed, and circuit adjustable electrical characteristics.

COMPLEMENTARY UNIJUNCTION TRANSISTOR—ultimate in temperature stability for timing and oscillator applications.

SILICON ASYMMETRICAL SWITCH (SAS)— asymmetrical voltage threshold, gate triggered

SILICON UNILATERAL SWITCH (SUS)—a stable fixed low voltage threshold, low cost, high performance "4-layer diode."

SILICON BILATERAL SWITCH (SBS)—low voltage triac trigger, two silicon unilateral switches connected back to back.

SILICON CONTROLLED SWITCH (SCS)—high triggering sensitivity, 4-lead capability for multiple loads or dv/dt suppression.

APPLICATIONS

	Device	Unijunctions				Triggers		
		Conventional		Complementary	Programmable			
	Use	2N489-94, 2N2417-22 2N1671, 2N2160	2N2646 2N2647	D5K1 D5K2	2N6027 2N6028	SUS 2N4983-90	SBS 2N4991-93	SAS D13H
Trigger for SCR's	DC, Lo Cost	P	F	P	E	E	E	E
	DC, Hi Perf.	F	F	F	E	F	F	F
	DC, Volt Regulator	P	P	F	F	E	E	E
	DC, Inverter	F	F	E	E	F	F	F
	DC, Hi $\Delta I/\Delta T$	P	P	P	E[1]	P	P	P
	AC, ϕ, Hi Perf.	F	F	E	E[1]	F	F	F
	AC, ϕ, Hi f	F	F	F	E	P	P	P
	AC, Lo RFI	P	P	F	F	E	E	E
	AC, ϕ, Lo Cost	P	F	P	E	E	E	E
Timers	>1 hr.	F[1]	P	F[1]	E[1]	N	N	N
	>1 min, Lo Cost	P	F	P	E	N	N	N
	>1 min, Stable	F	P	E	P	N	N	N
	<1 min, Lo Cost	P	F	P	E	F	F	F
	<1 min, Stable	F	P	E	P	F	N	N
	<10V	P	P	F	E	N	N	N
	10V-25V	E	E	E	E	F	F	F
	>25V	P	P	P	E	F	F	F
Oscillators	Stability	F	F	E	F	N	N	N
	Cost	P	F	P	E	N	N	N
	Adjust, Range	E	E	F	F[1]	N	N	N
Markets	Military	E	P	F	F[2]	P	P	P
	Hi-Rel	E	P	E	F[2]	F	F	P
	Economy	P	F	P	E	E	E	E
Trigger for Triac	SEE TRIAC SELECTOR GUIDE PAGE 153							

E = Excellent, F = Fair, P = Poor, N = Not Applicable
[1] With additional circuitry
[2] Hermetic version 2N6116-18

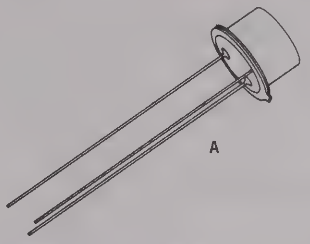
CONVENTIONAL UNIJUNCTIONS

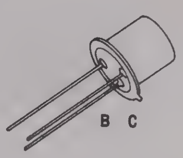
General Electric produces a very broad line of standard UJT's. The TO-5 ceramic disc bar structure device has been the workhorse of the unijunction industry for over 10 years. MIL versions are available on the 2N489-494 series. Equivalent types are available in TO-18 packages where small size is required.

The cube structure TO-18 series offers excellent value for those requiring proved, low cost units.

Applications

Oscillators	**SCR Triggers**
Timers	**Frequency Divider**
Sawtooth Generators	**Stable Voltage Sensing**





	GE Type	R_{BBO} Interbase Resistance @ V_{BB} = 3V I_E = 0 (KΩ)	η Intrinsic Standoff Ratio @ V_{BB} = 10V	I_V Valley Current Min. (mA)	I_P Peak Point Emitter Current Max. (μA)	I_{EO} Emitter Reverse Current		V_{OB_1} Base One Peak Pulse Voltage Min. (V)	Comments	Package	Specification Page No.
						Max. (μA)	T_J=25°C @ V_{B_2E}				
TO-5 Bar Structure	2N489	4.7- 6.8	.51-.62	8	12	2	60	—	"A" versions are guaranteed in recommended circuit to trigger GE SCR's over range T_A = −55°C to 125°C. "B" versions in addition to SCR triggering guarantees lower I_{EO} and I_P for long timing periods with a smaller capacitor.	A	405
	2N489A *				12	2	60	3			
	2N489B				6	0.2	30	3			
	2N490	6.2- 9.1	.51-.62	8	12	2	60	—			405
	2N490A *				12	2	60	3			
	2N490B				6	0.2	30	3			
	2N490C				2	.02	30	3			411
	2N491	4.7- 6.8	.56-.68	8	12	2	60	—		A	405
	2N491A *				12	2	60	3			
	2N491B				6	0.2	30	3			
	2N492	6.2- 9.1	.56-.68	8	12	2	60	—		A	405
	2N492A *				12	2	60	3			
	2N492B				6	0.2	30	3			
	2N492C				2	.02	30	3			411
	2N493	4.7- 6.8	.62-.75	8	12	2	60	—		A	405
	2N493A *				12	2	60	3			
	2N493B				6	0.2	30	3			
	2N494	6.2- 9.1	.62-.75	8	12	2	60	—		A	405
	2N494A *				12	2	60	3			
	2N494B				6	0.2	30	3			
	2N494C				2	.02	30	3			411
	2N1671	4.7- 9.1	.47-.62	8	25	12	30	—	Industrial types.	A	450
	2N1671A				25	12	30	3			
	2N1671B				6	0.2	30	3			
	2N1671C				2	.02	30	3			
	2N2160	4.0-12.0	.47-.80	8	25	12	30	3	General purpose—low cost.	A	463
TO-18 Bar Structure	2N2417	4.7- 6.8	.51-.62	8	12	2	60	—	"A" versions are guaranteed in recommended circuit to trigger GE SCR's over range T_A = −55°C to 125°C. "B" versions in addition to SCR triggering guarantees lower I_{EO} and I_P for long timing periods with a smaller capacitor.	B	405
	2N2417A				12	2	60	3			
	2N2417B				6	0.2	30	3			
	2N2418	6.2- 9.1	.51-.62	8	12	2	60	—		B	405
	2N2418A				12	2	60	3			
	2N2418B				6	0.2	30	3			
	2N2419	4.7- 6.8	.56-.68	8	12	2	60	—		B	405
	2N2419A				12	2	60	3			
	2N2419B				6	0.2	30	3			
	2N2420	6.2- 9.1	.56-.68	8	12	2	60	—		B	405
	2N2420A				12	2	60	3			
	2N2420B				6	0.2	30	3			
	2N2421	4.7- 6.8	.62-.75	8	12	2	60	—		B	405
	2N2421A				12	2	60	3			
	2N2421B				6	0.2	30	3			
	2N2422	6.2- 9.1	.62-.75	8	12	2	60	—		B	405
	2N2422A				12	2	60	3			
	2N2422B				6	0.2	30	3			
	D5G514	4.7- 9.1	.47-.62	8	25	12	30	—	TO-18 versions of 2N1671 industrial series.	B	—
	D5G515				25	12	30	3			
	D5G516				6	0.2	30	3			
	—				2	.02	30	3			
TO-18 Cube Structure	2N2646	4.7- 9.1	.56-.75	4	5	12	30	3	General purpose.	C	477
	2N2647	4.7- 9.1	.68-.82	8	2	0.2	30	6	For long timing periods and triggering high current SCR's.	C	477
	D5E-43	4.7- 9.1	.68-.82	6	2	1	30	5	General purpose.	C	1177
	D5E-44	4.7- 9.1	.68-.82	4	5	12	30	4	General purpose—low cost.	C	1178
	2N2840	4.7- 9.1 [2]	.62 Typical	.2	10	1	30	—	For 1.5 volt applications.	C	491

* JAN & JANTX types available

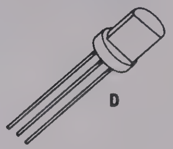
[2] V_{BB}=1.5V

PROGRAMMABLE UNIJUNCTIONS
(PUT—D13T SERIES)

The 2N6028 is specifically characterized for long interval timers and other applications requiring low leakage and low peak point current. The 2N6027 has been characterized for general use where the low peak point current of the 2N6028 is not essential.

Applications:

- SCR Trigger
- Pulse & Timing Circuits
- Oscillators
- Sensing Circuits
- Sweep Circuits



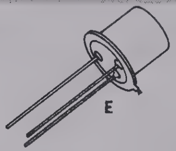
Outstanding Features of the PUT:

- Low Cost
- Low Leakage Current
- Low Peak Point Current
- Low Forward Voltage
- Fast, High Energy Trigger Pulse
- Programmable η
- Programmable R_{BB}
- Programmable I_p
- Programmable I_v
- Planar Passivated Structure

JEDEC Types	Gate to Anode Reverse Voltage Max. (V)	DC Anode Current Max. (mA)	Peak Anode Current 20 µsec. 1% D.C. Max. (A)	I_{GAO} Leakage Current @ 40V Max. (nA)	Pk. Point Current Max. @ R_G = 10 k (µA)	Pk. Point Current Max. @ R_G = 1 Meg. (µA)	I_V Valley Current Min. @ R_G = 10 k (µA)	V_O Output Voltage Min. (V)	t_r Pulse Rate of Rise Max. (nsec.)	Package	Specification Page No.
2N6027	40	150	2	10	5	2	70	6	80	D[1]	702
2N6028	40	150	2	10	1	.15	25	6	80	D[2]	702

[1] Hermetic version of 2N6027: 2N6116
[2] Hermetic version of 2N6028: 2N6118

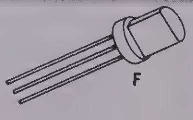
COMPLEMENTARY UNIJUNCTIONS
(D5K SERIES)



The D5K offers the ultimate in unijunction stability and uniformity. Low frequency oscillators and timers can be built using the D5K with better than 1.0% accuracy over extended temperature ranges. The D5K has characteristics like those of a standard unijunction except the currents and voltages applied to it are of opposite polarity than those of the standard devices.

GE Type	R_{BO} Interbase Resistance @ I_{B_2} = 0.1mA k Ω	η Intrinsic Standoff Ratio	I_V Valley Current Min. (mA)	I_P Peak Point Emitter Current Max. (µA)	I_{EO} Emitter Reverse Current Max. (nA)	V_O Peak Pulse Voltage Min. (V)	Operating Temp. Range Top (°C)	Frequency Stability from 25°C —55 to +150°C %	Package	Specification Page No.
D5K1	5.5-8.2	.58-.62	1	5	10	3.5	—55 to +150	1.0	E	1180
D5K2	5-15	.58-.62	1	15	10	3.5	—55 to +100	2.0	E	1184

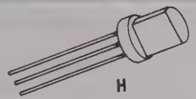
SILICON ASYMMETRICAL SWITCH
(SAS)

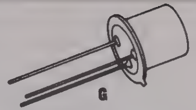


A Monolithic Integrated Switch for Bistable Application Where Stability of Switching Voltage is Required.

GE Type	V_{S2} Switching Voltage Min. (V)	V_{S2} Switching Voltage Max. (V)	V_{S1} Switching Voltage Min. (V)	V_{S1} Switching Voltage Max. (V)	I_{S2}, I_{S1} Switching Current Max. (µA)	V_{F2} Forward Voltage Drop @ 100 mA Max. (V)	V_{F1} Forward Voltage Drop @ 100 mA Min. (V)	V_{F1} Forward Voltage Drop @ 100 mA Max. (V)	Temperature Coefficient of V_S —55 to +125°C Typical	Package	Specification Page No.
D13H1	7	9	14	18	80	1.6	7	10	.03%/°C	F	1190

SILICON UNILATERAL AND BILATERAL SWITCHES
(SUS, SBS)





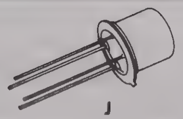
The General Electric SUS is a silicon, planar monolithic integrated circuit having thyristor electrical characteristics closely approximating those of an "ideal" four-layer diode. The device is designed to switch at 8 volts with a typical temperature coefficient of 0.02%/°C. A gate lead is provided to eliminate rate effect, obtain triggering at lower voltages, and to obtain transient-free waveforms.

The SBS is a bilateral version of the forward characteristics of the SUS. It provides excellently matched characteristics in both directions with the same low temperature coefficient.

	GE Type	V_{ACR} Reverse Voltage Max. (V)	I_F Continuous Forward Current Max. (mA)	I_F Peak Recurrent Forward Current @ 100°C, 10 μs, 1% duty cycle (A)	P_T Dissipation (mW)	T_C Temperature Coefficient of Switching Voltage (%/°C)	V_S Switching Voltage		I_S Switching Current Max. (μA)	I_B Forward Blocking Current @ 5V (μA)	V_F Forward Voltage @ 200mA (V)	I_H Holding Current (mA)	V_O Peak Pulse Voltage Min. (V)	Package	Specification Page No.
							Min. (V)	Max. (V)							
Unilateral	2N4987	30	175	1.0	300	—	6	10	500	1.0	1.5	1.5	3.5	G	570
	2N4988	30	200	1.0	350	±.05	7.5	9	150	0.1	1.5	.5	3.5		574
	2N4989	30	200	1.0	350	±.02	7.5	8.2	300	0.01	1.5	1.0	3.5		574
	2N4990	30	175	1.0	300	—	7	9	200	0.1	1.5	.75	3.5		570
	2N4983	30	175	1.0	300	—	6	10	500	1.0	1.5	1.5	3.5	H	562
	2N4984	30	200	1.0	350	±.05	7.5	9	150	0.1	1.5	.5	3.5		566
	2N4985	30	200	1.0	350	±.02	7.5	8.2	300	0.01	1.5	1.0	3.5		566
	2N4986	30	175	1.0	300	—	7	9	200	0.1	1.5	.75	3.5		562
Bilateral	2N4991	—	175	1.0	300	—	6	10	500	1.0	1.7	1.5	3.5	H	578
	2N4992	—	200	1.0	350	±.05	7.5	9	120	0.1	1.7	.5	3.5		582
	2N4993	—	175	1.0	300	—	6	10	500	1.0	1.7	1.5	3.5	G	586

SILICON CONTROL SWITCHES
(SCS)

High triggering sensitivity. 4 lead capability for multiple load or dv/dt suppression.



						Cutoff Characteristics	Conducting Characteristics	Max. Gate Ratings		Gate triggering Characteristics					
GE Type	V_{AK} Anode Voltage Blocking (V)	I_F Continuous DC Forward Current (mA)	Peak Recurrent Forward Current @ 100μsec (A)	Cathode Gate Peak Current (mA)	P_T (mW)	I_B @ V_{AK} R_{GK}=10KΩ 150°C (μA)	I_H R_{GK}=10KΩ (mA)	V_{GK} I_{GK}=20μA (V)	V_{GA} I_{GA}=1μA (V)	I_{GTK} @ V_{AK}=40V, R_L=800Ω, R_{GA}=∞ (μA)	V_{GTK} (V)	I_{GTA} @ V_{AK}=40V, R_L=800Ω, R_{GK}=10K (mA)	V_{GTA} (V)	Package	Specification Page No.
3N81	65	200	1.0	500	400	20	1.5	5	65	1.0	.4 to .65	1.5	—.4 to —.8	J	715
3N82	100	200	1.0	500	400	20	1.5	5	100	1.0	.4 to .65	1.5	—.4 to —.8	J	715
3N83	70	50	0.1	50	200	20 *	4.0 †	5	70	150 †	.4 to .80	—	—	J	720
3N84	40	175	0.5	100	320	20 *	2.0	5	40	10	.4 to .65	—	—	J	724
3N85	100	175	0.5	100	320	20 *	2.0	5	100	10	.4 to .65	—	—	J	724
3N86	65	200	1.0	500	400	20	0.2	5	65	1.0	.4 to .65	0.1	—.4 to —.8	J	728

* Measured @125°C. † Measured in special test circuit (See specification sheet).

ADDITIONAL REFERENCE PUBLICATIONS
ORDER BY PUBLICATION NUMBER

90.10	The Unijunction Transistor Characteristics and Applications
90.12	Unijunction Temperature Compensation
90.19	Unijunction Frequency Divider
90.70	The D13T—A Programmable Unijunction Transistor
90.72	Complementary Unijunction Transistors

OPTOELECTRONICS

DETECTORS

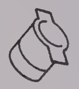
General Electric has a full line of Solid State Optoelectronic Products and is interested in assisting you choose products to perform your function with maximum effectiveness and minimum cost.

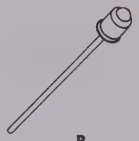
This Selection Guide contains information on products which have been formally introduced prior to its printing. General Electric has a continuing development program and will be introducing other products throughout the year. Information on these products will be published as they are introduced.

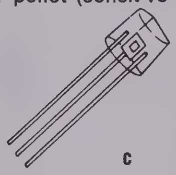
PACKAGES

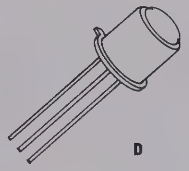
Package must have a small enough diameter to fit on the proper centers in the case of arrays.

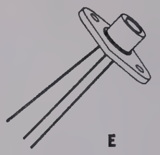
Package must be small enough to offer proper pellet (sensitive area) placement when a small aperture is being used.


A


B


C


D


E

SPEED

The device must have a sufficiently fast rise and fall time to see the signal in the case of a moving aperture or a signal from a pulsed source.

SENSITIVITY

Sensitivity is important to generate a signal sufficient to drive a logic gate or other following functions.

SATURATION VOLTAGE

The saturation is very important when the device is being used to drive a logic gate directly.

TYPES

Recommended stocking items in bold

	d	Package Outline	Speed (μs)		Sensitivity (mA/mW/cm^2)	Saturation Voltage	Specification Sheet Page
			t_r	t_f			
L15A600	.060″	A	3	3	.3	.4	1419
L15E	.097″	B	3	3	0.4	.4	1421
L14T5	.205″	C			Switches (100 mA)	1.6	1417
L14E	.205″	C	15	10	.05	.2	1411
L14D (2N5777	.205″	C	75	45	2.0	.7	643
L14A502	.230″	D	5	5	.7	.4	1403
L14F	.230″	D	100	100	150	1.0	1415
L1V	.230″	D	15	25	Switches (175 mA)	2.0	1423
L8/L9	.370″	E	0.6		Switches (1.6 A Rms)	1.2	1398

PHOTON COUPLED ISOLATORS

ISOLATION

The device must have sufficient isolation to prevent destruction of the device.

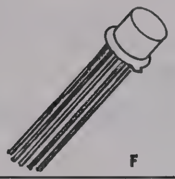
SPEED

The device must be fast enough to pass the signal without distortion.

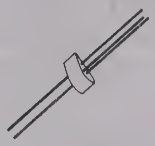
TRANSFER RATIO

Transfer ratio is important in that it can save you an additional stage of amplification.

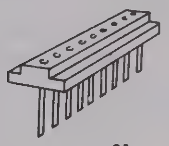
PACKAGES



F



G



GA

TYPES

Recommended stocking items in bold

	Package	Isolation Voltage (V)	Speed (μs)	Current Transfer Ratio (%)	Specification Sheet Page
H10A	F	1000	3	50	1390
H10B	F	1000	100	500	1392
H10C	F	1000	.6	Switches 1.0 Amp Rms Max.	1394
PC15-26	G	2500	3	35	1407
PC 4-73	G	2500	100	125	1409

ARRAYS

CENTER TO CENTER SPACING

Element must have proper spacing to be compatible with format to be read.

SPEED

Element must be fast enough to see the moving aperture.

MATCHING FACTOR

Most data formats (i.e. punched papertape, and punched cards) transmit some light when a hole is not present, hence we have two signal levels (an on-signal, and an off-signal). It is important to determine both levels. Once these levels are measured, the required matching factor for the devices in an array can be set, to insure an on-signal from the least sensitive device in the on-state, and an off-signal from the most sensitive device in the off-state.

SENSITIVITY

It is desirable to generate a sufficient signal to drive a logic gate or following functions directly.

SATURATION VOLTAGE

It is necessary that the photo-transistor have a low saturation voltage when it is being used to drive logic directly.

TYPES

Package GA	Number of Elements and Center to Center Spacing		Speed (μs)		Matching Factor %	Sensitivity mA/mW/cm²	Saturation Voltage Volts	Specification Sheet Page
	No.	Spacing	t_r	t_f				
J300	9	.100″	3	3	50	1.0	.4	1396
J300A	9	.100″	3	3	75	1.0	.4	1396

Special—Please contact your local GE Electronic Components Sales Office with your requirements on all special arrays.

VISIBLE SOLID STATE LAMPS & DISPLAYS

(EMITTERS)

PEAK EMISSION

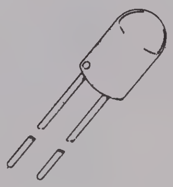
To insure that the film (in film annotation applications) or the eye (in visual applications) are sensitive to the emitted wavelength.

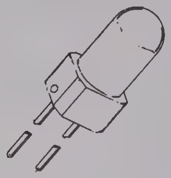
VISIBLE OUTPUT

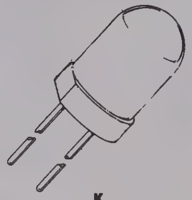
Millicandella is a measure of the time rate of flow, of visible radiation, out of the device.

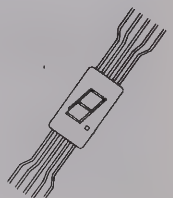
PACKAGE

Package is important for proper center to center spacing in linear and matrix arrays.
Package size is also important since the apparent size of the light source is the diameter of the package.


H


J


K


L

VISIBLE TYPES

Recommended stocking items in bold

	Peak Emission Wavelength A	Visible Output Millicandella	Package d	l	Outline	Comments	Specification Sheet Page
SSL212	7000	1.0	.080″	.125″	H		**
SSL12	7000	1.0	.095″	.187″	J	Square Base for Linear and Matrix Arrays	
SSL22L	7000	1.5	.230″	.230″	K	Longer Barrell for Panel Mounting (Panel Mount Clip Available)	
SSL3	5390/9200	80′ Lamberts @ 5390 A 1.0 mW @ 9000 A	.230″	.230″	K		

DISPLAYS

	Peak Emission Wavelength A	l	Package w	Outline	Character h	Specification Sheet Page
SSL140	7000	.400	.220	L	.140″	**
SSL190	7000	.400	.220	L	.190″	

**For Technical Information Contact: General Electric
Miniature Lamp Dept. Inquiry Bureau #482
Nela Park, Cleveland, Ohio 44112

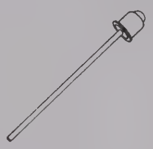
INFRARED SOLID STATE LAMPS
(EMITTERS)

POWER OUTPUT

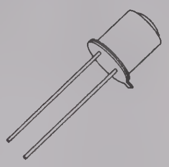
Infrared Solid State Lamps are used to irradiate silicon photo-detectors. The output from the detector is proportional to the radiant flux density incident upon its active area, hence power output is the most important parameter of the Infrared SSL.

PACKAGE

The package must have a small diameter for proper center to center spacing in arrays.



M



N

SPEED

The speed of the device is important in pulsed operation, primarily for signal coupling over large distances. In most applications the speed of the detector will be the limiting parameter rather than that of the SSL.

INFRARED TYPES
Recommended stocking items in bold

	Power Output (mW)	Package		Speed (μs)		Specification Sheet Page
		d	Outline	t_r	t_f	
SSL15	0.5	.097″	M	.7	.5	
SSL315	1.0	.097″	M	.7	.7	
SSL4	0.4	.230″	N	.005	.005	
SSL34	0.9	.230″	N	.010	.010	
SSL54	1.0	.230″	N	.010	.010	
SSL5A	1.5	.230″	N	.3	.2	**
SSL5B	2.3	.230″	N	.3	.2	
SSL5C	2.9	.230″	N	.3	.2	
SSL55B	4.8	.230″	N	.3	.2	
SSL35	5.5	.230″	N	.5	.5	
SSL55L	6.0	.230″	N	.3	.2	

**For Technical Information Contact: General Electric
Miniature Lamp Dept. Inquiry Bureau #482
Nela Park, Cleveland, Ohio 44112

SILICON RECTIFIERS

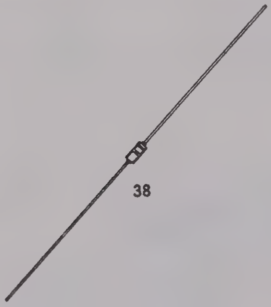
THE INDUSTRY'S BROADEST LINE OF POWER RECTIFIERS—.250 TO 1500 AMPERES, UP TO 3000 VOLTS

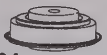
- CURRENT/VOLTAGE RATINGS
- PACKAGING
- MOUNTING AND COOLING
- HIGH-SPEED FAST RECOVERY
- TRANSIENT SELF-PROTECTION
- GENERAL PURPOSE

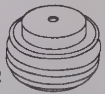
TYPES

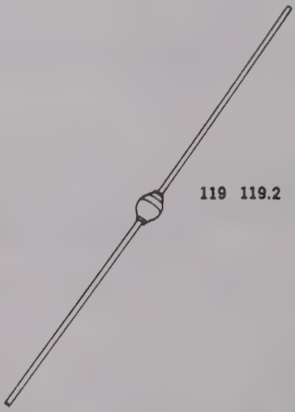
.25 TO 3 AMPERES .... PAGE 133
5 TO 12 AMPERES .... PAGE 134
20 TO 40 AMPERES .... PAGE 135
100 TO 275 AMPERES .... PAGE 136
400 TO 1500 AMPERES .... PAGE 137

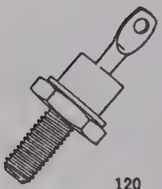
PACKAGES

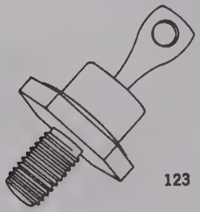

38

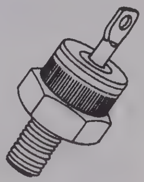

109.1

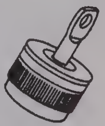

182

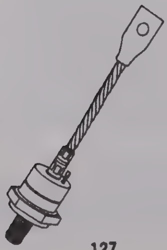

119 119.2

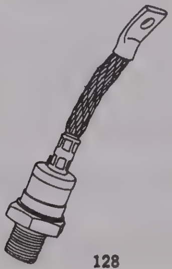

120

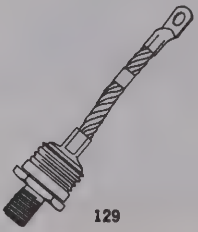

123


125


126


127


128


129

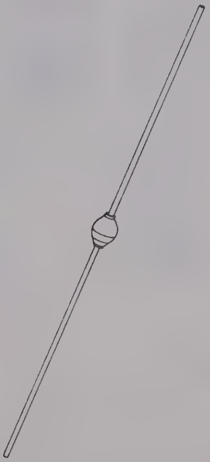
SILICON RECTIFIERS
.25 TO 3 AMPERES

JEDEC	—	—	—	—	1N5059-62	1N4245-49	—	—	1N5624-27	—	—
GE TYPE	DT230	MPR10-15	A14PD	A114PD2	A14A-P	—	GER4001-7	A114A-M	—	A15A-N	A115A-M
SPECIFICATIONS											
$I_{FM(AV)}$ (A)	.25	.5	1	1	1	1	1	1	3	3	3
@ T_A(°C)	50	100	75	75	100	55	75	55	70	70	55
$V_{RM(rep)}$ — Max. repetitive peak reverse voltage (V)											
50	DT230F	—	—	—	A14F	—	GER4001	A114F	—	A15F	A115F
100	DT230A	—	—	—	A14A	—	GER4002	A114A	—	A15A	A115A
150	DT230G	—	—	—	—	—	—	—	—	—	—
200	DT230B	—	—	—	1N5059	1N4245 *	GER4003	A114B	1N5624	A15B	A115B
250	DT230H	—	—	—	—	—	—	—	—	—	—
300	—	—	—	—	A14C	—	—	A114C	—	A15C	A115C
400	—	—	—	—	1N5060	1N4246 *	GER4004	A114D	1N5625	A15D	A115D
500	—	—	—	—	A14E	—	—	A114E	—	A15E	A115E
600	—	—	—	—	1N5061	1N4247 *	GER4005	A114M	1N5626	A15M	A115M
800	—	—	—	—	1N5062	1N4248 *	GER4006	A114N	1N5627	A15N	—
1000	—	MPR10	—	—	A14P [1]	1N4249	GER4007	—	—	—	—
1200	—	MPR12	—	—	—	—	—	—	—	—	—
1400	—	—	A14PD	A114PD2	—	—	—	—	—	—	—
1500	—	MPR15	—	—	—	—	—	—	—	—	—
$I_{FM\ (surge)}$ Max. peak one cycle, non-recurrent surge current (60 Hz sine wave, 1 phase operation) @ max. rated load conditions (A)	5	25	40	40	50	25	30	40	125	125	110
I^2t Max. non-repetitive for 8.3 msec. (A^2sec)	—	3	3.5	3.5	4	4	—	3.5	25	25	20
T_J Operating junction temperature range (°C)	—65 to 150	—65 to 175	—65 to 150	—65 to 150	—65 to 175 [1]	—65 to 160	—65 to 175	—65 to 125	—65 to 175	—65 to 175	—65 to 150
T_{stg} Storage temperature range (°C)	—65 to 200	—65 to 175	—65 to 175	—65 to 175	—65 to 175	—65 to 200	—65 to 175	—65 to 175	—65 to 200	—65 to 175	—65 to 175
V_{FM} Max. peak forward voltage drop @ rated $I_{F(AV)}$ (1 phase operation)	1.1	1.8	1.1	1.1	1.0	1.2@ +55°C	1.1	1.1	1.0	1.0	1.0
t_{rr} Max. reverse recovery time (μsec)	0.3	5	—	20	6	5	—	0.2	5	5	0.2
PACKAGE OUTLINE NO.	38	119	119	119	119	119	119	119	119.2	119.2	119.2
SPECIFICATION PAGE NO.	1274	1431	803	803	312 801	288	1355	819 821	316	805	825 827

NOTE:

[1] Average forward current 1 amp. @ T_A=90°C. Junction, operating and storage temperature range —65 to +165°C.

* JAN & JANTX types available



The best way to assure reliability in a low-current rectifier pellet is to put it in a package that really protects it. Protects it from shock, humidity, vibration and temperature.

And that's just what we do with General Electric's glassivated 1-amp (A14) and 3-amp (A15) rectifiers. Solid glass provides passivation and protection of the silicon pellet's P-N junction—no organic material is present within the hermetically sealed package. In addition, rigid mechanical support and excellent thermal characteristics are provided by the dual heat sink construction.

For high-frequency applications, GE offers a fast-recovery rectifier, the 1-amp A114, with a 200 nsec. max. reverse recovery.

Need a 1 ampere rectifier bridge? See the "GEB" A-14 Bridge on page 1284

SILICON RECTIFIERS
5 TO 12 AMPERES

JEDEC		1N1612-16	1N1341A-48A	1N3987-90	1N3879-83	1N1199A-1206A 1N3670A-73A 1N5331	1N3889-93			1N4510-11
GE TYPES		—	—	—	—	—	—	A28F-D	A129E-PB	—
SPECIFICATIONS										
$I_{FM(AV)}$	(A)	5	6	6	6	12	12	12	12	12
	@ T_C=(°C)	150	150	150	100	150	100	135	65	135
$V_{RM(rep)}$ — Max. repetitive peak reverse voltage (V)		—	—	—	—	—	—	—	—	—
	50	1N1612	1N1341A	—	1N3879	1N1199A	1N3889	A28F	—	—
	100	1N1613	1N1342A	—	1N3880*	1N1200A	1N3890*	A28A	—	—
	150	—	1N1343A	—	—	1N1201A	—	—	—	—
	200	1N1614*	1N1344A	—	1N3881*	1N1202A*	1N3891*	A28B	—	—
	300	—	1N1345A	—	1N3882	1N1203A	1N3892	A28C	—	—
	400	1N1615*	1N1346A	—	1N3883*	1N1204A*	1N3893*	A28D	—	—
	500	—	1N1347A	—	—	1N1205A	—	—	A129E	—
	600	1N1616*	1N1348A	—	—	1N1206A*	—	—	A129M	—
	700	—	—	1N3987	—	1N3670A	—	—	—	—
	800	—	—	1N3988	—	1N3671A	—	—	A129N	—
	900	—	—	1N3989	—	1N3672A	—	—	—	—
	1000	—	—	1N3990	—	1N3673A*	—	—	A129P	1N4510
	1200	—	—	—	—	1N5331	—	—	A129PB	1N4511
$I_{FM\ (surge)}$	Max. peak one cycle, non-recurrent surge current (60 Hz sine wave, 1 phase operation) @ max. rated load conditions (A)	150	150	150	75	240	150	240	150	240
I^2t	Max. non-repetitive for 8.3 msec (A^3sec)	25	25	25	—	60	—	67	38	67
T_J	Operating junction temperature range (°C)	—65 to +190	—65 to +200	—65 to +200	—65 to +150	—65 to +200	—65 to +200	—65 to +175	—40 to +125	—65 to +175
T_{stg}	Storage temperature range (°C)	—65 to +200	—65 to +200	—65 to +200	—65 to +175	—65 to +200	—65 to +200	—65 to +175	—40 to +125	—65 to +200
$\theta_{J\text{-}C}$	Max. thermal resistance, junction-to-case (°C/W)	7.0	4.25	4.25	2.5	2.5	2.0	2.0	3.25	2.0
V_{FM}	Max. peak forward voltage drop @ rated $I_{F(AV)}$ (1 phase operation) (V)	1.1	1.1	1.1	1.4	1.1	1.4	1.1	1.4	1.4
	@ T_C=(°C)	25	25	25	25	25	25	25	25	135
t_{rr}	Max. reverse recovery time (nsec)	—	—	—	200	—	200	100	500	—
PACKAGE OUTLINE NO.		120	120	120	120	120	120	120	120	120
SPECIFICATION PAGE NO.		227	223	—	269	219	271	807	831	298

*JAN & JANTX types available

SILICON RECTIFIERS
20 TO 40 AMPERES

JEDEC		1N248B-50B	1N1195A-98A	1N2154-60	1N1183-90 1N3765-68 1N5332	1N1183A-90A	1N3899-3903	1N3909-13	1N4529-30	1N3208-14		
GE TYPE										A40F-M	A44F-M	A139
SPECIFICATIONS												
$I_{FM(AV)}$	Max. average forward current (1 phase operation) (A)	20	20	25	35	40	20	30	35	20	20	25
	@ T_C=(°C)	150	150	145	140	150	100	100	115	110	110	75
$V_{RM(rep)}$	—Max. repetitive peak reverse voltage (V)											
	50	1N248B	—	1N2154	1N1183	1N1183A	1N3899	1N3909*	—	1N3208 A40F	A44F	—
	100	1N249B*	—	1N2155	1N1184*	1N1184A	1N3900	1N3910*	—	1N3209 A40A	A44A	—
	150	—	—	—	1N1185	1N1185A	—	—	—	—	—	—
	200	1N250B*	—	1N2156	1N1186*	1N1186A	1N3901	1N3911*	—	1N3210 A40B	A44B	—
	300	—	1N1195A	1N2157	1N1187	1N1187A	1N3902	1N3912*	—	1N3211 A40C	A44C	—
	400	—	1N1196A	1N2158	1N1188*	1N1188A	1N3903	1N3913*	—	1N3212 A40D	A44D	—
	500	—	1N1197A	1N2159	1N1189	1N1189A	—	—	—	1N3213 A40E	A44E	A139E
	600	—	1N1198A	1N2160	1N1190	1N1190A	—	—	—	1N3214 A40M	A44M	A139M
	700	—	—	—	1N3765	—	—	—	—	—	—	—
	800	—	—	—	1N3766	—	—	—	—	—	—	A139N
	900	—	—	—	1N3767	—	—	—	—	—	—	—
	1000	—	—	—	1N3768	—	—	—	1N4529	—	—	A139P
	1200	—	—	—	1N5332	—	—	—	1N4530	—	—	A139PB
$I_{FM\ (surge)}$	Max. peak one cycle, non-recurrent surge current (60 Hz sine wave, 1 phase operation) @ max. rated load conditions (A)	350	350	400	500	800	225	300	500	300	300	400
I^2t	Max. I^2t rating (non-repetitive for 8.3 msec.) A^2 sec	—	—	250	500	—	—	—	500	100	100	500
T_J	Operating junction temperature range (°C)	—65 to +175	—65 to +175	—65 to +200	—65 to +200	—65 to +200	—65 to +150	—65 to +150	—65 to +175	—65 to +175	—65 to +175	—40 to +125
T_{stg}	Storage temperature range (°C)	—65 to +175	—65 to +175	—65 to +200	—65 to +200	—65 to +200	—65 to +175	—65 to +175	—65 to +200	—65 to +175	—65 to +175	—40 to +200
$\theta_{J\text{-}C}$	Max. thermal resistance, junction-to-case (°C/W)	1.2	1.2	1.4	1.0	1.0	1.5	1.0	1.0	1.5 Typical	1.5 Typical	1.0
V_{FM}	Max. peak forward voltage drop @ rated $I_{F(AV)}$ (1 phase operation) (V)	—	—	—	1.7	1.3	1.4	1.4	1.4	1.35 Typical	1.35 Typical	1.85
	@ T_C=(°C)	150	150	145	140	25	25	25	115	25	25	75
T_{rr}	Max. reverse recovery time (nsec)	—	—	—	—	—	200	200	—	—	—	500
PACKAGE OUTLINE NO.		123	123	123	123	123	123	123	123	125	126	126
SPECIFICATION PAGE NO.		205	207	237	215	215	271	273	302	247	811	833

* JAN & JANTX types available

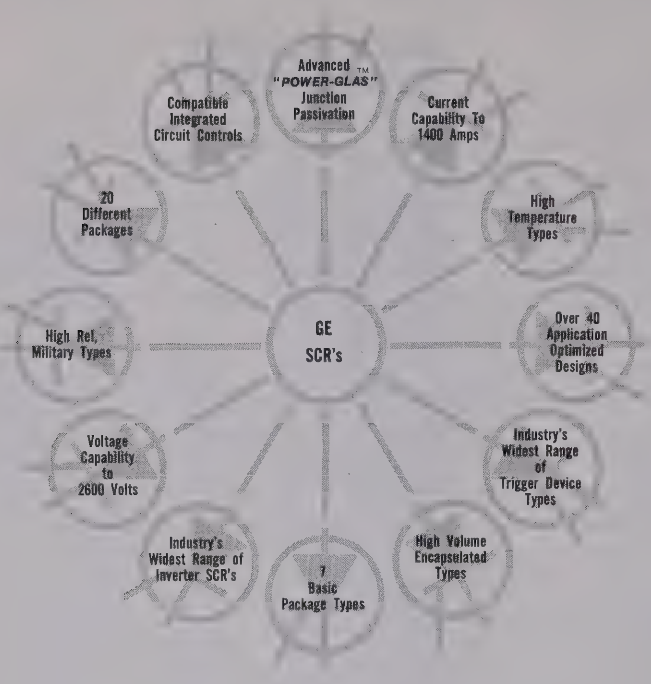
SILICON RECTIFIERS
100-275 AMPERES

JEDEC TYPE		1N3289-96	1N3260-73	1N3735-42				1N4044-56
GE TYPE		A70B-PB		A90A-PB	A96A-P	A396A-P	A291PC-PM	
SPECIFICATIONS								
$I_{FM(AV)}$	Max. average forward current (1 phase operation)	100	160	250	250	250	250	275
	@ T_C=(°C)	130	125	130	70	70	135	120
$V_{RM(rep)}$	— Max. repetitive peak reverse voltage (V)	—	—	—	—	—	—	—
	50	—	1N3260	—	—	—	—	1N4044
	100	—	1N3261	A90A, 1N3735	A96A	A396A	—	1N4045
	150	—	1N3262	—	—	—	—	1N4046
	200	A70B, 1N3289	1N3263	A90B, 1N3736	A96B	A396B	—	1N4047
	250	—	1N3264	—	—	—	—	1N4048
	300	A70C, 1N3290	1N3265	A90C, 1N3737	A96C	A396C	—	1N4049
	350	—	1N3266	—	—	—	—	—
	400	A70D, 1N3291	1N3267	A90D, 1N3738	A96D	A396D	—	1N4050
	500	A70E, 1N3292	1N3268	A90E, 1N3739	A96E	A396E	—	1N4051
	600	A70M, 1N3293	1N3269	A90M, 1N3740	A96S	A396M	—	1N4052
	700	A70S	1N3270	A90S	A96M	A396S	—	1N4053
	800	A70N, 1N3294	1N3271	A90N, 1N3741	A96N	A396N	—	1N4054
	900	A70T,	1N3272	A90T	A96T	A396T	—	1N4055
	1000	A70P, 1N3295	1N3273	A90P, 1N3742	A96P	A396P	—	1N4056
	1100	—	—	A90PA	—	—	—	—
	1200	A70PB, 1N3296	—	A90PB	—	—	—	—
	1300	—	—	—	—	—	A291PC	—
	1400	—	—	—	—	—	A291PD	—
	1500	—	—	—	—	—	A291PE	—
	1600	—	—	—	—	—	A291PM	—
$I_{FM\ (surge)}$	Max. peak one cycle, non-recurrent surge current (60 Hz sine wave, 1 phase operation) @ max. rated load conditions (A)	1600	2000	4500	3300	3300	4500	5000
I^2t	Max. non-repetitive for 8.3 msec. (A^2sec)	10,000	16,000	84,000	43,000	43,000	84,000	100,000
T_J	Operating junction temperature range (°C)	−40 to +200	−55 to +190	−40 to +200	−40 to +125	−40 to +125	−40 to +200	−65 to +190
T_{stg}	Storage temperature range (°C)	−40 to +200	−55 to +190	−40 to +200	−40 to +125	−40 to +125	−40 to +200	−65 to +190
$\theta_{J\text{-}C}$	Max. thermal resistance, junction-to-case (°C/W)	.4	.3	.18	.18	.18	.15	.18
V_{FM}	Max. peak forward voltage drop @ rated $I_{F(AV)}$ (1 phase operation)	1.15	1.6	1.3	1.25	1.25	1.0	1.35
	@ T_C=(°C)	25	125	130	25	25	25	120
Q_{RR}	Max. reverse recovered charge (μC)	—	—	—	19	19	—	—
PACKAGE OUTLINE NO.		127	128	128	128	109.1	129	128
SPECIFICATION PAGE NO.		251	249	263	813	842	835	277

SILICON RECTIFIERS
400-1500 AMPERES

GE TYPE		A390A-PB	A295A-PN	A500P-LP	A540PA-L	A570A-P
SPECIFICATIONS						
$I_{FM(AV)}$	Max. average forward current (1 phase operation) (A)	400	500	740	1000	1500
	@ T_C=(°C)	145	130	100	100	80
$V_{RM(rep)}$ — Max. repetitive peak reverse voltage (V)						
	100	A390A	—	—	A540A	A570A
	200	A390B	A295B	—	A540B	A570B
	300	A390C	A295C	—	A540C	A570C
	400	A390D	A295D	—	A540D	A570D
	500	A390E	A295E	—	A540E	A570E
	600	A390M	A295M	—	A540M	A570M
	700	A390S	A295S	—	A540S	A570S
	800	A390N	A295N	—	A540N	A570N
	900	A390T	A295T	—	A540T	A570T
	1000	A390P	A295P	A500P	A540P	A570P
	1100	A390PA	A295PA	A500PA	A540PA	—
	1200	A390PB	A295PB	A500PB	A540PB	—
	1300	—	A295PC	A500PC	A540PC	—
	1400	—	A295PD	A500PD	A540PD	—
	1500	—	A295PE	A500PE	A540PE	—
	1600	—	A295PM	A500PM	A540PM	—
	1700	—	A295PS	A500PS	A540PS	—
	1800	—	A295PN	A500PN	A540PN	—
	1900	—	—	A500PT	A540PT	—
	2000	—	—	A500L	A540L	—
	2100	—	—	A500LA	—	—
	2200	—	—	A500LB	—	—
	2300	—	—	A500LC	—	—
	2400	—	—	A500LD	—	—
	2500	—	—	A500LE	—	—
	2600	—	—	A500LM	—	—
	2700	—	—	A500LS	—	—
	2800	—	—	A500LN	—	—
	2900	—	—	A500LT	—	—
	3000	—	—	A500LP	—	—
$I_{FM\ (surge)}$	Max. peak one cycle, non-recurrent surge current (60 Hz sine wave, 1 phase operation) @ max. rated load conditions (A)	4500	7000	8400	10,000	15,000
I^2t	Max. non-repetitive for 8.3 msec (A^2sec)	84,000	200,000	270,000	400,000	920,000
T_J	Operating junction temperature range (°C)	−40 TO +200	−40 TO +200	−40 TO +200	−40 TO +200	−40 TO +200
T_{stg}	Storage temperature range (°C)	−40 TO +200	−40 TO +200	−40 TO +200	−40 TO +200	−40 TO +200
$\theta_{J\text{-}C}$	Max. thermal resistance, junction-to-case (°C/W)	.15	.12	.06	.06	.053
V_{FM}	Max. peak forward voltage drop @ rated $I_{F(AV)}$ (1 phase operation)	1.15	1.1	1.25	1.15	1.0
	@ T_C=(°C)	25	25	25	150	25
PACKAGE NO.		109.1	129	182	182	182
SPECIFICATION PAGE NO.		839	837	844	847	850

WELCOME TO THE WORLD OF GENERAL ELECTRIC SCR's


GE SCR's
Advanced "POWER-GLAS" TM Junction Passivation
Current Capability To 1400 Amps
High Temperature Types
Over 40 Application Optimized Designs
Industry's Widest Range of Trigger Device Types
High Volume Encapsulated Types
7 Basic Package Types
Industry's Widest Range of Inverter SCR's
Voltage Capability to 2600 Volts
High Rel, Military Types
20 Different Packages
Compatible Integrated Circuit Controls

TM Trademark of General Electric Company

PHASE CONTROL SCR's

"Phase Control" is a term used to describe SCR's where fast turn-off time is not a prime requirement. The trade-offs in SCR design are such that turn-off time has an inverse relationship to current and voltage capability for any given junction size. Primary applications for a device with relatively slow turn-off are AC phase control—hence the name "Phase Control." This type of device is also used for zero voltage switching and select pulse applications. See pages 140-146.

INVERTER SCR's

SCR's in this use category are characterized for turn-off time (commutation speed) capability and other speed characteristics. When designing for speed, the parameter trade offs must be carefully weighed. Thus the large matrix of speed, current and voltage capability for inverter SCR's. As the name implies, major applications for these devices are DC/AC inverters. Additionally, they are used in cycloconverters and other pulse applications requiring high speed capability. Inverter SCR types optimized for such applications are described on pages 146-151.

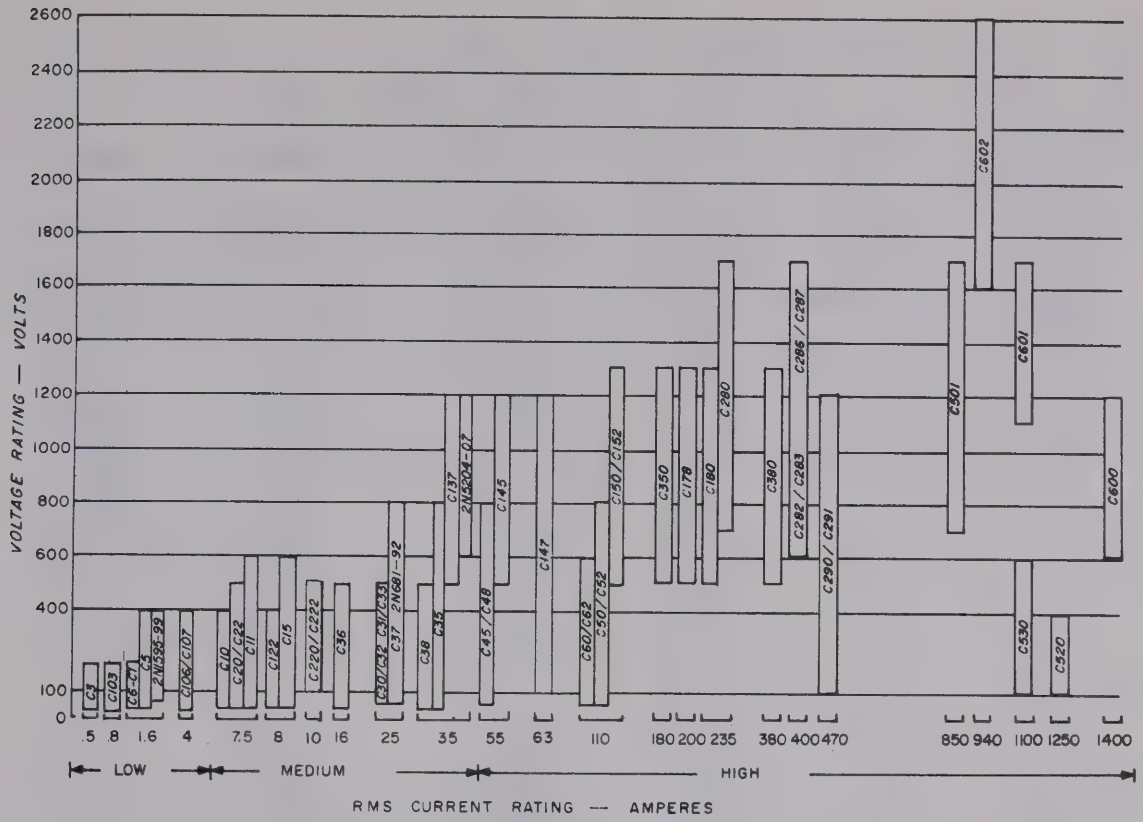
SELECTOR GUIDES

The Selector Guides for Phase Control and Inverter SCR's are laid out to provide quick recognition of the four major selecting parameters—current, voltage, speed (for Inverter SCR's) and package. Other important parameters such as surge current and dv/dt capability are also included. Comments highlighting unique characteristics, package types, etc., are included to aid you in your SCR selection.

Unabridged specifications should be consulted for detail design parameters.

Additional information or clarification is free for the asking—just write or call us.

SELECTOR GUIDE PHASE CONTROL SCR's



PHASE CONTROL SCR's
TYPES
CURRENT

The initial selection of an SCR starts with identifying the current requirements, since this offers a measure of SCR pellet and/or package size. SCR's are generally categorized by maximum allowable RMS current, $I_{T(RMS)}$. The designer is cautioned that actual SCR current capability is influenced by the

- cooling system
- switching frequency (more prevalent with inverter applications)
- ambient temperature
- coordination of SCR surge current capability with system current limiting (fusing).

It's prudent to check the detailed current rating information provided on the full specification insuring that the SCR's maximum current rating exceeds the worst case use conditions.

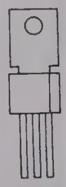
BLOCKING VOLTAGE

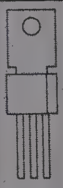
It is most economical to specify a SCR from a family (i.e. C35) having a "design" blocking voltage only slightly in excess of the maximum voltage rating that you require for yours. Generally, the upper end of the voltage range should be considered as the SCR's "design" voltage. The SCR so chosen is likely to have a mix of parameters (current, speed, voltage) which yield optimum performance and value.

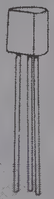
All GE SCR's are supplied with guard-bands on key parameters, including blocking voltage. These "plus parameters" are included to allow for normal measurement tolerances, and minor temperature variations. They should not be used as design parameters.

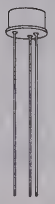
PHASE CONTROL SCR's
.8 TO 4.0 AMPERES

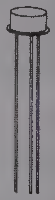
GE TYPE		C103	C6	C7	C5	—	C106	C107
JEDEC		—	—	2N2344-48	2N2322-29 *	2N1595-99	—	—
SPECIFICATIONS								
VOLTAGE RANGE		30-200	25-200	25-200	25-400	50-400	15-400	15-400
CONDUCTION								
$I_{T(RMS)}$	Max. RMS on-state current (A)	0.80	1.60	1.60	1.60	1.60	4.00	4.00
$I_{T(AV)}$	Max. average on-state current @ 180° conduction (A) @ T_C	0.50 @ 25°C	1.0 @ 85°C	1.0 @ 55°C	1.0 @ 85°C	1.0 @ 110°C	2.5 @ 30°C	2.5 @ 20°C
I_{TSM}	Max. peak one cycle, non-repetitive surge current (A)	8.0	—	15	15	15	20	15
I^2t	Max. I^2t for fusing for <1.5 msec (A^2 sec)	—	0.5	—	0.5	0.5	0.5	0.5
V_{FM}	Max. peak on-state voltage @ 25°C, 180° conduction, rated $I_{T(AV)}$ (V)	1.5	1.4	2.0	2.2	2.0	2.2	2.5
$\theta_{J\text{-}C}$	Max. internal thermal resistance, dc, junction-to-case (°C/W)	125	18	18	18	18	10	10
I_H	Typical holding current @ 25°C (mA)	5.0	1.0	1.0	2.0	0.5	1.0	3.0
t_q	Typical turn-off time (μsec)	15 —	40 —	20 —	40 —	40 —	40 100 [2]	40 100 [2]
$t_d + t_r$	Typical turn-on time (μsec)	—	1.4	1.4	1.4	1.2	1.2	1.2
di/dt	Max. rate-of-rise of on-state current (A/μsec)	—	—	—	50	—	50	50
T_J	Junction operating temperature range (°C)	−65 to 125	−40 to 125	−65 to 100	−65 to 125	−65 to 150	−40 to 110	−40 to 110
OFF-STATE								
dv/dt	Typical critical rate-of-rise of off-state voltage, exponential to rated V_{DRM} @ max. rated T_J (V/μsec)	20	20	20	20	20	8	8
SPECIFICATION PAGE NO.		953	886	467	880	446	957	965

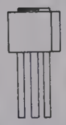

TYPE 1

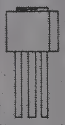

TYPE 1



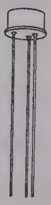


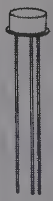



TYPE 2

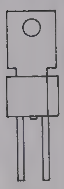

TYPE 2

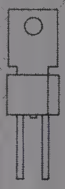
PLANAR PASSIVATED. EPOXY ENCAPSULATED. LOW CURRENT. FOR COST CONSCIENCE VOLUME APPLICATIONS.





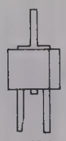
GENERAL PURPOSE. LOW CURRENT. HERMETIC PACKAGE.

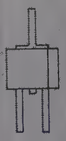

TYPE 3


TYPE 3

LOW T_J VERSION OF C6.

GENERAL PURPOSE LOW CURRENT. JAN & JANTX TYPES.


TYPE 4


TYPE 4

SIMILAR TO C5 SERIES. EXCEPT HIGHER 150°C T_J RATING.

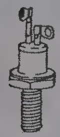
THE ORIGINAL SILICONE ENCAPSULATED, PLANAR PASSIVATED SCR. FOR COST CONSCIENCE VOLUME APPLICATIONS.

SIMILAR TO C106 EXCEPT 15A SURGE RATING. LOWER COST THAN C106.

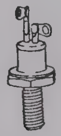
PHASE CONTROL SCR's
7.4 TO 25 AMPERES

GE TYPE		C10	C11	C15	C122	C20-22	C220, 222		C30,31,32,33	C37
JEDEC		2N1770A-77A*	2N1770-78	—	—	—	—	2N1842-50	—	—
SPECIFICATIONS										
VOLTAGE RANGE		25-400	25-800	25-600	50-500	25-500	25-500	25-500	25-500	25-800
CONDUCTION										
$I_{T(RMS)}$	Max. RMS on-state current (A)	7.40	7.40	8.0	8.0	7.40	10	16.0	25.0	25.0
$I_{T(AV)}$	Max. average on-state current @ 180° conduction (A) @ T_C	4.7 @ 105°C	4.7 @ 60°C	5.1 @ 50°C	5.1 @ 75°C	4.8 @ 67°C	63 @ 67°C	10.0 @ 35°C	16.0 @ 70°C	16.0 @ 35°C
I_{TSM}	Max. peak one cycle, non-repetitive surge current (A)	60	60	60	90	80	80	125	250	125
I^2t	Max. I^2t for fusing for <1.5 msec (A^2 sec)	5	5	5	25	27	27	—	260	40
$t_d + t_r$	Typical turn-on time (μsec)	1.0	1.0	1.0	—	2.5	40	3	3	3
di/dt	Typical rate-of-rise of on-state current (A/μsec)	40	40	40	40	40	20	20	20	20
T_J	Junction operating temperature range (°C)	—65 to 150	—65 to 125	—65 to 105	—40 to 100	—40 to 100	—40 to 100	—40 to 100	—40 to 100	—40 to 105
OFF-STATE										
dv/dt	Typical critical rate-of-rise of off-state voltage, exponential to rated V_{DRM} @ max. rated T_J (V/μsec)	40	50	60	40	40	40	40	40	40
SPECIFICATION PAGE NO.		890	894	906	970	910	1048	454	913	926

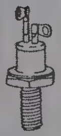
GENERAL PURPOSE 150°C T_J RATING.
JAN & JANTX & HI REL TYPES.



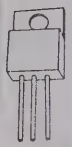
GENERAL PURPOSE. FOR INDUSTRIAL APPLICATIONS.



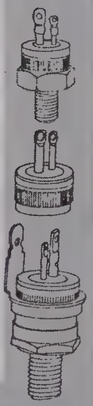
GENERAL PURPOSE.



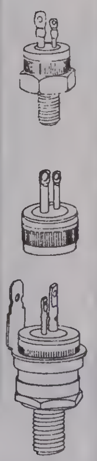
SILICONE ENCAPSULATED WITH POWER GLAS PASSIVATED PELLET.
FOR COST CONSCIENCE VOLUME APPLICATIONS.



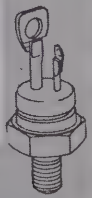
GENERAL PURPOSE. FOR VOLUME INDUSTRIAL APPLICATIONS.
3 PACKAGE CONFIGURATIONS.



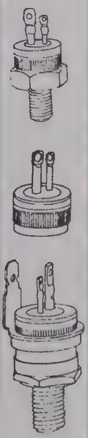
MEDIUM CURRENT SCR FEATURING POWER GLAS PELLET PASSIVATION.
3 PACKAGE CONFIGURATIONS.



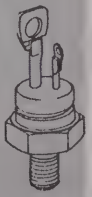
GENERAL PURPOSE CHASIS MOUNT SCR.



SIMILAR TO C20 EXCEPT HIGHER CURRENT RATINGS.

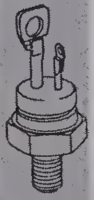


GENERAL PURPOSE.

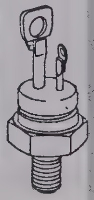


PHASE CONTROL SCR's
25 TO 35 AMPERES

GE TYPE		—	C35	C38	C137	—
JEDEC		2N681-92	—	—	—	2N5204-07
SPECIFICATIONS						
VOLTAGE RANGE		25-800	25-800	25-800	500-1200	600-1200
CONDUCTION						
$I_{T(RMS)}$	Max. RMS on-state current (A)	25.0	35.0	35.0	35	35
$I_{T(AV)}$	Max. average on-state current @ 180° conduction (A) @ T_C(°C)	16.0 @ 65°C	22.3 @ 40°C	22.5 @ 70°C	22.3 @ 67°C	22.3 @ 40°C
I_{TSM}	Max. peak one cycle, non-repetitive surge current (A)	150	225	225	360	300
I^2t	Max. I^2t for fusing for 5 to 8.3 msec (A^2 sec)	100	100	100	460	320
di/dt	Typical rate-of-rise of on-state current (A/μsec)	80	80	80	150	150
T_J	Junction operating temperature range (°C)	—65 to 125	—65 to 125	—65 to 150	—65 to 125	—40 to 125
OFF-STATE						
dv/dt	Min. critical rate-of-rise of off-state voltage, exponential @ max. rated T_J (V/μsec)	20 Typ.	10	20	100	100
SPECIFICATION PAGE NO.		420	922	930	978	595

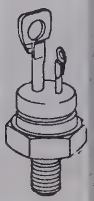


POPULAR GENERAL PURPOSE CHASSIS MOUNT SCR.
JAN & JANTX TYPES.

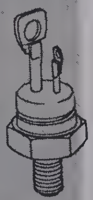


THE ORIGINAL SCR. FOR GENERAL PURPOSE
APPLICATIONS. HI REL TYPES AVAILABLE.

SIMILAR TO C35 SERIES
EXCEPT 150°C T_J RATING.



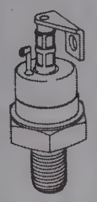
HIGH VOLTAGE. HIGH PERFORMANCE FOR DEMANDING
INDUSTRIAL APPLICATIONS. HI REL TYPES AVAILABLE.



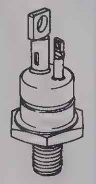
SIMILAR TO C137.

PHASE CONTROL SCR's
55 TO 200 AMPERES

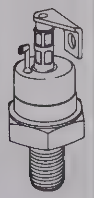
		C45, 46	C145	C147	C50, 52	C150, 152	C60, 62	C350	C178
GE TYPE		C45, 46	C145	C147	C50, 52	C150, 152	C60, 62	C350	C178
JEDEC					2N1909-16 2N1792-98		2N2023-30		
SPECIFICATIONS									
VOLTAGE RANGE		25-800	500-1200	100-1200	25-800	500-1300	25-600	500-1300	500-1300
CONDUCTION									
$I_{T(RMS)}$	Max. RMS on-state current (A)	55	55	63	110	110	110	180	200
$I_{T(AV)}$	Max. average on-state current @ 180° conduction (A) @ T_C	35 @ 87°C	35 @ 90°C	35 @ 90°C	70 @ 62°C	70 @ 80°C	70 @ 88°C	125 @ 80°C	127 @ 80°C
$I_{T(AV)}$	Max. average on-state current @ 120° conduction (A) @ T_C	29 @ 90°C	29 @ 93°C	29 @ 93°C	60 @ 64°C	59 @ 87°C	59 @ 90°C	110 @ 80°C	100 @ 80°C
I_{TSM}	Max. peak one cycle, non-repetitive surge current (A)	700	700	1000	1000	1500	1000	1500	2500
I^2t	Max. I^2t for fusing for 5 to 8.3 msec (A^2 sec)	2000	2000	4000	4000	7000	4000	10,000	25,000
di/dt	Rate-of-rise of on-state current (A/μsec)	30	100-200	100-200	30	50-75	30	50-100	50-100
T_J	Junction operating temperature range(°C)	−40 to 125°C	−40 to 125°C	−40 to 125°C	−40 to 125°C	−40 to 125°C	−65 to 150°C	−40 to 125°C	−40 to 125°C
OFF-STATE									
dv/dt	Min. critical rate-of-rise of off-state voltage, exponential @ max. rated T_J (V/μsec)	30 TYP.	200	200 TYP.	30 TYP.	200	30 TYP.	200	200
SPECIFICATION PAGE NO.		937	1006	1010	943	1011	949	1067	CONTACT FACTORY



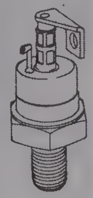
LOW CONDUCTOR LOSSES.
FOR GENERAL PURPOSE APPLICATIONS.



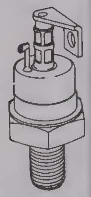
EXCELLENT dv/dt & di/dt RATINGS.
LOW POWER GATE REQUIREMENTS.



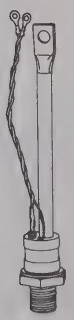
RUGGED HERMETIC PACKAGE.
¼-28 STUD. MIN DV/DT = 200 V/μSEC



VERY LOW FORWARD CONDUCTION LOSSES
& GATE POWER REQUIREMENTS.



HIGH dv/dt.
FOR MOTOR CONTROLS & POWER SUPPLIES.



150°C T_J RATING
FOR NATURAL CONVECTION APPLICATIONS.

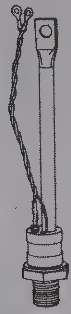
PRESS PAK FOR Θ_{J-C}
HIGH dv/dt. EXCELLENT FOR MOTOR CONTROLS & POWER SUPPLIES.

HIGH dv/dt FOR 200A CURRENT REQUIREMENTS.

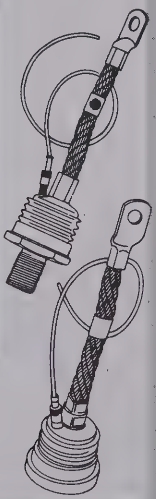
PHASE CONTROL SCR's
235 TO 470 AMPERES

GE TYPE		C180	C280	C380	C282, 283	C286, 287	C290, 291
SPECIFICATIONS							
VOLTAGE RANGE		500-1300	700-1700	500 - 1300	600 - 1700	600 - 1700	100 - 1200
CONDUCTION							
$I_{T(RMS)}$	Max. RMS on-state current (A)	235	235	380	400	400	470
$I_{T(AV)}$	Max. average on-state current @ 180° conduction (A) @ T_C	150 @ 88°C	150 @ 90°C	235 @ 80°C	200 @ 80°C	225 @ 80°C	300 @ 76°C
$I_{T(AV)}$	Max. average on-state current @ 120° conduction (A) @ T_C	122 @ 83°C	125 @ 90°C	180 @ 80°C	175 @ 80°C	200 @ 80°C	250 @ 80°C
I_{TSM}	Max. peak one cycle, non-repetitive surge current (A)	3500	3500	3500	4500	5000	5500
I^2t	Max. I^2t for fusing for 5 to 8.3 msec (A^2 sec)	50,000	50,000	50,000	85,000	100,000	120,000
di/dt	Rate-of-rise of on-state current (A/μsec)	50-100	50	50-100	50	50	50
T_J	Junction operating temperature range(°C)	—40 to 125°C	—40 to 125°C	—40 to 125°C	—40 to 120°C	—40 to 125°C	—40 to 125°C
OFF-STATE							
dv/dt	Min. critical rate-of-rise of off-state voltage, exponential @ max. rated T_J (V/μsec)	200	100	200	100	100	100
SPECIFICATION PAGE NO.		1035	1056	1089	1056	1056	1062

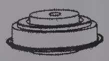
HIGH dv/dt MEDIUM VOLTAGE.
FOR DC & AC MOTOR CONTROL & POWER SUPPLIES.



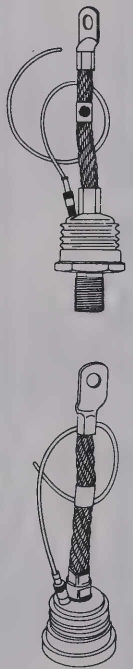
HIGH VOLTAGE. STUD PACKAGE.
FOR TAP CHANGING, AC CONTACTORS.



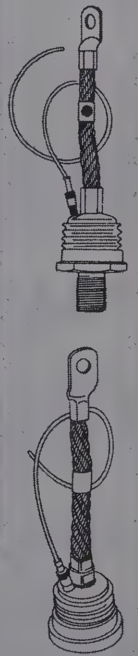
PRESS PAK VERSION OF C180.



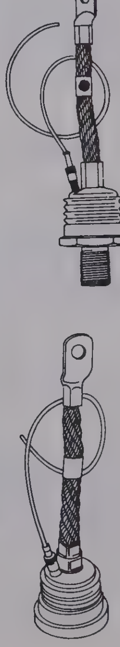
HIGH VOLTAGE. 400A CURRENT RATINGS.



HIGHEST POWER STUD PACKAGED SCR.
FOR MOTOR STARTING & AC CONTACTORS.



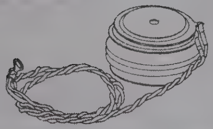
HIGHEST CURRENT STUD PACKAGED SCR.
FOR MOTOR CONTROLS & POWER SUPPLIES.



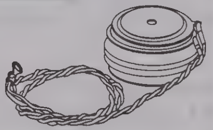
PHASE CONTROL SCR's
850 TO 1400 AMPERES

GE TYPE		C501	C530	C520	C600	C601	C602
SPECIFICATIONS							
VOLTAGE RANGE		700 - 1700	100 - 600	100 - 400	500 - 1200	1100 - 1700	1600 - 2600
CONDUCTION							
$I_{T(RMS)}$	Max. RMS on- state current (A)	850	1100	1250	1400	1100	940
$I_{T(AV)}$	Max. average on-state current @ 180° conduction (A) @ T_C	550 @ 67°C	700 @ 80°C	800 @ 75°C	900 @ 72°C	750 @ 72°C	600 @ 78°C
$I_{T(AV)}$	Max. average on-state current @ 120° conduction (A) @ T_C	400 @ 80°C	600 @ 80°C	700 @ 75°C	720 @ 80°C	600 @ 80°C	500 @ 80°C
I_{TSM}	Max. peak one cycle, non-repetitive surge current (A)	7000	10,000	10,000	13,000	10,500	6500
I^2t	Max. I^2t for fusing for 5 to 8.3 msec (A^2 sec)	200,000	415,000	415,000	700,000	516,000	176,000
di/dt	Rate-of-rise of on-state current (A/μsec)	30 - 75	75	75	30 - 75	30 - 75	30 - 75
T_J	Junction operating temperature range(°C)	—40 to 125°C	—40 to 125°C	—40 to 150°C	—40 to 125°C	—40 to 125°C	—40 to 125°C
OFF-STATE							
dv/dt	Min. critical rate-of-rise of off-state voltage, exponential @ rated T_J (V/μsec)	100	50 TYP	50 TYP	100	100	100
SPECIFICATION PAGE NO.		1133	1149	1145	1153	1157	1161

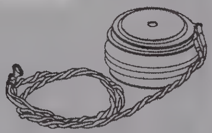
GENERAL PURPOSE HIGH POWER SCR.



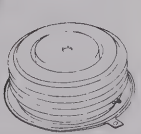
LOW CONDUCTIVE LOSSES. LOW VOLTAGE. HIGH CURRENT.
AVAILABLE IN WATER COOLED CONFIGURATION.



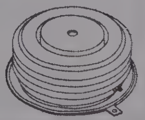
150°C T_J. [illegible]
AVAILABLE IN LIQUID COOLED HEAT EXCHANGERS.



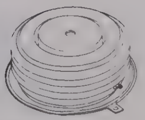
HIGH OPERATING & SURGE CURRENT RATINGS.



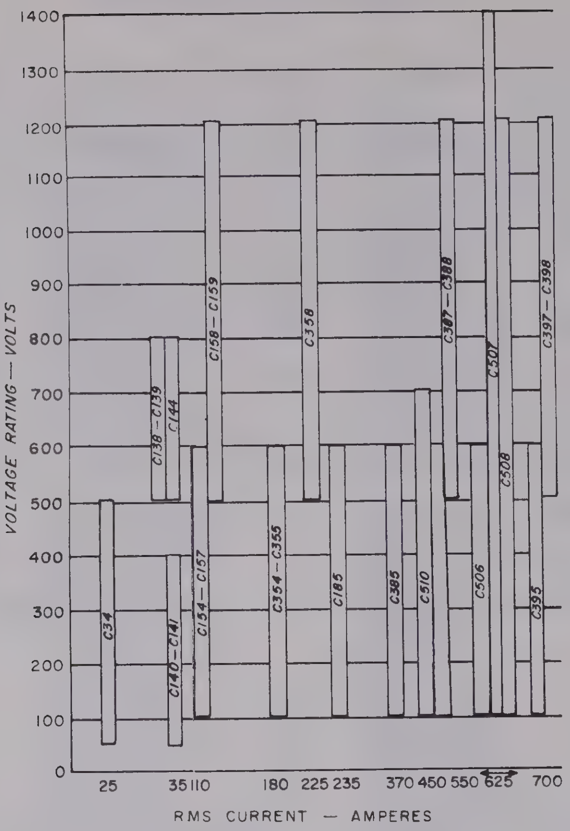
HIGH CURRENT. HIGH VOLTAGE.
FOR WELDING, HEATING & MOTOR CONTROL.



THE INDUSTRIES' HIGHEST VOLTAGE RATED SCR.
FOR CONTACTOR & MOTOR STARTING APPLICATIONS.



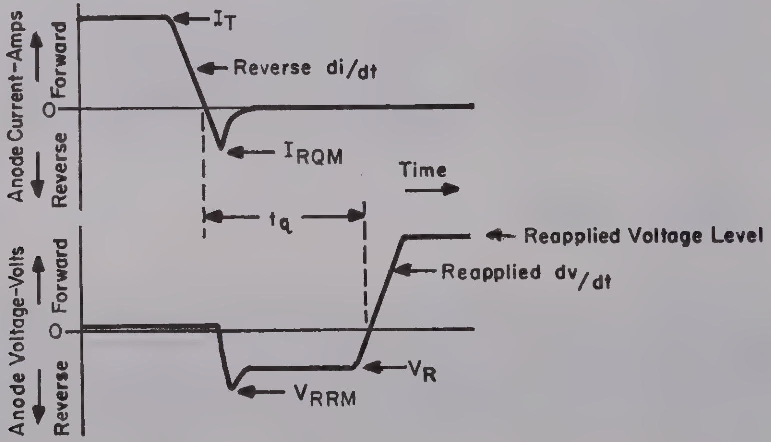
SELECTOR GUIDE
INVERTER SCR's



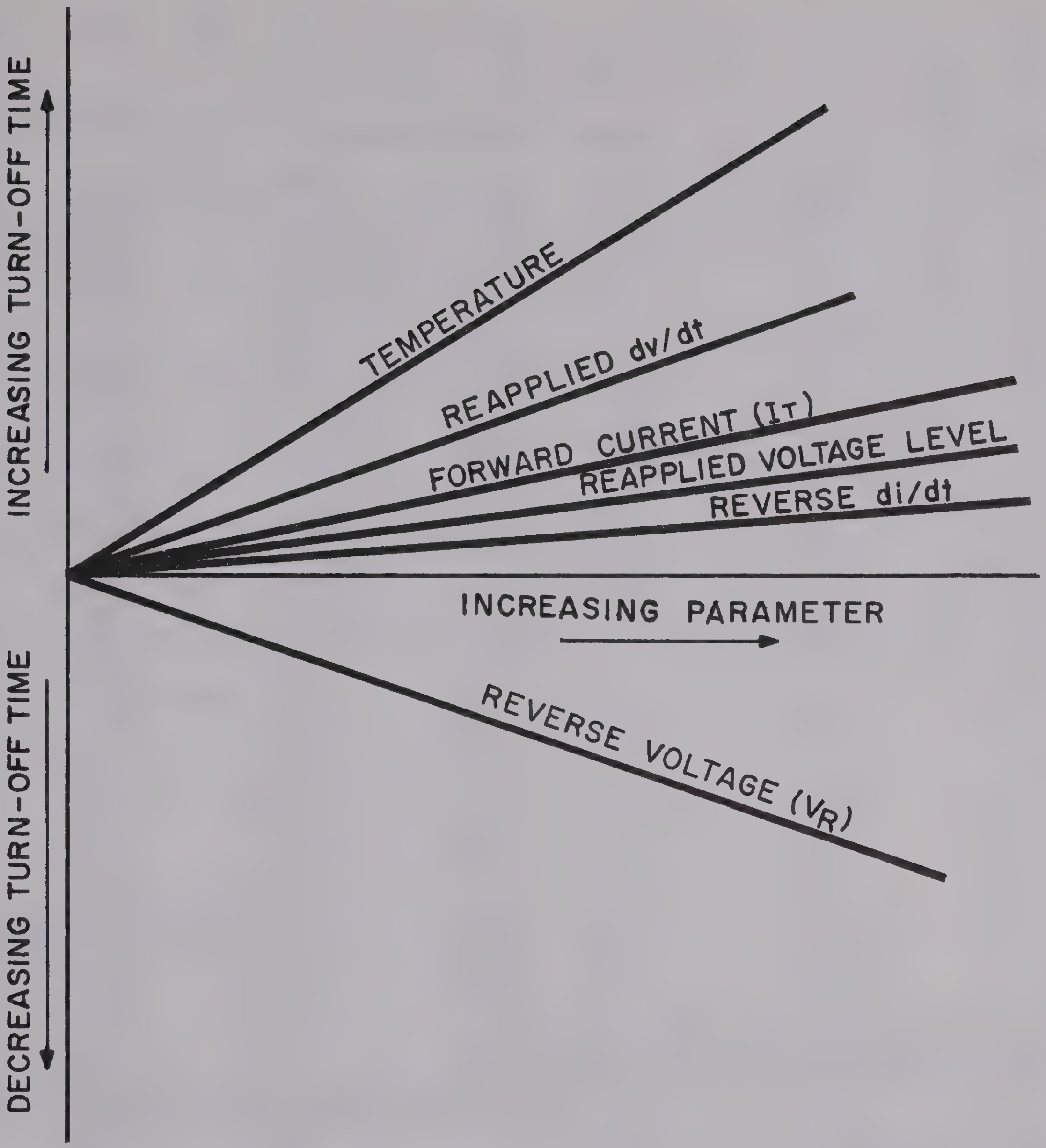
TURN-OFF TIME

Inverter SCR's (High Speed SCR's) are built to have reproducible speed characteristics. Voltage and current versus speed parameter trade-offs provide a matrix of different inverter type SCR's—each optimized for specific end use conditions.

Although consideration must be given to all parameters when designing high speed inverter circuits, special attention to turn-off time (t_q) is required to achieve optimum circuit performance. The following graphs describe SCR turn-off time.


Anode Current-Amps
Forward
Reverse
0
I_T
Reverse di/dt
I_{RQM}
Time
t_q
Anode Voltage-Volts
Forward
Reverse
0
Reapplied Voltage Level
Reapplied dv/dt
V_R
V_{RRM}

The equipment designer must determine if any of his circuit conditions are more severe than those for which the device turn-off time is specified. The following shows the general relationship of turn-off time to other SCR parameters.

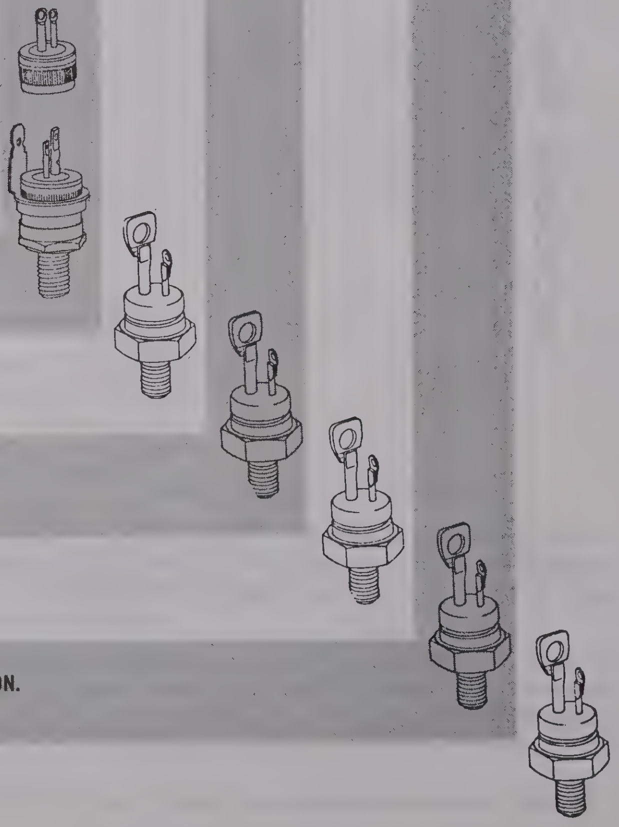


Although each type of High Speed SCR is affected to different degrees by various conditions, the directions of change remain the same. Additionally, the relative effect of each is roughly as shown above for a "generalized" High Speed SCR.

Should you determine that your conditions are more severe than those for which the turn-off time is specified, you are invited to contact General Electric to have turn-off time specified at the different conditions.

INVERTER SCR's
25 TO 35 AMPERES

		C34	C140	C141	C138	C139	C144
GE TYPE		C34	C140	C141	C138	C139	C144
JEDEC		—	2N3649-53	2N3654-58	—	—	—
SPECIFICATIONS							
VOLTAGE RANGE		50-500	50-400	50-400	500-800	500-800	500-800
CONDUCTION							
$I_{T(RMS)}$	Max. RMS on-state current @ T_C=65°C, 50% duty, (A)	25	35	35	35	35	35
	1KHz	25	26	26	26	26	32
	5KHz	—	26	26	22	22	32
	10KHz	—	20	20	18	18	30
I_{TSM}	Max. peak one cycle, non-repetitive surge current (A)	250	200	200	200	200	200
I^2t	Max. I^2t for fusing @ time (ms)	220 @ 1.0	165 @ 1.0	165 @ 1.0	165 @ 0.5	165 @ 0.5	165 @ 0.5
t_q	Max. turn-off time @ rated voltage and T_J (μsec) 20V/μsec reapplied	20	—	—	—	—	—
	@ 200V/μsec reapplied	—	15	10	10-20	10-20	15-30
di/dt	Critical rate-of-rise of on-state current (A/μsec)	—	400	400	100	100	100
T_J	Junction operating temperature range (°C)	—40 to 100	—65 to 120	—65 to 120	—65 to 125	—65 to 125	—65 to 125
OFF-STATE							
dv/dt	Min. critical rate-of-rise of off-state voltage exponential to rated V_{DRM} @ Max. rated T_J (V/μsec)	20	200	200	200	200	200
SPECIFICATION PAGE NO.		918	990	990	982	982	998



FOR COST SENSITIVE VOLUME APPLICATIONS.

CHARACTERIZED TO 25 KHz.
FOR PULSE MODULATOR & NON CRITICAL tq APPLICATIONS.

CHARACTERIZED TO 25 KHz.
FOR ULTRASONIC & CRITICAL tq APPLICATIONS.

OPTIMIZED FOR VOLTAGE & TURN-OFF.
FOR OPERATION WITH FEEDBACK DIODE.

SIMILAR TO C138, DESIGNED FOR REVERSE VOLTAGE OPERATION.
CHARACTERIZED TO 25 KHz.

OPTIMIZED FOR VOLTAGE & TURN OFF.
CHARACTERIZED TO 10 KHz.

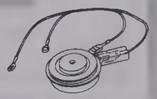
INVERTER SCR's
100-380 AMPERES

GE TYPE		C154, 156	C155, 157	C158, 159	C354	C355	C358	C185	C385
CONSTRUCTION		ALL DIFFUSED	ALL DIFFUSED	AMPLIFYING GATE	ALL DIFFUSED	ALL DIFFUSED	AMPLIFYING GATE	ALL DIFFUSED	ALL DIFFUSED
SPECIFICATIONS									
VOLTAGE RANGE		100-600	100-600	500-1200	100-600	100-600	500-1200	100-600	100-600
CONDUCTION									
$I_{T(RMS)}$	Max. forward conduction sinusodial @ $T_C = 65°C$, 50% duty (A)								
	@ 60 Hz	110	110	110	180	180	225	235	380
	@ 600 Hz	105	105	110	170	170	225	235	320
	@ 1200 Hz	102	102	110	160	160	225	210	275
	@ 2500 Hz	85	85	100	140	140	190	180	215
	@ 5000 Hz	65	65	90	120	120	125	115	170
I_{TSM}	Max. peak one cycle, non-repetitive surge current (A)	1200	1200	1600	1200	1200	1600	3500	3500
I^2t	Max. I^2t for fusing for 5 to 8.3 msec (A^2sec)	6000	6000	10,500	6000	6000	10,500	50,000	50,000
t_q	Turn-off time @ rated voltage & T_J, V_R = 50 volts min (μsec) @ 20V/μsec reapplied	10	20	30	10	20	30	20	20
	@ 100V/μsec reapplied	15	25	35	15	25	35	25	25
	@ 200V/μsec reapplied	20		40	20		40		
di/dt	Critical rate-of-rise of on-state current (A/μsec)	100	100	800	100	100	800	100	100
T_J	Junction operating temperature range (°C)	←			—40 to 125°C				→
OFF-STATE									
dv/dt	Min. critical rate-of-rise off-state voltage exponential to rated V_{DRM} @ Max. T_J (V/μsec)	200	100	200-500	200	200	200-500	200	200
SPECIFICATION PAGE NO.		1017	1017	1025	1071	1071	1079	1040	1093

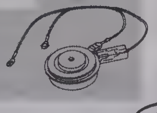
FASTEST TURN-OFF TIME AVAILABLE.
MEDIUM TO LOW FREQUENCY. LOW SWITCHING LOSSES.

FOR BATTERY VEHICLES, CHOPPERS & MOTOR CONTROLS.

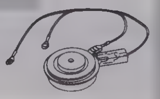
FEATURES AMPLIFYING GATE. HIGH VOLTAGE. LOW SWITCHING LOSSES.
CHARACTERIZED FOR SINUSOIDAL & RECTANGULAR WAVE FORMS.



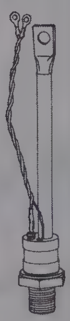
PRESS PAK, LOW SWITCHING LOSSES.
LOW THERMAL IMPEDANCE. FASTEST TURN-OFF TIME AVAILABLE.



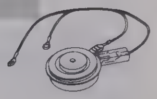
PRESS PAK VERSION OF C155.



PRESS PAK VERSION OF C158.



LOW SWITCHING LOSSES. FAST TURN-OFF.
FOR BATTERY VEHICLE & INVERTER MOTOR DRIVE.

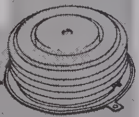


PRESS PAK VERSION OF C185.

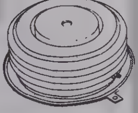
INVERTER SCR's
550-625 AMPERES

GE TYPE		C392	C393	C387	C388	C506	C507	C508
CONSTRUCTION		AMPLIFYING GATE	AMPLIFYING GATE	AMPLIFYING GATE	AMPLIFYING GATE	F-I GATE	F-I GATE	F-I GATE
SPECIFICATIONS								
VOLTAGE RANGE		100-600	100-600	500-1200	500-1200	100-600	100-1400	100-1200
CONDUCTION								
$I_{T(RMS)}$	Max. forward conduction sinusodial @ $T_C = 65°C$, 50% duty (A)							
	@ 60 Hz	550	550	550	550	625	625	625
	@ 600 Hz	450	450	530	530	625	625	625
	@ 1200 Hz	370	370	455	455	430	—	—
	@ 2500 Hz	210	210	225	225	250	—	—
	@ 5000 Hz	130	130	120	120	—	—	—
I_{TSM}	Max. peak one cycle, non-repetitive surge current (A)	5500	5500	5500	5500	8000	6500	9000
I^2t	Max. I^2t for fusing for 5 to 8.3 msec (A^2sec)	120,000	120,000	120,000	120,000	265,000	175,000	335,000
t_q	Turn-off time @ rated voltage & T_J, $V_R = 50$ V min. (μsec) @ 20V/μsec reapplied	10	15	30	20	35	100	60
	@ 100V/μsec reapplied	15	18	35	25	40	—	—
	@ 200V/μsec reapplied	20	20	40	30	—	—	—
di/dt	Critical rate-of-rise of on-state current (A/μsec)	800	800	800	800	100	50-75	50-75
T_J	Junction operating temperature range (°C)	← −40 to 125°C →						
OFF-STATE								
dv/dt	Min. critical rate-of-rise off-state voltage exponential to rated V_{DRM} @ Max. T_J (V/μsec)	200	200	200-500	200-500	200	200	200
SPECIFICATION PAGE NO.		1111	1111	1101	1101	← CONTACT FACTORY →		

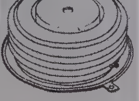
LOW SWITCHING LOSSES. FAST TURN-OFF.
FOR BATTERY VEHICLE & INVERTER MOTOR DRIVE.



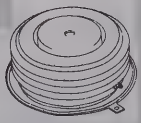
LOW SWITCHING LOSSES. FAST TURN-OFF.
FOR BATTERY VEHICLE & INVERTER MOTOR DRIVE.



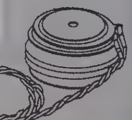
HIGH VOLTAGE.
FOR LOW-MEDIUM FREQUENCY APPLICATIONS.



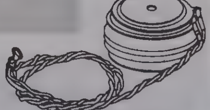
HIGH VOLTAGE. FAST TURN-OFF.
FOR MEDIUM FREQUENCY APPLICATIONS.



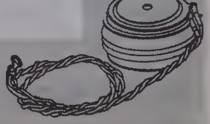
LOW VOLTAGE.
FOR MEDIUM FREQUENCY APPLICATIONS.



HIGH VOLTAGE.
FOR LOW FREQUENCY APPLICATIONS.



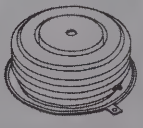
HIGH I^2t. LOW LOSS
FOR LOW FREQUENCY APPLICATIONS.



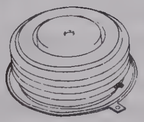
INVERTER SCR's
625-700 AMPERES

GE TYPE		C397	C398	C510	C394	C395
CONSTRUCTION		AMPLIFYING GATE	AMPLIFYING GATE	F-I GATE	AMPLIFYING GATE	AMPLIFYING GATE
SPECIFICATIONS						
VOLTAGE RANGE		500-1200	500-1200	100-700	100-600	100-600
CONDUCTION						
$I_{T(RMS)}$	Max. forward conduction sinusodial @ T_C=65°C, 50% duty (A)					
	@ 60 Hz	700	700	625	700	700
	@ 600 Hz	650	650	625	700	650
	@ 1200 Hz	550	550	300	600	550
	@ 2500 Hz	275	275	190	425	275
	@ 5000 Hz	150	150	130	290	150
I_{TSM}	Max. peak one cycle, non-repetitive surge current (A)	7500	7500	4000	8000	8000
I^2t	Max. I^2t for fusing for 5 to 8.3 msec (A^2sec)	230,000	230,000	65,000	250,000	250,000
t_q	Turn-off time @ rated voltage & T_J, V_R = 50 V min. (μsec) @ 20V/μsec reapplied	40	30	12	15	15
	@ 100V/μsec reapplied	50	35	15	18	18
	@ 200V/μsec reapplied	60	40	—	20	20
di/dt	Critical rate-of-rise of on-state current (A/μsec)	800	800	400	800	800
T_J	Junction operating temperature range (°C)	← −40 to 125°C →				
OFF-STATE						
dv/dt	Min. critical rate-of-rise off-state voltage exponential to rated V_{DRM} @ Max. T_J (V/μsec)	200-500	200-500	200	200	200
SPECIFICATION PAGE NO.		1123	1123	1138	1111	1111

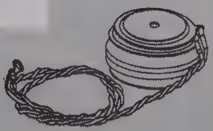
HIGH POWER.
FOR LOW FREQUENCY APPLICATIONS.



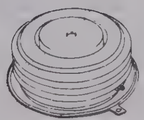
FULL CONCURRENT CHARACTERIZATION OPTIMIZED
FOR IKHz SWITCHING.



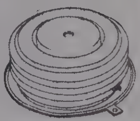
MEDIUM VOLTAGE. FAST TURN-OFF.
FOR HIGH FREQUENCY APPLICATIONS.



LOW SWITCHING LOSSES. FAST TURN-OFF.
FOR BATTERY VEHICLE & INVERTER MOTOR DRIVE.



LOW VOLTAGE. MEDIUM SPEED
FOR VERY HIGH POWER CHOPPERS, INVERTER MOTOR CONTROLS.



TRIACS

The Triac is a bi-directional triode thyristor which may be gate triggered from a blocking to a conducting state for either polarity of applied voltage. This device will perform most of the functions of two SCR's connected in inverse parallel.

The major selection parameters for Triacs are voltage, current and package. Other important parameters such as surge current, dv/dt capability and junction temperature have also been included in the selector guides, but the individual specification sheet should be consulted for final design purposes.

All Triacs are available with voltage ratings to 500 volts and can be supplied as press-fit, stud or isolated stud mounted or plastic encapsulated (up to 10A). Within each Triac family, there are three electrical classes:

- Standard Type
- Selected Gate
- 400 Hz Operation

STANDARD TYPE

This Triac is characterized for gate triggering in three modes:

MT2+, gate +
MT2+, gate −
MT2−, gate −

Commutating dv/dt and latching currents are normal.

SELECTED GATE TYPE

This Triac class can be used with any mode of gate triggering.

MT2+, gate +	MT2−, gate +
MT2−, gate −	MT2−, gate −

Latching current and commutating dv/dt are identical to the standard type. This Triac finds its particular application in dc gate triggering.

400 Hz OPERATION TYPE

As its name applies, this Triac can be used on 400 Hz line voltage. Selection criterion is commutating dv/dt.

TRIAC TRIGGER DEVICES

Because of its bilateral nature, the Triac requires its own unique trigger element, distinct from SCR's. GE offers a full line of suitable Triac triggers . The total power system is easily assembled consisting of a suitable sensor, IC, Triac and a few other passive components. The Triac may also be triggered by an SCR trigger element by using a pulse transformer.

APPLICATIONS

DEVICE	UJT PUT	SBS 2N4991-93	ST2	ST4
USE				
HEAT CONTROL	E	F	F	N
LIGHT CONTROL	F	F	F	E
MOTOR SPEED CONTROL	P	F	F	N
POWER REGULATION	E	F	F	N
SOLID STATE CONTRACTORS & RELAYS	F	F	F	N

E=EXCELLENT F=FAIR P=POOR

TYPES

CONVENTIONAL UNIJUNCTION (UJT) AND PROGRAMMABLE UNIJUNCTION TRANSISTORS (PUT)

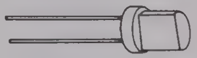
- Unilateral triggers requiring pulse transformers.
- See unijunctions, switches, & triggers selector guide. Page 124

DIAC (ST2)

- Diffused silicon bi-directional trigger diode.
- Specification sheet page 1524

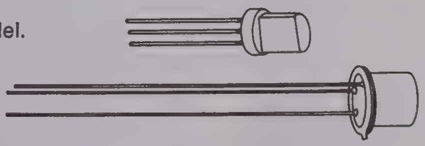
SILICON ASSYMMETRICAL SWITCH (ST4)

- Assymmetrical trigger device for hysteresis free lamp dimming circuits.
- Specification sheet page 1525



SILICON BILATERAL SWITCH (SBS)

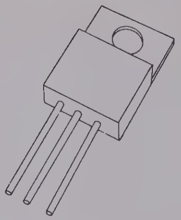
- Low voltage triac trigger, two silicon unilateral switches connected in inverse parallel.
- Specification sheet page 562 - 589

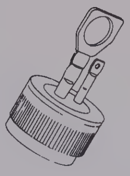


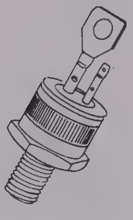
TRIACS
6 AMPERES RMS

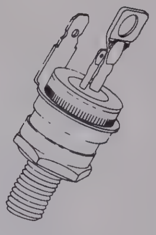
General purpose 6 ampere TRIACS with **POWER GLAS™** passivated pellets in 4 different package configurations including a silicone encapsulated **POWER PAC** series.

SPECIFICATION SHEETS
SC240/241—PAGE NO. 1499
SC141 —PAGE NO. 1491


POWER PAC


PRESS FIT


STUD


ISOLATED STUD

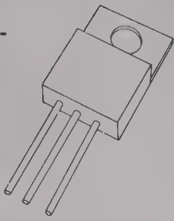
	GE Type	Package Type	V_{DRM} Repetitive Pk Off-State Voltage @Tc = —40 to 100°C (V)	Igt DC Gate Trigger Current @ 12V, 25°C Max. (mA)				Vgt DC Gate Trigger Voltage @ 12V, 25°C Max. (V)				dv/dt Static @ 100°C Rated V_{DRM} Gate Open Typical (V/μsec)	dv/dt Commutating @ 75°C Rated V_{DRM} and I_T Gate Open Min. (V/μsec)	I_{DRM} Leakage Current @ 25°C Max. (mA)	I_{TSM} Surge Current @ 60 Hz One Cycle Non-repetitive Max. (A)
				MT_2 + Gate +	+ —	— —	— +	MT_2 + Gate +	+ —	— —	— +				
Standard	SC241B	Press Fit	200	50	50	50	—	2.5	2.5	2.5	—	20	4.0[2]	0.1	80
	SC240B	Stud	200	50	50	50	—	2.5	2.5	2.5	—	20	4.0[2]	0.1	80
	SC240B2	Isolated Stud	200	50	50	50	—	2.5	2.5	2.5	—	20	4.0[2]	0.1	80
	SC141B	Power Pac	200	50	50	50	—	2.5	2.5	2.5	—	20	4.0[2]	0.1	80
	SC241D	Press Fit	400	50	50	50	—	2.5	2.5	2.5	—	20	4.0[2]	0.1	80
	SC240D	Stud	400	50	50	50	—	2.5	2.5	2.5	—	20	4.0[2]	0.1	80
	SC240D2	Isolated Stud	400	50	50	50	—	2.5	2.5	2.5	—	20	4.0[2]	0.1	80
	SC141D	Power Pac	400	50	50	50	—	2.5	2.5	2.5	—	20	4.0[2]	0.1	80
	SC241E	Press Fit	500	50	50	50	—	2.5	2.5	2.5	—	20	4.0[2]	0.1	80
	SC240E	Stud	500	50	50	50	—	2.5	2.5	2.5	—	20	4.0[2]	0.1	80
	SC240E2	Isolated Stud	500	50	50	50	—	2.5	2.5	2.5	—	20	4.0[2]	0.1	80
Zero Voltage Switch	SC241B12	Press Fit	200	—	30[1]	30[1]	—	—	2.0[1]	2.0[1]	—	20	4.0[2]	0.1	80
	SC240B12	Stud	200	—	30[1]	30[1]	—	—	2.0[1]	2.0[1]	—	20	4.0[2]	0.1	80
	SC240B22	Isolated Stud	200	—	30[1]	30[1]	—	—	2.0[1]	2.0[1]	—	20	4.0[2]	0.1	80
	SC241D12	Press Fit	400	—	30[1]	30[1]	—	—	2.0[1]	2.0[1]	—	20	4.0[2]	0.1	80
	SC240D12	Stud	400	—	30[1]	30[1]	—	—	2.0[1]	2.0[1]	—	20	4.0[2]	0.1	80
	SC240D22	Isolated Stud	400	—	30[1]	30[1]	—	—	2.0[1]	2.0[1]	—	20	4.0[2]	0.1	80
	SC241E12	Press Fit	500	—	30[1]	30[1]	—	—	2.0[1]	2.0[1]	—	20	4.0[2]	0.1	80
	SC240E12	Stud	500	—	30[1]	30[1]	—	—	2.0[1]	2.0[1]	—	20	4.0[2]	0.1	80
	SC240E22	Isolated Stud	500	—	30[1]	30[1]	—	—	2.0[1]	2.0[1]	—	20	4.0[2]	0.1	80
Selected Gate	SC241B13	Press Fit	200	25	25	25	25	2.0	2.0	2.0	2.0	20	4.0[2]	0.1	80
	SC240B13	Stud	200	25	25	25	25	2.0	2.0	2.0	2.0	20	4.0[2]	0.1	80
	SC240B23	Isolated Stud	200	25	25	25	25	2.0	2.0	2.0	2.0	20	4.0[2]	0.1	80
	SC241D13	Press Fit	400	25	25	25	25	2.0	2.0	2.0	2.0	20	4.0[2]	0.1	80
	SC240D13	Stud	400	25	25	25	25	2.0	2.0	2.0	2.0	20	4.0[2]	0.1	80
	SC240D23	Isolated Stud	400	25	25	25	25	2.0	2.0	2.0	2.0	20	4.0[2]	0.1	80
	SC241E13	Press Fit	500	25	25	25	25	2.0	2.0	2.0	2.0	20	4.0[2]	0.1	80
	SC240E13	Stud	500	25	25	25	25	2.0	2.0	2.0	2.0	20	4.0[2]	0.1	80
	SC240E23	Isolated Stud	500	25	25	25	25	2.0	2.0	2.0	2.0	20	4.0[2]	0.1	80
400 Hz Operation	SC241B14	Press Fit	200	50	50	50	—	2.5	2.5	2.5	—	20	4.0[3]	0.1	173 @ 400Hz
	SC240B14	Stud	200	50	50	50	—	2.5	2.5	2.5	—	20	4.0[3]	0.1	173 @ 400Hz
	SC240B24	Isolated Stud	200	50	50	50	—	2.5	2.5	2.5	—	20	4.0[3]	0.1	173 @ 400Hz
	SC241D14	Press Fit	400	50	50	50	—	2.5	2.5	2.5	—	20	4.0[3]	0.1	173 @ 400Hz
	SC240D14	Stud	400	50	50	50	—	2.5	2.5	2.5	—	20	4.0[3]	0.1	173 @ 400Hz
	SC240D24	Isolated Stud	400	50	50	50	—	2.5	2.5	2.5	—	20	4.0[3]	0.1	173 @ 400Hz
	SC241E14	Press Fit	500	50	50	50	—	2.5	2.5	2.5	—	20	4.0[3]	0.1	173 @ 400Hz
	SC240E14	Stud	500	50	50	50	—	2.5	2.5	2.5	—	20	4.0[3]	0.1	173 @ 400Hz
	SC240E24	Isolated Stud	500	50	50	50	—	2.5	2.5	2.5	—	20	4.0[3]	0.1	173 @ 400Hz

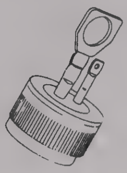
---

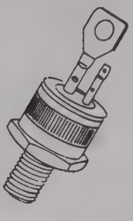
[1] Pulse Condition V_D = 3V, Gate Pulse Width = 50 μsec
[2] Commutating di/dt = 3.2 A/msec
[3] Commutating di/dt = 21.5 A/msec
TM Trademark of General Electric Company

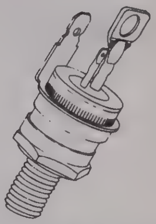
TRIACS
10 AMPERES RMS

General Purpose 10 ampere TRIACS with **POWER GLAS** ™ passivated pellets in 4 different package configurations including a silicone encapsulated **POWER PAC** series.


POWER PAC


PRESS FIT


STUD


ISOLATED STUD

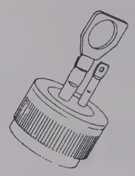
SPECIFICATION SHEETS
SC245/246—PAGE NO. 1507
SC146 —PAGE NO. 1491

	GE Type	Package Type	V_{DRM} Repetitive Pk Off-State Voltage @T_C = —40 to 100°C (V)	I_{gt} DC Gate Trigger Current @ 12V, 25°C Max. (mA)				V_{gt} DC Gate Trigger Voltage @ 12V, 25°C Max. (V)				dv/dt Static @ 100°C Rated V_{DRM} Gate Open Typical (V/µsec)	dv/dt Commutating @ 75°C Rated V_{DRM} and I_T Gate Open Min. (V/µsec)	I_{DRM} Leakage Current @ 25°C Max. (mA)	I_{TSM} Surge @ 60 Hz Current One Cycle Non-repetitive Max. (A)
				MT_2 + Gate +	+ —	— —	— +	MT_2 + Gate +	+ —	— —	— +				
Standard	SC246B	Press Fit	200	50	50	50	—	2.5	2.5	2.5	—	20	4.0 [2]	0.1	100
	SC245B	Stud	200	50	50	50	—	2.5	2.5	2.5	—	20	4.0 [2]	0.1	100
	SC245B2	Isolated Stud	200	50	50	50	—	2.5	2.5	2.5	—	20	4.0 [2]	0.1	100
	SC146B	Power Pac [4]	200	50	50	50	—	2.5	2.5	2.5	—	20	4.0 [2]	0.1	80
	SC246D	Press Fit	400	50	50	50	—	2.5	2.5	2.5	—	20	4.0 [2]	0.1	100
	SC245D	Stud	400	50	50	50	—	2.5	2.5	2.5	—	20	4.0 [2]	0.1	100
	SC245D2	Isolated Stud	400	50	50	50	—	2.5	2.5	2.5	—	20	4.0 [2]	0.1	100
	SC146D	Power Pac [4]	400	50	50	50	—	2.5	2.5	2.5	—	20	4.0 [2]	0.1	80
	SC246E	Press Fit	500	50	50	50	—	2.5	2.5	2.5	—	20	4.0 [2]	0.1	100
	SC245E	Stud	500	50	50	50	—	2.5	2.5	2.5	—	20	4.0 [2]	0.1	100
	SC245E2	Isolated Stud	500	50	50	50	—	2.5	2.5	2.5	—	20	4.0 [2]	0.1	100
Zero Voltage Switch	SC246B12	Press Fit	200	—	30 [1]	30 [1]	—	—	2.0 [1]	2.0 [1]	—	20	4.0 [2]	0.1	100
	SC245B12	Stud	200	—	30 [1]	30 [1]	—	—	2.0 [1]	2.0 [1]	—	20	4.0 [2]	0.1	100
	SC245B22	Isolated Stud	200	—	30 [1]	30 [1]	—	—	2.0 [1]	2.0 [1]	—	20	4.0 [2]	0.1	100
	SC246D12	Press Fit	400	—	30 [1]	30 [1]	—	—	2.0 [1]	2.0 [1]	—	20	4.0 [2]	0.1	100
	SC245D12	Stud	400	—	30 [1]	30 [1]	—	—	2.0 [1]	2.0 [1]	—	20	4.0 [2]	0.1	100
	SC245D22	Isolated Stud	400	—	30 [1]	30 [1]	—	—	2.0 [1]	2.0 [1]	—	20	4.0 [2]	0.1	100
	SC246D12	Press Fit	500	—	30 [1]	30 [1]	—	—	2.0 [1]	2.0 [1]	—	20	4.0 [2]	0.1	100
	SC245E12	Stud	500	—	30 [1]	30 [1]	—	—	2.0 [1]	2.0 [1]	—	20	4.0 [2]	0.1	100
	SC245E22	Isolated Stud	500	—	30 [1]	30 [1]	—	—	2.0 [1]	2.0 [1]	—	20	4.0 [2]	0.1	100
Selected Gate	SC246B13	Press Fit	200	25	25	25	25	2.0	2.0	2.0	2.0	20	4.0 [2]	0.1	100
	SC245B13	Stud	200	25	25	25	25	2.0	2.0	2.0	2.0	20	4.0 [2]	0.1	100
	SC245B23	Isolated Stud	200	25	25	25	25	2.0	2.0	2.0	2.0	20	4.0 [2]	0.1	100
	SC246D13	Press Fit	400	25	25	25	25	2.0	2.0	2.0	2.0	20	4.0 [2]	0.1	100
	SC245D13	Stud	400	25	25	25	25	2.0	2.0	2.0	2.0	20	4.0 [2]	0.1	100
	SC245D23	Isolated Stud	400	25	25	25	25	2.0	2.0	2.0	2.0	20	4.0 [2]	0.1	100
	SC246E13	Press Fit	500	25	25	25	25	2.0	2.0	2.0	2.0	20	4.0 [2]	0.1	100
	SC245E13	Stud	500	25	25	25	25	2.0	2.0	2.0	2.0	20	4.0 [2]	0.1	100
	SC245E23	Isolated Stud	500	25	25	25	25	2.0	2.0	2.0	2.0	20	4.0 [2]	0.1	100
400 Hz Operation	SC246B14	Press Fit	200	50	50	50	—	2.5	2.5	2.5	—	20	4.0 [3]	0.1	187 @ 400Hz
	SC245B24	Stud	200	50	50	50	—	2.5	2.5	2.5	—	20	4.0 [3]	0.1	187 @ 400Hz
	SC245B24	Isolated Stud	200	50	50	50	—	2.5	2.5	2.5	—	20	4.0 [3]	0.1	187 @ 400Hz
	SC246D14	Press Fit	400	50	50	50	—	2.5	2.5	2.5	—	20	4.0 [3]	0.1	187 @ 400Hz
	SC245D14	Stud	400	50	50	50	—	2.5	2.5	2.5	—	20	4.0 [3]	0.1	187 @ 400Hz
	SC245D24	Isolated Stud	400	50	50	50	—	2.5	2.5	2.5	—	20	4.0 [3]	0.1	187 @ 400Hz
	SC246E14	Press Fit	500	50	50	50	—	2.5	2.5	2.5	—	20	4.0 [3]	0.1	187 @ 400Hz
	SC245E14	Stud	500	50	50	50	—	2.5	2.5	2.5	—	20	4.0 [3]	0.1	187 @ 400Hz
	SC245E24	Isolated Stud	500	50	50	50	—	2.5	2.5	2.5	—	20	4.0 [3]	0.1	187 @ 400Hz

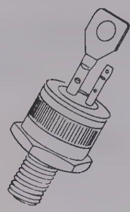
[1] Pulse Conditions V_D = 3V, Gate Pulse Width = 50 µsec
[2] Commutating di/dt = 5.4 A/msec
[3] Commutating di/dt = 36 A/msec
TM Trademark of General Electric Company

TRIACS
15 AMPERES RMS

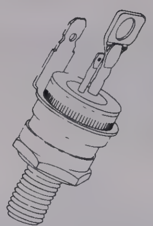
General purpose 15 ampere TRIACS with **POWER GLAS**™ passivated pellets for reliability.



PRESS FIT



STUD



ISOLATED STUD

SPECIFICATION PAGE NO. 1515

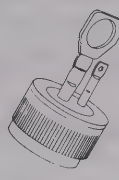
	GE Type	Package Type	V$_{DRM}$ Repetitive Pk Off-State Voltage @T$_C$ = −40 to 115°C (V)	Igt DC Gate Trigger Current @ 12V, 25°C Max. (mA)				Vgt DC Gate Trigger Voltage @ 12V, 25°C Max. (V)				dv/dt Static @ 115°C Rated V$_{DRM}$ Gate Open Typical (V/μsec)	dv/dt Commutating @ 80°C Rated V$_{DRM}$ and I$_T$ Gate Open Min. (V/μsec)	I$_{DRM}$ Leakage Current @ 25°C Max. (mA)	I$_{TSM}$ Surge Current @ 60 Hz One Cycle Non-repetitive Max. (A)
				MT$_2$ +	+	−	−	MT$_2$ +	+	−	−				
				Gate +	−	−	+	Gate +	−	−	+				
Standard	SC251B	Press Fit	200	50	50	50	—	2.5	2.5	2.5	—	20	4.0[2]	0.1	100
	SC250B	Stud	200	50	50	50	—	2.5	2.5	2.5	—	20	4.0[2]	0.1	100
	SC250B2	Isolated Stud	200	50	50	50	—	2.5	2.5	2.5	—	20	4.0[2]	0.1	100
	SC251D	Press Fit	400	50	50	50	—	2.5	2.5	2.5	—	20	4.0[2]	0.1	100
	SC250D	Stud	400	50	50	50	—	2.5	2.5	2.5	—	20	4.0[2]	0.1	100
	SC250D2	Isolated Stud	400	50	50	50	—	2.5	2.5	2.5	—	20	4.0[2]	0.1	100
	SC251E	Press Fit	500	50	50	50	—	2.5	2.5	2.5	—	20	4.0[2]	0.1	100
	SC250E	Stud	500	50	50	50	—	2.5	2.5	2.5	—	20	4.0[2]	0.1	100
	SC250E2	Isolated Stud	500	50	50	50	—	2.5	2.5	2.5	—	20	4.0[2]	0.1	100
Zero Voltage Switch	SC251B12	Press Fit	200	—	30[1]	30[1]	—	—	2.0[1]	2.0[1]	—	20	4.0[2]	0.1	100
	SC250B12	Stud	200	—	30[1]	30[1]	—	—	2.0[1]	2.0[1]	—	20	4.0[2]	0.1	100
	SC250B22	Isolated Stud	200	—	30[1]	30[1]	—	—	2.0[1]	2.0[1]	—	20	4.0[2]	0.1	100
	SC251D12	Press Fit	400	—	30[1]	30[1]	—	—	2.0[1]	2.0[1]	—	20	4.0[2]	0.1	100
	SC250D12	Stud	400	—	30[1]	30[1]	—	—	2.0[1]	2.0[1]	—	20	4.0[2]	0.1	100
	SC250E12	Isolated Stud	400	—	30[1]	30[1]	—	—	2.0[1]	2.0[1]	—	20	4.0[2]	0.1	100
	SC251E12	Press Fit	500	—	30[1]	30[1]	—	—	2.0[1]	2.0[1]	—	20	4.0[2]	0.1	100
	SC250E12	Stud	500	—	30[1]	30[1]	—	—	2.0[1]	2.0[1]	—	20	4.0[2]	0.1	100
	SC250E22	Isolated Stud	500	—	30[1]	30[1]	—	—	2.0[1]	2.0[1]	—	20	4.0[2]	0.1	100
Selected Gate	SC251B13	Press Fit	200	25	25	25	25	2.0	2.0	2.0	2.0	20	4.0[2]	0.1	100
	SC250B13	Stud	200	25	25	25	25	2.0	2.0	2.0	2.0	20	4.0[2]	0.1	100
	SC250B23	Isolated Stud	200	25	25	25	25	2.0	2.0	2.0	2.0	20	4.0[2]	0.1	100
	SC251D13	Press Fit	400	25	25	25	25	2.0	2.0	2.0	2.0	20	4.0[2]	0.1	100
	SC250D13	Stud	400	25	25	25	25	2.0	2.0	2.0	2.0	20	4.0[2]	0.1	100
	SC250D23	Isolated Stud	400	25	25	25	25	2.0	2.0	2.0	2.0	20	4.0[2]	0.1	100
	SC251E13	Press Fit	500	25	25	25	25	2.0	2.0	2.0	2.0	20	4.0[2]	0.1	100
	SC250E13	Stud	500	25	25	25	25	2.0	2.0	2.0	2.0	20	4.0[2]	0.1	100
	SC250E23	Isolated Stud	500	25	25	25	25	2.0	2.0	2.0	2.0	20	4.0[2]	0.1	100
400 Hz Operation	SC251B14	Press Fit	200	50	50	50	—	2.5	2.5	2.5	2.0	20	4.0[3]	0.1	187 @ 400Hz
	SC250B14	Stud	200	50	50	50	—	2.5	2.5	2.5	2.0	20	4.0[3]	0.1	187 @ 400Hz
	SC250B24	Isolated Stud	200	50	50	50	—	2.5	2.5	2.5	2.0	20	4.0[3]	0.1	187 @ 400Hz
	SC251D14	Press Fit	400	50	50	50	—	2.5	2.5	2.5	2.0	20	4.0[3]	0.1	187 @ 400Hz
	SC250D14	Stud	400	50	50	50	—	2.5	2.5	2.5	2.0	20	4.0[3]	0.1	187 @ 400Hz
	SC250D24	Isolated Stud	400	50	50	50	—	2.5	2.5	2.5	2.0	20	4.0[3]	0.1	187 @ 400Hz
	SC251E14	Press Fit	500	50	50	50	—	2.5	2.5	2.5	2.0	20	4.0[3]	0.1	187 @ 400Hz
	SC250E14	Stud	500	50	50	50	—	2.5	2.5	2.5	2.0	20	4.0[3]	0.1	187 @ 400Hz
	SC250E24	Isolated Stud	500	50	50	50	—	2.5	2.5	2.5	2.0	20	4.0[3]	0.1	187 @ 400Hz

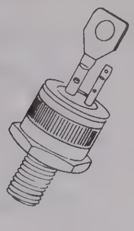
(1) Pulse conditions V$_D$ = 3V, gate pulse width = 50μsec.
(2) Commutating di/dt = 8A/Msec.
(3) Commutating di/dt = 54A/Msec.
TM Trademark of General Electric Company

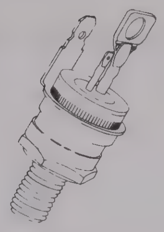
TRIACS
25 AMPERES RMS

General Purpose 25 ampere TRIACS in 3 different package configurations.

SPECIFICATION PAGE NO. 1483


PRESS FIT


STUD


ISOLATED STUD

	GE Type	Package Type	V_{DRM} Repetitive Pk Off-State Voltage @T_C = —40 to 115°C (V)	Igt DC Gate Trigger Current @ 12V, 25°C Max. (mA)				Vgt DC Gate Trigger Voltage @ 12V, 25°C Max. (V)				dv/dt Static @ 100°C Rated V_{DRM} Gate Open Typical (V/μsec)	dv/dt Commutating @ 80°C Rated V_{DRM} and I_T Gate Open Min. (V/μsec)	I_{DRM} Leakage Current @ 25°C Max. (mA)	I_{TSM} Surge Current @ 60 Hz One Cycle Non-repetitive Max. (A)
				MT_2 +	—	—	+	MT_2 +	—	—	+				
				Gate +	+	—	—	Gate +	+	—	—				
Standard	SC61B	Press Fit	200	50	50	50	—	2.5	2.5	2.5	—	100	5.0	0.5	250
	SC60B	Stud	200	50	50	50	—	2.5	2.5	2.5	—	100	5.0	0.5	250
	SC60B2	Isolated Stud	200	50	50	50	—	2.5	2.5	2.5	—	100	5.0	0.5	250
	SC61D	Press Fit	400	50	50	50	—	2.5	2.5	2.5	—	100	5.0	0.5	250
	SC60D	Stud	400	50	50	50	—	2.5	2.5	2.5	—	100	5.0	0.5	250
	SC60D2	Isolated Stud	400	50	50	50	—	2.5	2.5	2.5	—	100	5.0	0.5	250
	SC61E	Press Fit	500	50	50	50	—	2.5	2.5	2.5	—	100	5.0	0.5	250
	SC60E	Stud	500	50	50	50	—	2.5	2.5	2.5	—	100	5.0	0.5	250
	SC60E2	Isolated Stud	500	50	50	50	—	2.5	2.5	2.5	—	100	5.0	0.5	250
Zero Voltage Switch	SC61B12	Press Fit	200	—	30[1]	30[1]	—	—	2.0[1]	2.0[1]	—	100	5.0	0.5	250
	SC60B12	Stud	200	—	30[1]	30[1]	—	—	2.0[1]	2.0[1]	—	100	5.0	0.5	250
	SC60B22	Isolated Stud	200	—	30[1]	30[1]	—	—	2.0[1]	2.0[1]	—	100	5.0	0.5	250
	SC61D12	Press Fit	400	—	30[1]	30[1]	—	—	2.0[1]	2.0[1]	—	100	5.0	0.5	250
	SC60D12	Stud	400	—	30[1]	30[1]	—	—	2.0[1]	2.0[1]	—	100	5.0	0.5	250
	SC60D22	Isolated Stud	400	—	30[1]	30[1]	—	—	2.0[1]	2.0[1]	—	100	5.0	0.5	250
	SC61E12	Press Fit	500	—	30[1]	30[1]	—	—	2.0[1]	2.0[1]	—	100	5.0	0.5	250
	SC60E12	Stud	500	—	30[1]	30[1]	—	—	2.0[1]	2.0[1]	—	100	5.0	0.5	250
	SC60E22	Isolated Stud	500	—	30[1]	30[1]	—	—	2.0[1]	2.0[1]	—	100	5.0	0.5	250
Selected Gate	SC61B13	Press Fit	200	50	50	50	50	2.5	2.5	2.5	2.5	100	5.0	0.5	250
	SC60B13	Stud	200	50	50	50	50	2.5	2.5	2.5	2.5	100	5.0	0.5	250
	SC60B23	Isolated Stud	200	50	50	50	50	2.5	2.5	2.5	2.5	100	5.0	0.5	250
	SC61D13	Press Fit	400	50	50	50	50	2.5	2.5	2.5	2.5	100	5.0	0.5	250
	SC60D13	Stud	400	50	50	50	50	2.5	2.5	2.5	2.5	100	5.0	0.5	250
	SC60D23	Isolated Stud	400	50	50	50	50	2.5	2.5	2.5	2.5	100	5.0	0.5	250
	SC61E13	Press Fit	500	50	50	50	50	2.5	2.5	2.5	2.5	100	5.0	0.5	250
	SC60E13	Stud	500	50	50	50	50	2.5	2.5	2.5	2.5	100	5.0	0.5	250
	SC60E23	Isolated Stud	500	50	50	50	50	2.5	2.5	2.5	2.5	100	5.0	0.5	250
400 Hz Operation	SC61B14	Press Fit	200	50	50	50	—	2.5	2.5	2.5	—	100	5.0[3]	0.5	510 @ 400Hz
	SC60B14	Stud	200	50	50	50	—	2.5	2.5	2.5	—	100	5.0[3]	0.5	510 @ 400Hz
	SC60B24	Isolated Stud	200	50	50	50	—	2.5	2.5	2.5	—	100	5.0[3]	0.5	510 @ 400Hz
	SC61D14	Press Fit	400	50	50	50	—	2.5	2.5	2.5	—	100	5.0[3]	0.5	510 @ 400Hz
	SC60D14	Stud	400	50	50	50	—	2.5	2.5	2.5	—	100	5.0[3]	0.5	510 @ 400Hz
	SC60D24	Isolated Stud	400	50	50	50	—	2.5	2.5	2.5	—	100	5.0[3]	0.5	510 @ 400Hz
	SC61E14	Press Fit	500	50	50	50	—	2.5	2.5	2.5	—	100	5.0[3]	0.5	510 @ 400Hz
	SC60E14	Stud	500	50	50	50	—	2.5	2.5	2.5	—	100	5.0[3]	0.5	510 @ 400Hz
	SC60E24	Isolated Stud	500	50	50	50	—	2.5	2.5	2.5	—	100	5.0[3]	0.5	510 @ 400Hz

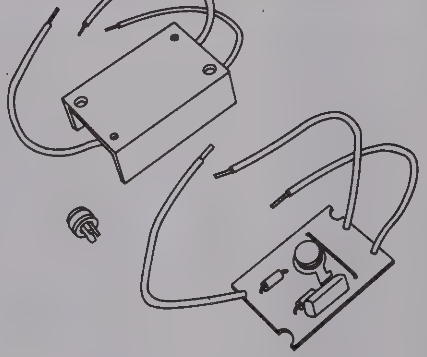
[1] Pulse Condition V_D = 3V, Gate Pulse Width = 50 μsec
[2] Commutating di/dt = 13.5 A/msec
[3] Commutating di/dt = 89 A/msec

SPECIFY GE SOLID-STATE SUB-ASSEMBLIES FOR A WIDE VARIETY OF CUSTOMER APPLICATIONS

- variable voltage AC controls
- AC motor speed controls
- static switching
- zero-voltage switching AC power controls
- temperature controls
- thyratron and high voltage rectifier tube replacements

"S100"—STANDARD TRIAC CIRCUIT SUB-ASSEMBLIES

- **Available in ratings of 6, 10 and 15 amperes (RMS) at 120 or 240 volts (RMS), the seven circuit configurations offer 42 different sub-assemblies in one "family" package type (1 x 2 x 3 inches).**
- **As circuit diagram titles imply, the variations allow usage in a wide variety of applications where the ability to vary applied voltage is desired. Such usage includes a simple voltage control, shaded-pole or permanent split-capacitor type motor speed control, resistance heating control, and many others.**

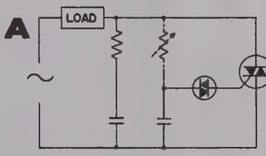


NOMENCLATURE

S100 | — | —

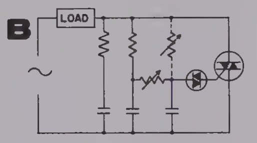
SCHEMATICS

A



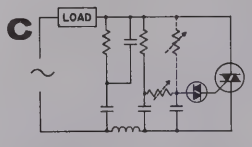
BASIC VARIABLE VOLTAGE ASSEMBLY

B



EXTENDED RANGE VARIABLE VOLTAGE ASSEMBLY

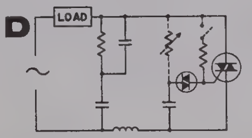
C



EXTENDED RANGE VARIABLE VOLTAGE ASSEMBLY WITH RFI SUPPRESSION

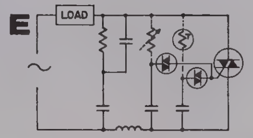
SUFFIX	CURRENT	VOLTAGE
1	6A	120V
2	6A	240V
3	10A	120V
4	10A	240V
5	15A	120V
6	15A	240V

D



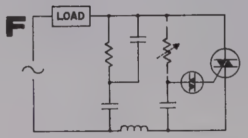
COMBINATION STATIC SWITCH AND VARIABLE VOLTAGE CONTROL WITH RFI SUPPRESSION

E



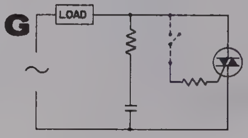
FURNACE BLOWER MOTOR SPEED CONTROL WITH LOW SPEED LIMIT (RFI SUPPRESSED)

F



BASIC VARIABLE VOLTAGE ASSEMBLY WITH RFI SUPPRESSION

G



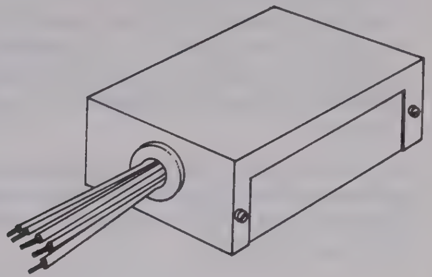
A-C STATIC SWITCH ASSEMBLY

SPECIFICATION SHEET PAGE 1439 – 1446

"S200"—AC POWER CONTROLLERS

Features:

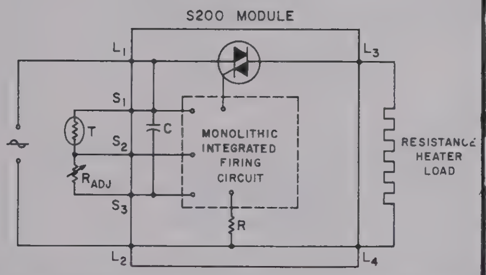
- Available ratings of 10 and 15 amperes (RMS) at 120, 240 and 277 volts (RMS) for controlling resistive loads from 500 to 4150 watts.
- "Zero-Voltage Switching" provides much lower RFI levels than are possible with mechanical contacts.
- All solid-state control for long life and high reliability.
- Capable of operating with a variety of variable resistance sensors such as thermistors, photo-resistors, humidity sensitive devices, etc.
- High input impedance allows use of sensors operating at any point from 5K to 100K ohms.
- Control point repeatability better than ±5.0% of sensor resistance.



NOMENCLATURE

S200A	—

SCHEMATIC



SUFFIX	CURRENT	VOLTAGE
1	10A	120V
2	10A	240V
21	10A	277V
3	15A	120V
4	15A	240V
41	15A	277V

Contact factory for special types

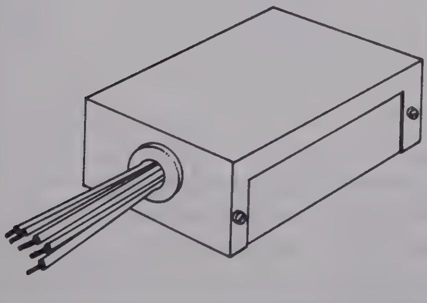
SPECIFICATION SHEET PAGE 1447

"S300"—PHASE CONTROL POWER MODULES WITH FEEDBACK

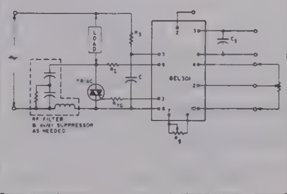
- Available in ratings of 6, 10 and 15 amperes (RMS) at 120 or 240 volts (RMS), for controlling resistive or inductive motor loads up to 3600 watts.
- All solid-state control for long life and high reliability.
- Capable of operating with a variety of variable resistance sensors (thermistors, photo-resistors, humidity sensitive resistors, etc.) as well as DC tachometer signals.
- High input impedance allows use of sensors operating at any point from 5K or 100K ohms.
- High gain trigger circuitry allows wide range of controlled output with small changes in input signal
- Adjustable gain allows module usage in a variety of AC motor speed control applications.
- Voltage-regulated (zener) control circuit provides stability in supply voltage variations.
- Ambient compensated for stability during temperature fluctuations.
- Inductive load logic allows use with any resistive or lagging power factor motor loads. Minimizes DC components commonly found in phase-controlled inductive load circuits.
- Radio frequency interference suppression network minimizes conducted and radiated RFI.

NOMENCLATURE

S300A	—



SCHEMATIC

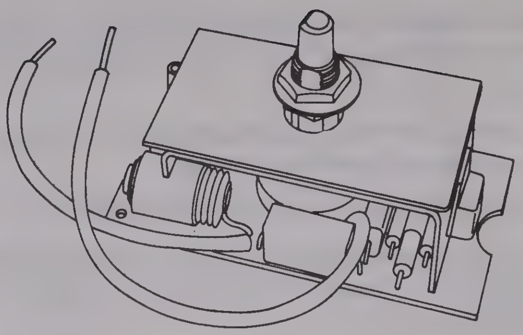


SUFFIX	CURRENT	VOLTAGE
1	6A	120V
2	6A	240V
3	10A	120V
4	10A	240V
5	15A	120V
6	15A	240V

SPECIFICATION SHEET PAGE 1450

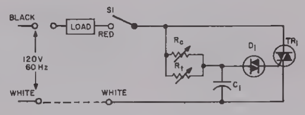
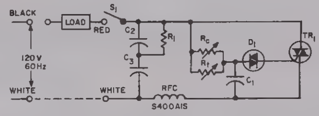
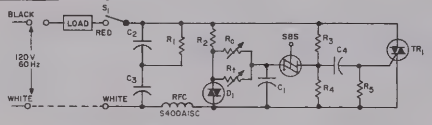
"S400"—FAN MOTOR SPEED CONTROLS

- All models rated at 4.0 amperes, 120 volts (RMS).
- Optimized circuit for primary use as fan motor speed control.
- All solid-state control for long life and high reliability.
- Line voltage compensation feature automatically compensates for input variations of ±12 volts, from 108 to 132 volts. Output variation limited to ±3 volts.
- Capable of operating in a wide variety of applications, within its rating, such as; room air conditioners, window fans, fan and coil air conditioners, exhaust fans, unit heaters and coolers, centrifugal pumps, air curtains, dehumidifiers and vacuum cleaners.
- All units include; a main control potentiometer, a trimmer potentiometer for adjusting minimum output voltage, a self-contained copper heatsink, and UL approved printed circuit board and line switch.



NOMENCLATURE

S400A —

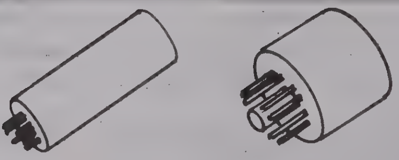
SCHEMATICS	SUFFIX	FUNCTION
 BLACK LOAD RED SI 120V 60Hz Rc Rt D1 TR1 C1 WHITE WHITE	AI	Basic Power Control
 BLACK LOAD RED S1 C2 R1 C3 Rc Rt D1 TR1 C1 120V 60Hz WHITE WHITE RFC S400AIS	AIS	Basic Power Control with RFI Suppression
 BLACK LOAD RED S1 C2 R1 R2 Rc Rt SBS R3 C4 TR1 120V 60Hz C3 C1 D1 R4 R5 WHITE WHITE RFC S400AISC	AISC	Basic Power Control with RFI Suppression and Line Voltage Compensation

SPECIFICATION SHEET PAGE 1453

TUBE REPLACEMENTS

Solid-state tube replacements are available for high-voltage rectifier tubes, thyratrons, and other special purpose tubes. Since most replacements are for retrofit purposes, it is absolutely essential that they be direct mechanical and electrical replacements. For multi-purpose tubes, such as thyratrons, special care is taken to insure that the solid-state replacement is in fact a true replacement for the particular customer application. Close liaison is maintained between customer engineers and our own to assure proper design.

SPECIFICATION SHEET PAGE 1437



Standard solid-state thyratron replacements available are:

G-E Type Number	Peak Anode Voltage	Cathode Current	Max. Temp. T_A	May Replace
S26	200V	1.0A RMS @ 30°C	125°C	2D21
S27	200V	1.0A RMS @ 30°C	125°C	2050

CUSTOMIZED ASSEMBLIES

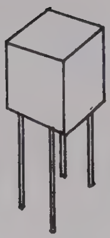
Complete semiconductor circuit assemblies using discrete components are available in a variety of mechanical configurations, including printed circuit boards, potted modules, standard tube shells and many special packages to meet individual customer needs.

SCR and TRIAC motor speed controls. Solid state replacements for thyratron tubes. Static switching. High voltage rectifier stacks. Molded multiple diode modules for computer logic circuits. Molded SCR and transistor modules for computer and other uses. Temperature controllers. Automatic exposure lamp controls for copying machines, etc. Light activated controls.

RECTIFIER & SCR MODULES

- Most Standard Rectifier Diodes and SCR's, or Combinations of Both, Available with Heatsinks.
- A Wide Variety of Standard Circuit Configurations.
- Special Circuit Configurations Available Upon Request.
- Only Mounting Bolts and Electrical Connections for Power (Trigger Signal also, if SCR's are used) are Required.
- Proven Construction—GE's Long Years of Experience in Designing and Supplying Thousands of Industrial Stacks form the Basis for this Rugged Construction.

2 AMP BRIDGES—UP TO 1000V



- Single phase full wave performance
- 4 hermetically sealed avalanche protected A14 rectifiers
- ½" cube package
- −65°C to +150°C operating temperature range
- 2 amps @ 25°C; 1.6 amps @ 50°C
- 7 standard types:

GEB100	50V
GEB101	100V
GEB102	200V
GEB104	400V
GEB106	600V
GEB108	800V
GEB110	1000V

- Other customer package configurations and electrical ratings available

SPECIFICATION SHEET PAGE 1284

SILICON RECTIFIER MODULES—UP TO 3A, 12,000V

Standard modules are offered in single-phase, fullwave bridges, 3-phase bridges, center tap or voltage-doublers, and half-wave series strings, in addition any other circuit configuration desired may be built upon special order.

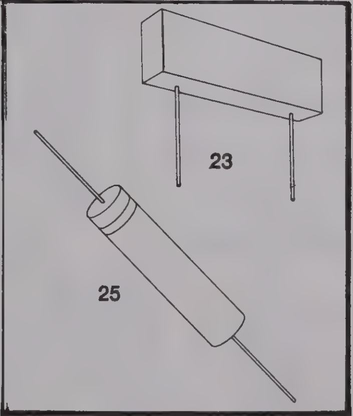
A1423BB1AB1 is a 200V, 1.5A, Single Phase Full Wave Bridge in a .5 x .25 x 6" Potted Block.

A14 23 B B 1 A B 1

CELL DATA

- A14'S
- 1000 V/CELL MAX
- 50A SINGLE CYCLE SURGE

PACKAGE TYPE



CELL RATING

F	50V
A	100V
B	200V
D	400V
M	600V
N	800V

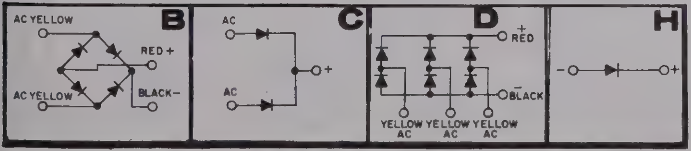
# CELLS EACH PARALLEL LEG

NO HARDWARE INCLUDED

POLARITY A=+, B=−

# OF CELLS EACH SERIES LEG

CIRCUIT



*Includes IN1730-4 & IN2382-5 types.

SPECIFICATION SHEET PAGE 231

Medium & High Current Rectifier Modules

NOMENCLATURE

A2011BC1AD1 is a 200V, single phase center tap, using A20 cells on type 11 Fins, capable of conducting 6.3A ave. per cell at 180° C conduction angle in free air or 9.8A per cell in 2000 linear feet per minute forced air.

A20 | 11 | B | C | 1 | A | D | 1

NUMBER OF CELLS IN PARALLEL EACH LEG.

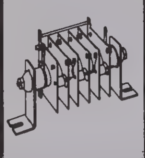
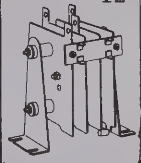
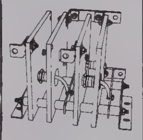
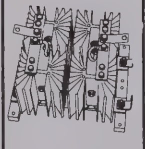
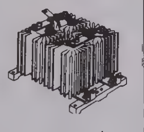
MECHANICAL FEATURES
- A. NO BRACKETS OR MOUNTING FEET.
- D. STANDARD

OTHERS AVAILABLE ON SPECIAL ORDER.

POLARITY

A. POSITIVE B. NEGATIVE

NUMBER OF CELLS IN SERIES EACH LEG

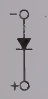
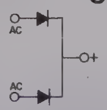
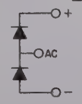
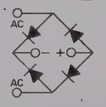
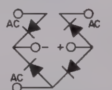
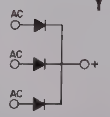
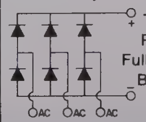
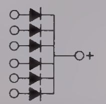
CELL DATA			FIN DATA									
			11 		12 		13 		14 		15 	
CELL NUMBER	MAX VOLT PER CELL	SINGLE ∿ SURGE-AMPS	FREE CONVECT	2000 LFPM	FREE CONVECT	2000 LFPM	FREE CONVECT	2000 LFPM	FREE CONVECT	2000 LFPM	FREE CONVECT	2000 LFPM
A20	600	150	6.3	9.8								
A25	600	240	9.4	15.5								
A28	400	150			6.3	9.8						
A27	1200	240			12.5	18.4						
A35	600	400	12.5	25.0	20.0	29.0						
A38	1200	500	12.5	25.0	20.0	29.0						
A70	1000	1600	60.4*	99.4*	44.2	80.6	64.4	99.4	78.2	96.9		
A90	1000	4500					83.7	220			160	250

* 3½" X 3½" extrusion

CELL PEAK REVERSE VOLTAGE RATING

25V - U	200V - B	500V - E	800V - N	2000V - L	NOTE: FOR PRV RATINGS NOT LISTED USE MULTIPLE LETTERS FOR ie. - PB = 1200V
50V - F	300V - C	600V - M	900V - T		
100V - A	400V - D	700V - S	1000V - P		

CIRCUIT DESIGNATOR

H	C	D	B	M	Y	F	S	X
 Single Phase Halfwave	 Single Phase Center Tap	 Doubler	 Single Phase Bridge	 Single Phase Mag Amp Bridge	 Three Phase Halfwave	 Three Phase Fullwave Bridge	 Six Phase Star	SPECIAL Example: Voltage Grade A2011DX239 Engineering Number Used For All Specials
1 Fin (Cell) In Basic Circuit	2 Fins (Cells) In Basic Circuit	2 Fins (Cells) In Basic Circuit	4 Fins (Cells) In Basic Circuit	4 Fins (Cells) In Basic Circuit	3 Fins (Cells) In Basic Circuit	6 Fins (Cells) In Basic Circuit	6 Fins (Cells) In Basic Circuit	

SCR Medium & High Current Modules

NOMENCLATURE

C10 12BA1AD1 is a 200V, full wave (back to back) bridge connected C10 cells on type 12 Fins, capable of controlling 4.7 amp average per SCR in free air or 6.2 amp average per cell with 1000 linear feet per minute forced air.

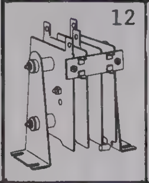
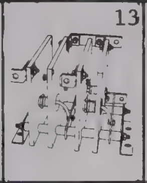
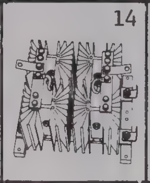
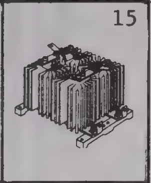
C10 | **12** | **B** | **A** | **1** | **A** | **D** | **1**

NUMBER OF CELLS IN PARALLEL EACH LEG.

MECHANICAL FEATURES
A. NO BRACKETS OR MOUNTING FEET.
D. STANDARD
OTHERS AVAILABLE ON SPECIAL ORDER.

POLARITY & MINOR ELECTRICAL MODIFICATIONS
A. POSITIVE OR STANDARD
B. NEGATIVE
C. D. } OTHER DEPENDING ON CIRCUIT

NUMBER OF CELLS IN SERIES EACH LEG

CELL DATA				FIN DATA							
				12 		13 		14 		15 	
CELL NUMBER	MAX VOLT PER CELL	SINGLE ∿ SURGE-AMPS	COMPATIBLE RECTIFIER	FREE CONVECT	1000 LFPM	FREE CONVECT	1000 LFPM	FREE CONVECT	1000 LFPM	FREE CONVECT	1000 LFPM
C10	400	60	1N13414-46A	4.7	6.2	4.7	6.2				
C11	600	60	1N1341A-46A	4.7	6.2	3.98	6.0				
C35	800	150	1N2154-59	10.1	16.3	6.3	12.2				
C150	1300	1500	1N3292-96					44.0			
C50	500	1000	1N3289-92					52.0	62.9		
C60	400	1000	1N3289-91					64	78.1		
C180	1300	3500	1N3735-42							106	
C185	500	3500	1N3735-39							106	

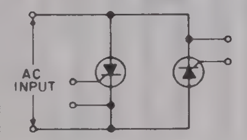
CELL PEAK REVERSE VOLTAGE RATING

25V - U	200V - B	500V - E	800V - N	2000V - L
50V - F	300V - C	600V - M	900V - T	
100V - A	400V - D	700V - S	1000V - P	

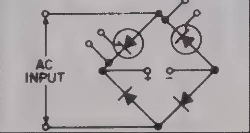
NOTE: FOR PRV RATINGS NOT LISTED USE MULTIPLE LETTERS: FOR ie. - PB = 1200V

CIRCUIT DESIGNATOR

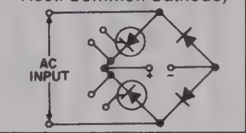
A
Back To Back



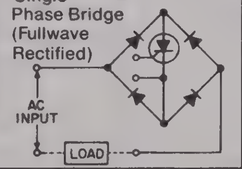
B*
Single Phase Bridge (SCR's Common Cathode)



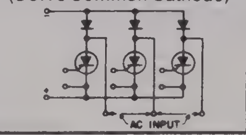
B*
Single Phase Bridge (SCR Rect. Common Cathode)



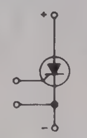
B*
Single Phase Bridge (Fullwave Rectified)



F
Three Phase Fullwave Bridge (SCR's Common Cathode)



H
Single Phase Halfwave



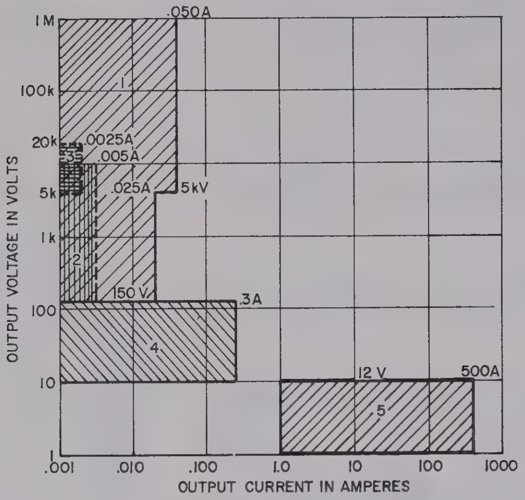
X
SPECIAL (Followed By Arbitrary Number)
Example:
Voltage Grade
C1012DX239
Engineering Number
Used For All Specials

(Many Additional Variations Are Available Upon Request)

*Note: Circuit description is necessary when ordering stacks to this circuit configuration.

SELENIUM COMPONENTS

Many of the inherent advantages of polycrystalline selenium over single-crystal germanium or silicon have gone relatively unnoticed in recent years. Yet, in certain applications General Electric's unique vacuum process, VAC-U-SEL*, selenium cells can reduce circuit component costs while assuring you of uniform quality, of high temperature operation, of excellent margins of safety, and of high reliability.



Selenium Application Locator

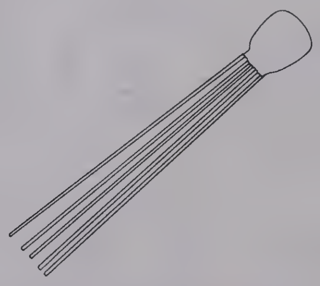
Locator Areas	Application	Equipment	Output Range
1	High-Voltage Industrial Power Supplies	Oscilloscopes Radar X-Ray Equipment	150 to 1 million volts Up to .050 amperes
2	High-Voltage Commercial and Consumer Power Supplies	Duplication Equipment Air Precipitators Electrostatic Painting Equipment Engine Ignition Display Equipment	150 to 10,000 volts Up to .005 amperes
3	Entertainment Power Supplies	TV "Ultor" Supplies	5,000 to 20,000 volts Up to .0025 amperes
4	Entertainment and Consumer Intermediate and Low Voltage Power Supplies	TV Radio Phono Hi Fi Tape Recorders NiCad Battery Chargers Toys Battery Eliminators Intercom Systems	10 to 150 volts Up to .300 amperes
5	Low-Voltage Power Supplies	Battery Chargers Electroplaters Single-Phase Welders Cathodic Protection	0 to 12 volts 1 to 500 amperes

Locator Application Areas

ENCAPSULATED MINIATURES

A complete line of low-cost, miniature selenium rectifier diodes offer optimized application opportunities in NiCad battery charging, phonograph amplifiers, motor speed controls, and lamp dimmers.

Epoxy encapsulated, these miniatures exhibit exceptional electrical and mechanical properties. Available in a variety of standard circuit configurations including single-phase, half-wave, center-tap doublers and bridges, plus specials in cell sizes up to 15/32″ round.



Ratings and Specifications

Current Range .... 2 mA to 150 mA

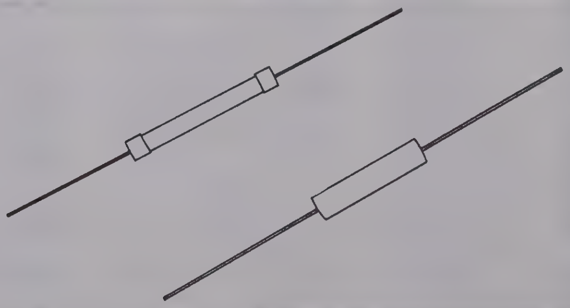
Input Voltage Range .... Up to 540 volts (RMS)

Complete ratings and specifications available in Publication Number 180.25.

HIGH-VOLTAGE MINIATURE CARTRIDGE

Industrial, high-voltage miniature cartridge (tubular) rectifier diodes incorporate thin cells which greatly increase function capacity in a given unit size. Metal end cap and epoxy-sealed types are available.

Applications include commercial and consumer precipitators, painting equipment, duplicating machines, automotive ignition analyzers, radiation detectors, and commercial radar sets.

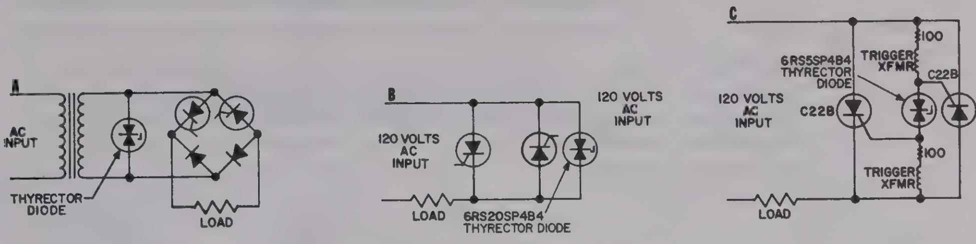


Current ratings range from 1.5 mA to 8.0 mA, and stacks are available with PRV ratings as high as 31,500 volts. Complete ratings and specifications available in Publication Numbers 180.50 and 180.51.

***Registered Trade Mark of the General Electric Company**

THYRECTOR DIODES

General Electric Thyrector Diodes (Transient Voltage Suppressors) have unique capabilities as voltage suppressors for guarding single-crystal rectifier diodes and transistors against damaging voltage transients.



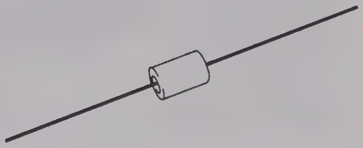
A
AC INPUT
THYRECTOR DIODE
LOAD
B
120 VOLTS AC INPUT
120 VOLTS AC INPUT
LOAD
6RS20SP4B4 THYRECTOR DIODE
C
100
TRIGGER XFMR
6RS5SP4B4 THYRECTOR DIODE
C22B
C22B
120 VOLTS AC INPUT
100
TRIGGER XFMR
LOAD

Effective Transient Voltage Suppression With GE Thyrector Diodes

In (A) and (B) the Thyrector Diode shunts transient energy around the semiconductors while clipping voltage within semiconductor capability. In variation (C) the Thyrector Diode is connected in the gate circuit of the SCR's so that a portion of transient energy triggers the forward biased SCR into conduction, thereby protecting the reverse biased SCR from damage. This latter scheme utilizes a smaller, lower cost Thyrector Diode for a given degree of protective effectiveness.

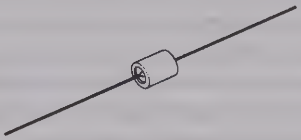
MINIATURE THYRECTORS

Available in either 9/32″ or 15/32″ round cells, from 30 to 600 volts (RMS). Complete ratings and specifications available in Publication Numbers 180.31 and 180.36.



ARC SUPPRESSORS

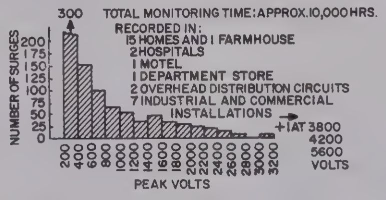
A special variation of the GE VAC-U-SEL process provides suitable characteristics for reduction of transient voltage magnitudes in solenoid circuits. Available in 9/32″ and 15/32″ round cell sizes. Maximum DC supply voltage per series blocking cell is 30 volts. Complete ratings and specifications available in Publication Number 180.40.

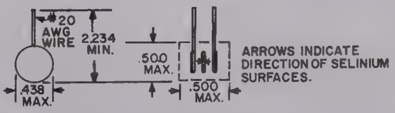


EPOXY-ENCAPSULATED THYRECTORS

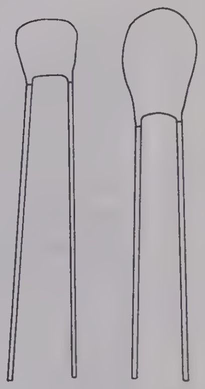
Transients exist in all low-voltage distribution systems, and originate both inside and outside the system. Without protection, damage is likely to occur to all connected loads; especially semiconductors, lamps, clock motors, and other electronic devices.

Two (2), miniature, epoxy-encapsulated Thyrector Diodes have been designed specifically for application in household appliances, TV, and radio protection. They provide protection from line-conducted transient voltages having magnitudes as high as 2000 and 3000 volts, respectively. Complete ratings and specifications available in Publication Numbers 180.33 and 180.34.



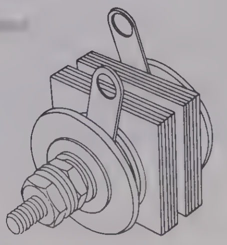


20 AWG WIRE
2.234 MIN.
.500 MAX.
.438 MAX.
.500 MAX.
ARROWS INDICATE DIRECTION OF SELINIUM SURFACES.



1″ SQUARE THYRECTORS

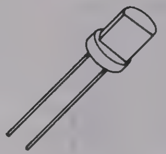
Twenty (20) sizes, from 25 to 500 volts (RMS). Through-bolt and stud mounting lockwashers and nuts. Brackets also available. Complete ratings and specifications available in Publication Numbers 180.30 and 180.35.



SPECIAL PRODUCTS

INTEGRATED VOLTAGE REGULATOR (IVR) D13V SERIES

The D13V is a monolithic integrated voltage regulator circuit. Designed for use as a shunt voltage regulating element, it can be utilized over wide voltage and current ranges. It also features a specified voltage temperature coefficient. It has a power dissipation rating of 500 MW or 1 watt with heatsink.

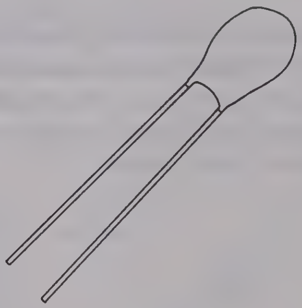


GE Type	Regulated Voltage Range (V)	T.C. of Regulated Voltage (%/°C)	Thevinin Impedance Max. (Ω)	Thevinin Reference Voltage		Specification Sheet Page
				Min. (V)	Max. (V)	
D13V1	8.5-40	.03	20	7.0	8.5	1192
D13V2	8.5-40	.03	10	7.5	7.8	1192
D13V3	8.0-80	.03	10	7.3	8.0	1192
D13V4	8.0-80	.03	10	7.6	7.9	1192

METAL OXIDE VARISTORS (MOV)

TYPICAL APPLICATIONS

Voltage transient/surge suppressor.
Improve reliability of voltage sensitive circuitry.
Reduce system costs by reducing level of voltage withstand needs.
Extend life of low voltage contacts.
Division and multiplication of frequency.
Stabilization of circuit voltages.



FEATURES

Instantaneous response
High reliability
Good temperature stability
Humidity resistant
Excellent clamping
Minimum $\alpha = 25$

General Electric Metal Oxide Varistors are voltage dependent, symmetrical resistors having a high degree of non-linearity. Terminal impedance at voltages lower than nominal are very high while impedance progresses to an extremely low value as voltage is increased to a models upper range. Essentially instantaneous E-I relationships can be expressed by the formula:

$$I = KV^{\alpha}$$

The K—value is dependent upon device material and process as well as shape and dimensions. The α—value is a figure of merit for GE-MOV's, with higher numbers being desirable, and depends upon material and process methods. Alpha's can be measured from E-I characteristics or calculated from the following formula:

$$\alpha = \frac{\text{LOG}(I_2/I_1)}{\text{LOG}(V_2/V_1)} \quad \text{where } I_1 = 1 \text{ ma.} \quad I_2 = 10 \text{ ma.}$$

AVAILABLE OCT. 1971, CONTACT FACTORY FOR SPECIFICATION SHEET.

REFERENCE AMPLIFIERS

	Circuit Characteristics					Transistor Characteristics						
	$V_{CB}=3$ Volts, $I_C=0.5$mA, $I_Z=0$, $R_B=1$K					$V_{CE}=3$V, $I_C=.5$mA		$V_{CB}=30$V		$V_{CB}=45$V		
			V_{REF}		G_{MC}	h_{FE}		I_{CBO}		I_{CBO}		
GE Type	Temperature Coefficient (%/°C)	Temperature Range (°C)	Min. (V)	Max. (V)	Minimum Trans-conductance (μMHO)	Min.	Max.	Typ. (μA)	Max. (μA)	Typ. (μA)	Max. (μA)	Specification Sheet Page
RA1	.02	0 to 70	6.3	7.7	3,000	10	120	.004	1.0			14 33
RA1A	.005											
RA1B	.002											
RA1C	.001											
RA2	.02	—55 to +150	6.65	7.35	6,000	40	120	.004	0.1			14 33
RA2A	.005											
RA2B	.002											
RA3	.02	—55 to +150[1]	6.65[1]	7.35[1]	2,000[1]	30[2]	90[2]			.006	0.1	
RA3A	.005											
RA3B	.002											

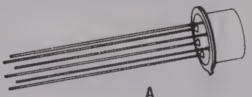
[1] $V_{CB}=3$ Volts, $I_C=0.1$mA, $I_Z=5$mA, $R_B=1$K
[2] At $V_{CE}=3$V, $I_C=.1$mA

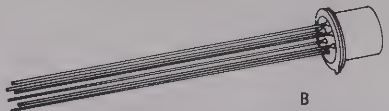
SILICON ZENER DIODES

	V_{ZT} AVALANCHE VOLTAGE[1] @ I_{ZT}, 25°C (V)					I_s Leakage Current @ V_s, 25°C Max.				I_{ZM} AVALANCHE CURRENT Max. (mA)		
Type	10% Min.	Nominal	10% Max.	I_{ZT} Test Current (mA)	Z_{ZT} Maximum Dynamic Impedance @ I_{ZT}, 25°C (Ω)	V_s (V)	I_s (mA)	Temp. Coefficient Typical (%/°C)	ΔV_Z Voltage Regulation Typical (V)	@ 50°C	@ 100°C	@ 150°C
Z4X5.1B	4.6	5.1	5.6	100	7.0	4.1	15.00	0.013	0.11	160	96	32
1N1765	5.0	5.6	6.2	100	1.2	4.5	5.00	0.021	0.14	150	88	29
1N1766	5.6	6.2	6.8	100	1.5	5.0	1.70	0.030	0.16	130	79	26
1N1767	6.1	6.8	7.5	100	1.7	5.4	0.95	0.037	0.20	120	72	24
1N1768	6.8	7.5	8.3	100	2.1	6.0	0.75	0.044	0.24	109	65	22
1N1769	7.4	8.2	9.0	100	2.4	6.6	0.64	0.050	0.28	100	60	20
1N1770	8.2	9.1	10.0	50	3.0	7.3	0.52	0.056	0.34	90	54	18
1N1771	9.0	10.0	11.0	50	3.5	8.0	0.44	0.062	0.41	82	49	16
1N1772	9.9	11.0	12.1	50	4.2	8.8	0.38	0.067	0.48	74	45	15
1N1773	10.8	12.0	13.2	50	5.0	9.6	0.34	0.071	0.57	68	41	14
1N1774	11.7	13.0	14.3	50	5.8	10.4	0.31	0.074	0.66	63	38	13
Z4X14B	12.6	14.0	15.4	50	6.6	11.2	0.29	0.077	0.75	58	35	12
1N1775	13.5	15.0	16.5	50	7.6	12.0	0.26	0.080	0.86	54	33	11
1N1776	14.4	16.0	17.6	50	8.6	12.8	0.24	0.082	0.97	51	31	10
	20% Min.		20% Max.								@ 125°C	
Z4XL6.2	4.96	6.2	7.44	20	9			.030		123	48	
Z4XL7.5	6.00	7.5	9.00	20	12			.044		101	39	
Z4XL9.1	7.28	9.1	10.9	20	15			.056		83	32	
Z4XL12	9.60	12.0	14.4	20	24			.071		63	24	
Z4XL14	11.2	14.0	16.8	20	3.0			.077		54	20	
Z4XL16	12.8	16.0	19.2	20	40			.082		47	18	
Z4XL18	14.4	18.0	21.6	20	50			.085		43	16	
Z4XL20	16.0	20.0	24.0	20	60			.088		38	14	
Z4XL22	17.6	22.0	26.0	20	72			.090		34	13	

[1] Standard 1N or Z4X types are supplied to the ±10% of voltage values listed.
For 5% tolerance; (1) Add "A" suffix to 1N number, i.e. 1N1776A.
(2) Change "B" suffix on Z4X number to "A" i.e. Z4X5.1A.
Standard Z4XL types are supplied to the ±20% of voltage values listed.
For 10% tolerance, add suffix "B" to type number, i.e. Z4XL6.2B.

DIFFERENTIAL AMPLIFIERS NPN


A


B

GE Type	V_{CEO} Min. (V)	h_{FE} @ 100μA		h_{FE_1}/h_{FE_2} Match @ 100μA	h_{FE} @ 1mA		h_{FE_1}/h_{FE_2} Match @ 1mA	△ V_{BE}		I_{CBO} @ V_{CB} (V) Max.		Package Outline No.	Specification Sheet Page
		Min.	Max.		Min.	Max.		@ 10μA (mV)	@ 1mA (mV)	(nA)	(V)		
2N2060 [4]	60 [1]	30	—	0.9-1.0	40	—	—	—	5	2	80	A	462
2N2223	60	25	—	0.8-1.0	50 [2]	200	—	—	15 [3]	10	80	A	465
2N2223A	60	25	150	.9-1.0	50 [2]	200	—	—	5 [3]	10	80	A	465
2N2453 [5]	30	80 [1]	—	—	150	600	0.9-1.0	3	5	5	50	A	471
2N2453A [5]	50	—	—	—	150	600	.9-1.0	3	5	5	60	A	471
2N2480	40	20	—	0.8-1.0	30	350	0.8-1.0	—	10	50	60	A	473
2N2480A	40	35	—	0.8-1.0	50	200	0.8-1.0	—	5	20	60	A	473
2N2639 [5]	45	55	—	—	65	—	.9-1.0 [1]	5	—	10	45	A	475
2N2640 [5]	45	55	—	—	65	—	.8-1.0 [1]	10	—	10	45	A	475
2N2641 [5]	45	55	—	—	—	—	—	—	—	10	45	A	475
2N2642 [5]	45	110	—	—	130	—	.9-1.0 [1]	5	—	10	45	A	475
2N2643 [5]	45	110	—	—	130	—	.8-1.0 [1]	10	—	10	45	A	475
2N2644 [5]	45	110	—	—	—	—	—	—	—	10	45	A	475
2N2652	60	35	—	.85-1.0	50	200	0.85-1.0	—	3	10	50	A	481
2N2652A	60	35	—	0.9-1.0	50	200	0.9-1.0	—	3	2	50	A	481
2N2903	30	60 [1]	—	—	125	625	.8-1.0	10	—	—	—	A	—
2N2910	25	70	—	0.8-1.0	80	—	0.8-1.0	—	10	10	20	A	494
2N2913 [5]	45	100	—	—	150	—	—	—	—	10	45	A	496
2N2914 [5]	45	225	—	—	300	—	—	—	—	10	45	A	496
2N2915 [5]	45	100	—	0.9-1.0	150	—	—	5	5	10	45	A	496
2N2916 [5]	45	225	—	0.9-1.0	300	—	—	5	5	10	45	A	496
2N2917 [5]	45	100	—	0.8-1.0	150	—	—	10	10	10	45	A	496
2N2918 [5]	45	225	—	0.8-1.0	300	—	—	10	10	10	45	A	496
2N2919 [5]	60	100	—	0.9-1.0	150	—	—	5	5	2	45	A	496
2N2920 [5]	60	225	—	0.9-1.0	300	—	—	5	5	2	45	A	496
2N3521 [5]	45	155 [6]	500	0.8-1.0 [1]	200	600 [2]	0.8-1.0	5	10	5	50	A	517
D12A8	30	30	—	0.6-1.0	—	—	—	—	15 [3]	25	30	A	1188

[1] $I_C = 10\mu A$
[2] $I_C = 10mA$
[3] $I_C = 100\mu A$
[4] JAN & JANTX types available
[5] TO-18 packages available
[6] $I_C = 5mA$

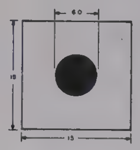
DARLINGTONS NPN

GE Type	V_{CEO} @ 30mA Min. (V)	h_{FE} @ 100mA		h_{FE} @ 10mA		h_{FE} @ 1mA Min.	I_{CBO} @ V_{CB} (V) Max.		Package Outline No.	Specification Sheet Page
		Min.	Max.	Min.	Max.		(nA)	(V)		
2N997	40	7000	70,000	4000	—	—	10	60	C	432
2N998	60	2000	—	1600	8000	800	10	90	C	433
2N999	60	7000	70,000	4000	—	—	10	60	C	433
2N2785	40 [1]	2000	20,000	1200	—	600	50	30	C	490

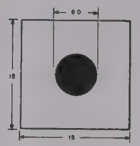
[1] Measured at 20mA

[2] For Plastic Encapsulated Darlington types see Silicon Signal Transistor Section Page 106

SILICON SIGNAL DIODE CHIPS



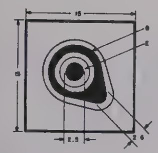
1



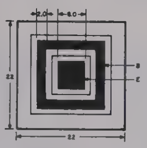
2

Equivalent JEDEC Number	GE Type	Description	Chip Dwg.	Specification Sheet Page
1N914	M46P-X503	Designed for high-speed switching and general purpose applications.	1	213
1N914A				
1N914B	M46P-X510			214
1N3064	M46P-X507	Very high speed		242
1N3600	M79P-X506	High conductance and high-speed switching in logic, core, hammer driver circuits and general purpose applications.	2	257
1N3605	M46P-X516	High-speed switching: high conductance, fast recovery time, low leakage and low capacitance.	1	258
1N4150	M79P-X506	Similar to 1N3600 (Chip)	2	257
1N4152	M46P-X516	Similar to 1N3605 (Chip)	1	258
1N4454	M46P-X507	Similar to 1N3064 (Chip)	1	242
1N4532				
1N4533	M46P-X516	Similar to 1N3605 (Chip)		257
1N4606	M79P-X501	Similar to 1N3600 (Chip) except high voltage.	2	257

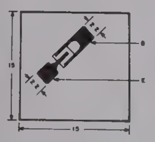
SILICON SIGNAL TRANSISTOR CHIPS



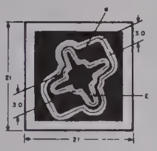
3



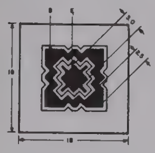
8



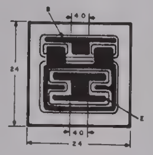
4



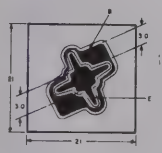
9



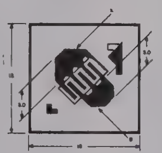
5



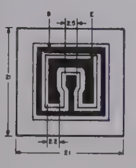
10



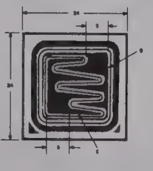
6



11



7



12

Equivalent JEDEC Number	GE Type	Description	Chip Dwg.	Specification Sheet Page
2N708	M82P-X500	NPN chip for high-speed switching. Also suitable as small signal device.	3	424
2N918	M63P-X503	NPN chip for high frequency	4	429
2N929	M26P-X531	NPN chip for low-level amplifiers.	5	430
2N930	M26P-X505			431
2N2219-22	M23P-X504	NPN chip for high-speed switching, amplifiers and core drivers.	6	464
2N2222A	M23PX503			464
2N2369	M33PX504	NPN chip ideal for high speed switching	11	475
2N2484	M26P-X504	NPN chip for low-level, high gain preamplifiers in hybrid and micro-miniature circuits.	5	474
2N2604	M92PX500	PNP chip featuring high BV_{CEO} and low capacitance	11	—
2N2714	M24P-X502	NPN chip for general purpose.	8	489
2N2905-7	M67P-X504	PNP chip for amplifiers, drivers and general purpose switching. (Electrically similar to JEDEC series only.)	9	493
2N3414	M32P-X503	NPN chip suited for high-level linear amplifiers or medium-speed switching circuits.	7	513
2N3415	M32P-X509			514
2N3416	M32P-X506			515
2N3417	M32P-X508			516
2N3855A	M28P-X507	NPN chip for RF, IF and converters in AM and FM radio and TV video amplifiers.	5	535
2N3856A	M28P-X508			536
2N3859	M26P-X516	NPN chip for AM radio, IF and converters.		546
2N3860	M26P-X560			547
2N3975	M23P-X509	NPN chip for medium-speed switching and large signal RF amplifiers.	6	554
2N3976	M23P-X516			555
2N5172	M26P-X558	NPN chip for general purpose.	5	593
2N5232	M26P-X517	NPN chip for low noise preamp and small signal amplifier.		601
2N5306	M73P-X502	NPN darlington chip for preamp input stages.	10	608
2N5814	M86PX503	NPN chip for general purpose amplifier applications at audio and intermediate frequencies	12	—
2N5815	M85PX506	PNP chip—complement to M86PX503	12	—
	M22P2	NPN chip for general low signal levels.	8	—
	M22P3			
	M22P4			
	M73P1	NPN darlington chip for preamp input stages.	10	—

---

[1] Similar to chip drawing #2 except chip is 20 mils square with 12 mil diameter cathode dot

MILITARY TYPES AVAILABLE

Type	TX Type	Military Specification
JAN 1N93A		MIL-S-19500/293
JAN 1N1184, 6, 8	JANTX 1N1184, 6, 8	MIL-S-19500/297
JAN 1N1202A, 04A	JANTX 1N1202A, 04A	MIL-S-19500/260
JAN 1N1206A	JANTX 1N1206A	MIL-S-19500/260
JAN 1N1614, 15, 16		MIL-S-19500/162
JAN 1N3289, 91, 93 94, 95		MIL-S-19500/246
JAN 1N3673A		MIL-S-19500/260
JAN 1N3713, 15, 17 19, 21		MIL-S-19500/269
JAN 1N3880, 81, 83		MIL-S-19500/266
JAN 1N3890, 91, 93	JANTX 1N3890, 91, 93	MIL-S-19500/304
JAN 1N3909, 10, 11 12, 13		MIL-S-19500/308
JAN 1N4148	JANTX 1N4148	MIL-S-19500/116
JAN 1N4150	JANTX 1N4150	MIL-S-19500/231
JAN 1N4153	JANTX 1N4153	MIL-S-19500/337
JAN 1N4245		MIL-S-19500/286
JAN 1N4246, 7, 8		MIL-S-19500/286
JAN 1N4454	JANTX 1N4454	MIL-S-19500/144
JAN 1N4531	JANTX 1N4531	MIL-S-19500/116
JAN 1N4532		MIL-S-19500/144
JAN 2N43A, 44A		MIL-S-19500/6

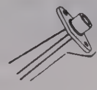
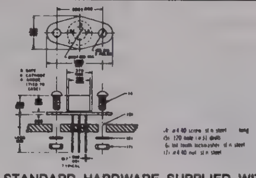
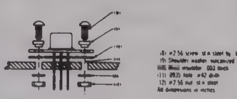
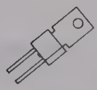
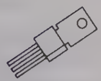
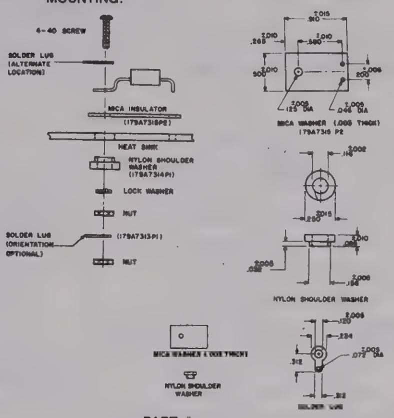
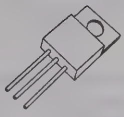
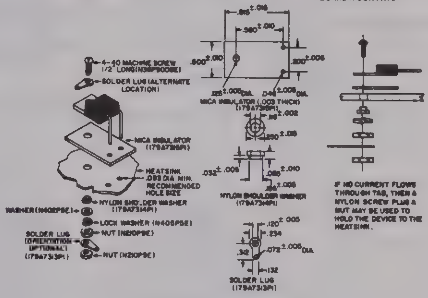
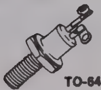
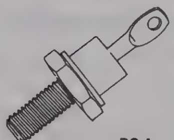
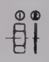
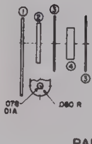
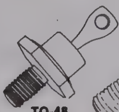
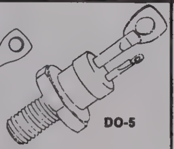
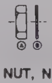
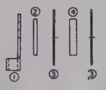
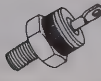
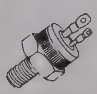
Type	TX Type	Military Specification
JAN 2N78A		MIL-S-19500/90
JAN 2N167A		MIL-S-19500/11
JAN 2N396A		MIL-S-19500/64
JAN 2N461		MIL-S-19500/45
JAN 2N489A-94A	JANTX 2N489A-94A	MIL-S-19500/75
JAN 2N526		MIL-S-19500/60
JAN 2N682, 3, 5, 6 7, 8, 9		MIL-S-19500/108
JAN 2N1303, 5		MIL-S-19500/126
JAN 2N1307		MIL-S-19500/126
JAN 2N1771A, 2A, 4A, 6A, 7A	JANTX 2N1771A, 2A, 4A, 6A, 7A	MIL-S-19500/168
JAN 2N1792, 3, 5 7, 8		MIL-S-19500/204
JAN 2N1910, 11, 13, 15, 16		MIL-S-19500/204
JAN 2N2031		MIL-S-19500/204
JAN 2N2060	JANTX 2N2060	MIL-S-19500/270
JAN 2N2323, 24, 26 &A	JANTX 2N2323, 24, 26 & A	MIL-S-19500/276

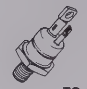
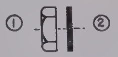
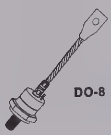
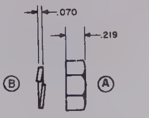
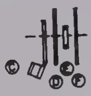
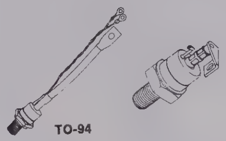
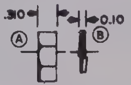
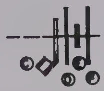
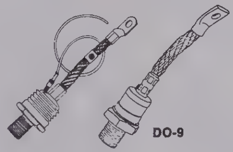
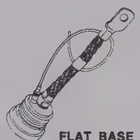
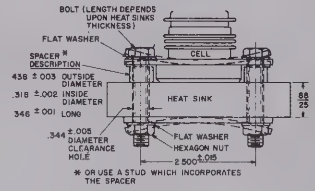
FOR OTHER RELIABILITY CONDITIONING, CONTACT FACTORY.

HIGH RELIABILITY SPECIFICATIONS

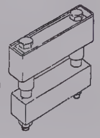
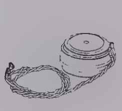
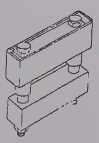
High Rel. Type	Commercial Type	Conservative Design Maximum Conditions				Estimated Maximum Failure Rate in Conservatively Designed Equipment %/1000 hrs.
		I_O	T_{STG}, T_{JOP}	V_{DRM}, V_{RRM}	V_{RSM}	
A27BR1200	1N1202	12A	−65 to +100°C	100V	200V	.001
A27DR1200	1N1204	12A	−65 to +100°C	200V	400V	.001
A27MR1200	1N1206	12A	−65 to +100°C	400V	600V	.001
A28BR1200	A28B	12A	−65 to +100°C	100V	200V	.001
A28DR1200	A28D	12A	−65 to +100°C	200V	400V	.001
A28BR1201	1N3891	12A	−65 to +100°C	100V	200V	.001
A28DR1201	1N3893	12A	−65 to +100°C	200V	400V	.001
A38BR1200	1N2156	25A	−65 to +100°C	100V	200V	.001
A38DR1200	1N2158	25A	−65 to +100°C	200V	400V	.001
A38MR1200	1N2160	25A	−65 to +100°C	400V	600V	.001
A38BR1202	1N3911	30A	−65 to +100°C	100V	200V	.001
A38DR1202	1N3913	30A	−65 to +100°C	200V	400V	.001
C5AR1200	2N2324	1.6A	−65 to +85°C	50V	100V	.001
C5BR1200	2N2326	1.6A	−65 to +85°C	100V	200V	.001
C5DR1200	2N2329	1.6A	−65 to +85°C	200V	400V	.001
C10AR1200	2N1772A	4.7A	−65 to +100°C	50V	100V	.001
C10BR1200	2N1774A	4.7A	−65 to +100°C	100V	200V	.001
C10DR1200	2N1777A	4.7A	−65 to +100°C	200V	400V	.001
C11AR1200	2N1772	4.7A	−65 to +85°C	50V	100V	.001
C11BR1200	2N1774	4.7A	−65 to +85°C	100V	200V	.001
C11DR1200	2N1777	4.7A	−65 to +85°C	200V	400V	.001
C11MR1200	2N2619	4.7A	−65 to +85°C	300V	600V	.001
C35AR1200	2N683	16A	−65 to +85°C	50V	100V	.001
C35BR1200	2N685	16A	−65 to +85°C	100V	200V	.001
C35DR1200	2N688	16A	−65 to +85°C	200V	400V	.001
C35ER1200	2N689	16A	−65 to +85°C	250V	500V	.001
C35MR1200	2N690	16A	−65 to +85°C	300V	600V	.001
C38BR1200	2N685	16A	−65 to +100°C	100V	200V	.001
C38HR1200	2N686	16A	−65 to +100°C	125V	250V	.001
C38DR1200	2N688	16A	−65 to +100°C	200V	400V	.001
C137MR1200	2N5204	22.3A	−65 to +85°C	300V	600V	.001

HARDWARE

STUD	PACKAGE	MOUNTING KIT	INSULATING KITS NOT SUPPLIED WITH UNITS UNLESS STATED ORDER BY PART #
	 **T-05 DIAMOND BASE**	 STANDARD HARDWARE SUPPLIED WITH UNIT. PART # A7149416GR1	 PART # A7149416GR2
	 **POWER TAB WITH 2 LEADS**  **POWER TAB WITH 3 LEADS**	NO HARDWARE SUPPLIED WITH UNIT. SUGGESTED MOUNTINGS: 1) 6-32 SCREW, LOCK WASHER AND NUT 2) RIVET OF EQUIVALENT SIZE 3) DIRECT SOLDER MOUNT	TYPICAL ISOLATED MOUNTING: INSULATING KIT  4-40 SCREW SOLDER LUG (ALTERNATE LOCATION) MICA INSULATOR (179A7316P2) HEAT SINK NYLON SHOULDER WASHER (179A7314P1) LOCK WASHER NUT SOLDER LUG (ORIENTATION OPTIONAL) (179A7313P1) NUT MICA WASHER (.005 THICK) 179A7316 P2 NYLON SHOULDER WASHER MICA WASHER (.005 THICK) NYLON SHOULDER WASHER SOLDER LUG PART # 138B8189GR11 PART # 138B8189GR4
	 **POWER PAC** **TO-220**		CHASSIS MOUNTING TO-66 INSULATING KIT PRINTED CIRCUIT BOARD MOUNTING  4-40 MACHINE SCREW 1/2" LONG(N36P9008E) SOLDER LUG (ALTERNATE LOCATION) MICA INSULATOR (179A7316P1) HEATSINK .093 DIA MIN. RECOMMENDED HOLE SIZE NYLON SHOULDER WASHER (179A7314P1) WASHER (N402P9E) LOCK WASHER (N405P5E) NUT (N210P9E) SOLDER LUG (ORIENTATION OPTIONAL) (179A7313P1) NUT (N210P9E) MICA INSULATOR (.003 THICK) (179A7316P1) NYLON SHOULDER WASHER (179A7314P1) SOLDER LUG (179A7313P1) IF NO CURRENT FLOWS THROUGH TAB, THEN A NYLON SCREW PLUS A NUT MAY BE USED TO HOLD THE DEVICE TO THE HEATSINK. PART # 138B8189GH3
10-32 STUD	 **TO-64**  **DO-4**	 ① 10-32 BRASS NUT, NICKEL PLATED ② LOCKWASHER, NICKEL PLATED STEEL STANDARD HARDWARE SUPPLIED WITH UNIT PART # 138B8021GR10N	 .078 DIA .080 R ① COPPER TERMINAL, .016 THICK, TIN PLATED ② BRASS WASHER, .036 THICK NICKEL PLATED ③ MICA WASHERS, TWO, .625 O.D., .204 I.D., .005 THICK ④ TEFLON WASHER, .270 O.D. .204 I.D., .050 THICK * AVAILABLE UPON REQUEST PART # 138B8021GR10S
¼-28 STUD	 **TO-48**  **DO-5**	 (A) ¼-28 STEEL NUT, NI. PLATED, .178 MIN. THK. (B) EXT. TOOTH LOCKWASHER, STEEL NI. PLATED, .023 MIN. THK. STANDARD HARDWARE SUPPLIED WITH UNIT. PART # 138B8021GR-20X	 ① COPPER TERMINAL, .040 THICK, TIN PLATED ② BRASS WASHER, .047 THICK, NICKEL PLATED ③ MICA WASHERS (2) .975 O.D. X .260 I.D. X .005 THICK ④ TEFLON WASHER .315 O.D X .260 I.D. X .060 THICK PART # 138B8021GR20Y
	 		THIS PACKAGE IS AVAILABLE IN ISOLATED STUD. REFER TO APPROPRIATE SPECIFICATIONS OR USE 138B8021GR20Y AS ABOVE.

<table>
<tr><th>STUD</th><th>PACKAGE</th><th>MOUNTING KIT</th><th>INSULATING KITS
NOT SUPPLIED WITH UNITS UNLESS STATED
ORDER BY PART #</th></tr>
<tr><td>5/16-24 STUD</td><td>
TO-103</td><td>
(1) 5/16-24 STEEL NUT, CAD PLATED 180 MIN. THICK NOT AVAILABLE
(2) EXTERNAL TOOTH LOCKWASHER, CAD PLATED STEEL .028 MIN THICK
STANDARD HARDWARE SUPPLIED WITH UNIT.
PART # 138B8021GR25</td><td>NOT AVAILABLE</td></tr>
<tr><td>⅜-24 STUD</td><td>
DO-8</td><td>
BOTH CAD PLATED STEEL
STANDARD HARDWARE SUPPLIED WITH UNIT.
PART # 138B8021GR36</td><td>
(C) COPPER TERMINAL .050 THICK, TIN PLATED
(D) (F) MICA WASHERS 1.375 O.D. X .386 I.D. X .005 THICK
(E) TEFLON WASHER .450 O.D. X .373 I.D.
PART # 138B8021GR33</td></tr>
<tr><td>½-20 STUD</td><td>
TO-94</td><td>
BOTH PARTS CAD PLATED STEEL
STANDARD HARDWARE SUPPLIED WITH UNIT.
PART # 138B8021GR46</td><td>
(C) COPPER TERMINAL .050 THICK, TIN PLATED
(D) (F) MICA WASHERS 1.375 O.D. X .505 I.D. X .050 THICK
(E) TEFLON WASHER .565 O.D. X .505 I.D. X .050 THICK
PART # 138B8021GR42</td></tr>
<tr><td>¾-16 STUD</td><td>
DO-9</td><td>¾ X 16 CAD PLATED STEEL NUT, .312 THICK AND INTERNAL TOOTH LOCK WASHER, .050 THICK
STANDARD HARDWARE SUPPLIED WITH UNIT.
PART # 138B8021GR53</td><td>NOT RECOMMENDED FOR THIS PACKAGE OR LARGER</td></tr>
<tr><td></td><td>
FLAT BASE</td><td colspan="2">

BOLT (LENGTH DEPENDS UPON HEAT SINKS THICKNESS)
FLAT WASHER
SPACER * DESCRIPTION
.438 ± .003 OUTSIDE DIAMETER
.318 ± .002 INSIDE DIAMETER
.346 ± .001 LONG
.344 ± .005 DIAMETER CLEARANCE HOLE
CELL
HEAT SINK
.88 .25
FLAT WASHER
HEXAGON NUT
2.500 ± .015

* OR USE A STUD WHICH INCORPORATES THE SPACER
<table>
<tr><th>Item</th><th>GE Dwg.</th><th>Description</th></tr>
<tr><td>Bolts, 1.25″ long</td><td>N22P23020B11 170.58</td><td>Material: ASTM A335
Thread: ASA B1.1-1949 .3125—18UNC-2A</td></tr>
<tr><td>Washers</td><td>N402P12B11</td><td>Material: Steel
Size: .344″ Inside Diameter .625″ Outside Diameter .063″ Thick</td></tr>
<tr><td></td><td>O887B0889 P-1</td><td>Inconel X-750</td></tr>
<tr><td>Spring Clamp</td><td>O165A9165 P-1</td><td>Stainless Steel (17-7PH) with lead plating</td></tr>
<tr><td>Spacers</td><td>O195A9611 P-2</td><td>See Figure</td></tr>
<tr><td>Nuts</td><td>N258P23B11</td><td>Material: Steel
Thread: ASA B1.1-1949 .3125—18UNC-2B</td></tr>
</table></td></tr>
<tr><td></td><td>
½″ PRESS PAK</td><td colspan="2">SERIES 1000  SEE SPECIFICATION SHEET
PAGE 1530</td></tr>
<tr><td></td><td>
1″ PAK</td><td colspan="2">SERIES 2500  SEE SPECIFICATION SHEET
PAGE 1532</td></tr>
</table>

TEXTBOOKS

Textbooks on basic principles, circuits, and reference authored by GE engineers and scientists.

"Semiconductor Controlled Rectifiers: Principles and Applications of P-N-P-N Devices" by Gentry, Gutzwiller, Holonyak, and Von Zastrow, Prentice-Hall, Inc., Englewood Cliffs, N.J. 07632; 1964, $16.95.

"Transistor Audio Amplifiers" by D. V. Jones and R. F. Shea, John Wiley & Sons, Inc., 605 Third Avenue, New York, New York, 10016; 1968, $10.95.

"Transistor Engineering" by A. B. Phillips, McGraw-Hill Book Co., 330 West 42nd Street, New York, New York 10036; $13.50.

"Transistor Circuit Engineering" edited by R. F. Shea, John Wiley & Sons, Inc., 605 Third Avenue, New York, New York 10016; 1957, $13.95.

"Transistor Applications" by R. F. Shea, John Wiley & Sons, Inc., 605 Third Avenue, New York, New York 10016; 1964, $10.95.

Please order the above textbooks directly from the publisher.

SEMICONDUCTOR APPLICATION INFORMATION

Particular publications which interest you may be ordered by publication number from: **General Electric Co., Advertising & Sales Promotion, Semiconductor Products Department, Bldg. 7, Electronics Park, Syracuse, N.Y. 13201.**

1. General Applications for Signal Semiconductors

90.15	An Integrated Reference Amplifier for Precision Power Supplies
90.22	The 2N3605 in RTL Application
90.23	Economy Transistors in Linear Industrial Applications
90.50	An Economy Silicon Transistor with Wide Range Voltage & Current Capability—Characteristics & Applications for 2N3402 & 2N3414-17
90.56	Belting Out Plastic Transistors on Mechanized Assembly Lines
90.60	Application of Multi-pellet Diodes in DTL Circuits
90.61	DC Coupling of Multivibrators Using Multi-pellet Diodes
90.62	Y Parameters: Their Accuracy and Measurement

2. General Applications for Power Semiconductors

90.16	Silicon Controlled Switches
90.21	How to Suppress Rate Effect in PNPN Devices
90.57	Using the Silicon Bilateral/Unilateral Switch
90.58	Reversible Ring Counter Utilizing the Silicon Controlled Switch
90.68	The Silicon Unilateral Switch Provides Stable, Economical Frequency Division
90.83	A Highly Reliable, Fail Safe, Precision Undervoltage Protection Circuit
90.84	A Low Cost Precision Current Source Using The Integrated Voltage Regulator
90.85	A High Performance Symmetrical Power Supply Utilizing An Integrated Voltage Regulator (IVR)
90.94	The Complementary SCR
200.1	Characteristics of Common Rectifier Circuits
200.5	General Electric Selenium Thyrector Diodes
200.9	Power Semiconductor Ratings Under Transient and Intermittent Loads
200.10	Overcurrent Protection of Semiconductor Rectifiers
200.15	Turn Off Time Characterization and Measurement of Silicon Controlled Rectifiers
200.19	Using Low Current SCR's
200.28	The Rating of SCR's When Switching Into High Currents
200.30	Capacitor Input Filter Design With Silicon Rectifier Diodes
200.32	A Variety of Mounting Techniques for Pres-Fit SCR's and Rectifiers
200.34	The Light Activated SCR
200.35	Using the Triac for Control of AC Power
200.36	The Solid State Thyratron
200.38	Application of Fast Recovery Rectifiers
200.39	The Series Connection of Rectifier Diodes
200.42	Commutation Behaviour of Diffused High Current Rectifier Diodes
200.50	Mounting Press Pak Semiconductors
200.52	The Characterization of Power Transistors to Avoid Forward Bias Second Breakdown
200.55	Thermal Mounting Considerations for Plastic Power Semiconductor Packages
200.56	On Switching Inductive Loads with Power Transistors
200.57	An Assortment of High Frequency Transistor, Transistor Inverters/Converters Utilizing Saturating Core Transformers
200.58	Solid State Electric Heating Controls
201.23	SCR—Ignitron Comparison
660.13	The Rating and Application of SCR's Designed for Power Switching at High Frequencies
660.14	Basic Magnetic Functions in Converters and Inverters Including New Soft Commutation
660.15	SCR Inverter Commutated by an Auxiliary Impulse
660.16	An SCR Inverter with good Regulation and Sine-Wave Output
660.21	Take the Guesswork Out of Fuse Selection
CP65-937	A Progress Report on Solid State Appliance Controls

3. Transistor Circuits

90.6	Use of Complementary Transistors in Switching Circuits
90.7	Silicon Transistor Chopper for Low Impedance Sources
90.8	A High Performance Portable Broadcast Receiver Using Silicon Planar Passivated Transistors
90.14	Tape Erase and Bias Oscillator
90.18	A Tuned R.F. Stage High Performance Portable Broadcast Receiver using Silicon Planar Passivated Transistors
90.24	A Ring Counter for Driving Incandescent Bulbs
90.28	The Use of "y" Parameters in Transistor Circuit Design
90.30	Measurement of Stored Charge in High Speed Diodes
90.51	Transistor Cascode in F.M. Tuner
90.53	Practical Circuit Applications for the New D16U Dual Diode
90.63	Simplified Transistor Color TV Processing Circuitry
90.69	Five Transistor Line Operated AM Radio Receiver (With Untuned RF Stage)
90.75	Designing a 12 Volt DC to High Voltage DC Converter
90.76	Complementary Audio Outputs Make a High Performance, Low Cost Automobile Receiver
90.78	Portable T.V. Sound System
90.79	Silicon Power Transistor Amplifier Circuits with High Performance at Low Cost
90.81	TV Color Difference Amplifiers Using High Voltage Transistors
90.82	Video Output Design Considerations Using A High Voltage Transistor
90.86	Transistor Models for CACD
90.87	A Four Transistor Line Operated Radio Receiver
90.88	RGB Video Amplifiers for Color TV Offer High Performance
90.89	1 to 2 Watt Amplifier Circuits Requiring Minimum Components
90.90	A Practical R-C Tone Generator System For Electronic Organs
90.91	TV Audio Amplifier
90.92	Low Voltage Regulated Supply For Color TV
90.95	General Purpose Power Supplies with Good Performance to Cost Ratio

4. Silicon Controlled Rectifier Circuits

200.18	Fluorescent Lamp Dimming With SCR's and Associated Semiconductors
200.21	Three Phase SCR Firing Circuits for DC Power Supplies
200.31	Phase Control of SCR's With Transformer and Other Inductive AC Loads
200.33	Regulated Battery Charges Using the Silicon Controlled Rectifier
200.43	Solid State Control for DC Motors Provides Variable Speed With Synchronous—Motor Performance
200.44	Speed Control for Shunt-Wound Motors
200.45	Temperature Controls Incorporating Zero Voltage Switching
200.47	Speed Control for Universal Motors
200.48	Flashers, Ring Counters and Chasers
200.49	A Low-Cost, Ultrasonic-Frequency Inverter Using A Single SCR
200.51	Better Room Conditioning via Solid State Controls
200.53	Solid-State Incandescent Lighting Control
200.54	Design of Triggering Circuits for Power SCR's
201.1	A Plug-In Speed Control for Standard Portable Tools and Appliances
201.6	Touch Switch or Proximity Detector
201.9	Precision Temperature Controller
201.10	Auto, Boat, or Barricade Flasher
201.11	Time-Delay Relay
201.12	500 Watt AC Line Voltage and Power Regulator
201.13	Universal Motor Control With Built-in Self-Timer
201.15	Solid-State Control for Electric Blankets
201.16	Fan Motor Speed Control—"Hi-Intensity" Lamp Dimmer
201.17	Sequential Turn Signal System for Automobiles
201.18	High Voltage Power Supply for Low Current Applications
201.24	Thyristor Selection for Incandescent Lamp Loads
201.25	A High Input Voltage Converter

5. Unijunction Applications

90.10	The Unijunction Transistor Characteristics and Applications
90.12	Unijunction Temperature Compensation
90.19	Unijunction Frequency Divider
90.70	The D13T—A Programmable Unijunction Transistor
90.72	Complementary Unijunction Transistors

6. Tunnel Diode Applications

90.42	Tunnel Diode—UHF-TV Tuner
90.43	A Tunnel Diode R.F. Radiation Detector
90.44	Practical Tunnel Diode Converter Circuit Considerations
90.45	Tunnel Diode Sinewave Oscillators
90.66	Applications For The 1N3712 Series Tunnel Diodes

7. Test Circuits

201.3	Portable SCR and Silicon Rectifier Tester

PLEASE ORDER BY PUBLICATION NUMBER.

TRANSISTOR MANUAL

Written for circuit designers by circuit designers. Applications, characteristics, and theory for transistors, unijunctions, diodes and tunnel diodes, plus other discrete signal devices. Includes Chapters on:

- Digital Circuits
- Oscillators
- Feedback & Servo Amplifiers
- Regulated DC Supplies
- Logic
- Audio & High Fidelity Amplifier Circuits

7th Edition, Over 600 Pages . . . . *List Price $2.00

SCR MANUAL

The complete story on SCR's, plus expertise on Triacs, regulating circuits, motor controls and other power semiconductor applications. Includes Chapters on:

- AC Phase Control
- Motor Controls Employing Phase Control
- Choppers, Inverters, and Cycloconverters
- Regulating Systems using Thyristors
- Light Activated Thyristor Applications
- Selecting the Proper Thyristor and Checking the Complete Circuit Design

5th Edition, Over 500 Pages . . . . *List Price $3.00

EXPERIMENTERS CIRCUIT MANUAL

A select collection of useful and intriguing circuits covering audio, automotive and marine, home, farm, and camping applications, plus other areas. Personal enjoyment for engineers, as well as hobbyists.

3rd Edition, Over 250 Pages . . . . *List Price $2.00

*Suggested List Price

HOW TO ORDER

Individual or bulk quantities may be obtained from your local authorized GE Distributor for electronic components. Consult the telephone YELLOW PAGES under Electronic Equipment & Supplies. Or send your order accompanied by check or money order to:

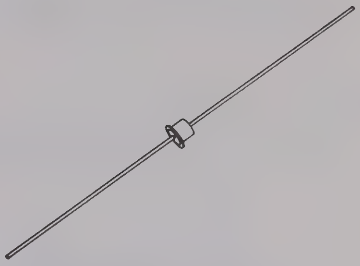
General Electric Company
3800 North Milwaukee Avenue
Department B
Chicago, Illinois 60641

(Pages 177-200 reserved for future use)

Germanium
RECTIFIERS

1N91,2,3

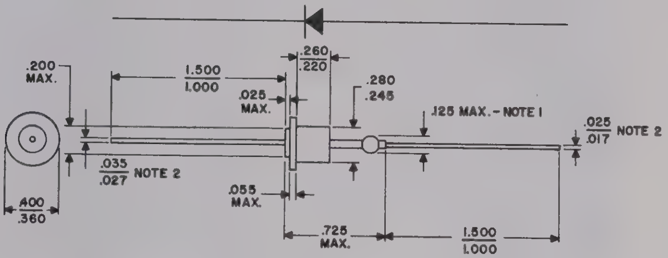
The General Electric germanium alloy junction rectifiers types 1N91, 1N92 and 1N93 have become industry standards of quality. They have demonstrated satisfactory life for over 25,000 hours with no significant change in characteristics. The General Electric-developed top hat package and associated hermetic seal, coupled with a closely controlled manufacturing process, guarantees continued product excellence. These germanium rectifiers offer extremely low forward resistance that is difficult to match with any other type rectifier. The new ratings permit operation up to 95°C ambient and storage up to 105°C.



FEATURES

- **High Efficiency—Extremely Low Forward Drop**
- **Axial Leads—Easy Assembly**
- **Long Life—Satisfactory Operation for over 25,000 hrs.**
- **Reliability—Guaranteed by hermetic seal and rugged construction under severe environmental conditions.**

OUTLINE DRAWING



NOTES

1. DIM. TO ALLOW FOR PINCH OR SEAL DEFORMATION ANYWHERE ALONG TUBULATION (OPTIONAL).
2. DIM. TO BE CONTROLLED TO WITHIN .250 FROM THE POINT OF ATTACHMENT TO RECTIFIER.

COMPLIES WITH E!A REGISTERED OUTLINE DO-3

RATINGS AND SPECIFICATIONS
(60 cps Sinusoidal, Resistive or Inductive Load)
55°C Free Convection Ambient

	1N91	1N92	1N93
Maximum Allowable Peak Inverse Voltage	100	200	300 volts
Maximum Allowable RMS Voltage	70	140	210 volts
Max. Allowable Cont. Reverse D-C Voltage (working, or blocking, voltage)*	65	95	125 volts
Maximum D-C Output*	150	100	75 ma
Maximum Leakage Current (Full-cycle average)	1.35	.95	.6 ma
Maximum Full-load Voltage Drop (Full cycle ave.)	.22	.19	.18 volts
Max. Allowable One-cycle Surge Current	25	25	25 amps
Max. I^2t at 75°C (Junction) ($t \leqq .008$ sec.)	2.6	2.6	2.6 amps² sec.
Max. I^2t at 105°C (Junction) ($t \leqq .008$ sec.)	1.0	1.0	1.0 amps² sec.
Maximum Operating Frequency	50	50	50 kc
Ambient Operating Temperature	←——— —65 to + 95°C ———→		
Storage Temperature	←——— —65 to +105°C ———→		

For military types see USN 1N93 and USAF 1N315

*For values at temperatures other than 55°C see charts.

PARAMETER RELATIONSHIPS

Maximum current and voltage ratings are listed under Ratings and Specifications for 55°C and resistive or inductive loads. The power loss in a germanium rectifier is a variable dependent on forward current, applied voltage, temperature, and type of load. Chart Nos. I, II, III and IV show the relationship of these parameters. It is possible to increase forward current several times as either temperature and/or voltage is reduced. Conversely, higher ambient temperatures are permissible provided suitable reductions in forward current and/or voltage are made.

EXAMPLE NO. I

How much forward current is allowable for a 1N91 operating in a 45°C ambient temperature at 75 PIV into a resistive load? Also what is allowable continuous D-C voltage? Referring to chart No. I, locate the 75 volt vs. 45°C point. Reading across to the current scale we find that 350 ma is permissible. Referring to chart No. VI, we find that the allowable continuous D-C voltage or blocking voltage is 70 volts.

EXAMPLE NO. II

How much forward current is allowable for a IN93 operating in a 65°C ambient temperature, at 120 PIV into a 1000 mfd capacity load? Refer to chart No. IV. To find the percentage rated PIV we divide 120 by 300 which equals 40%. Locating this point on the 65°C line we read a current of 275 ma. From chart No. V we find that the minimum surge resistor necessary is 1.70 ohms.

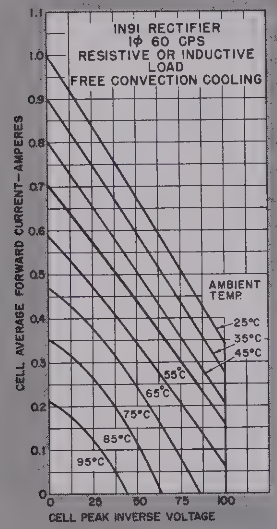


CHART I

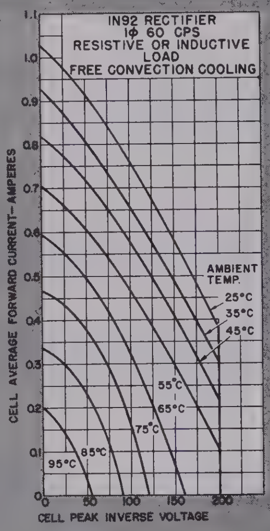


CHART II

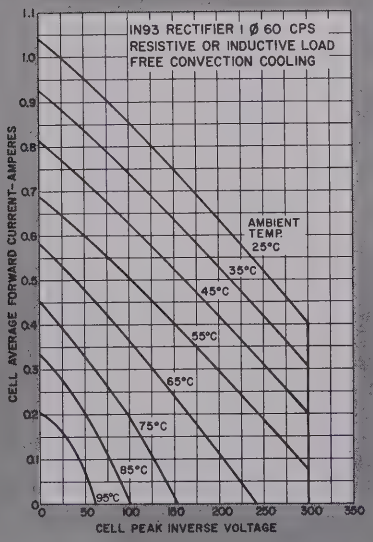


CHART III

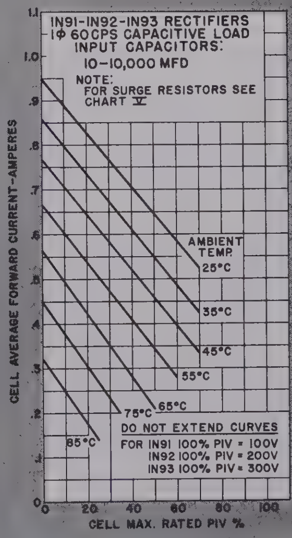


CHART IV

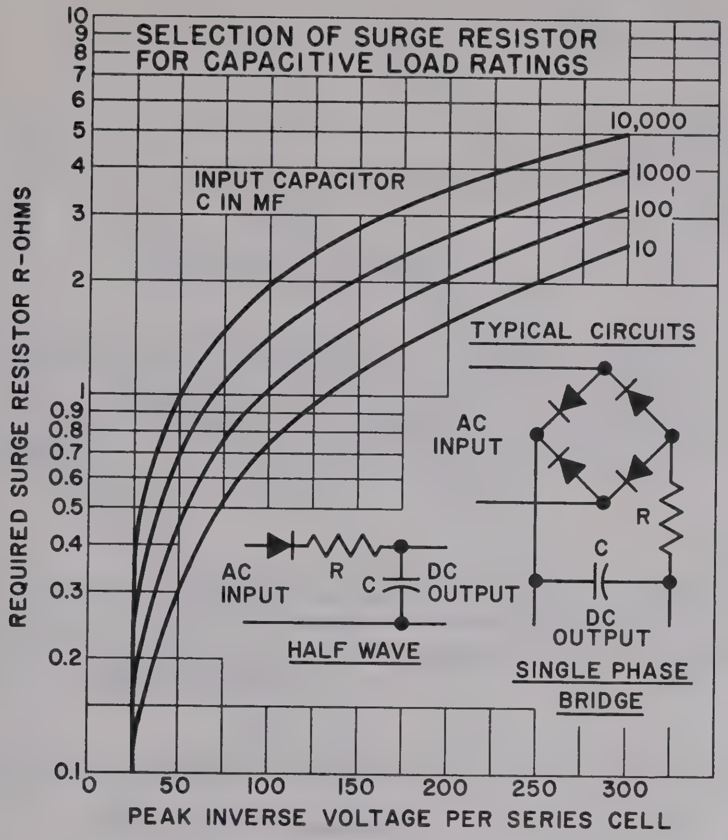


CHART V

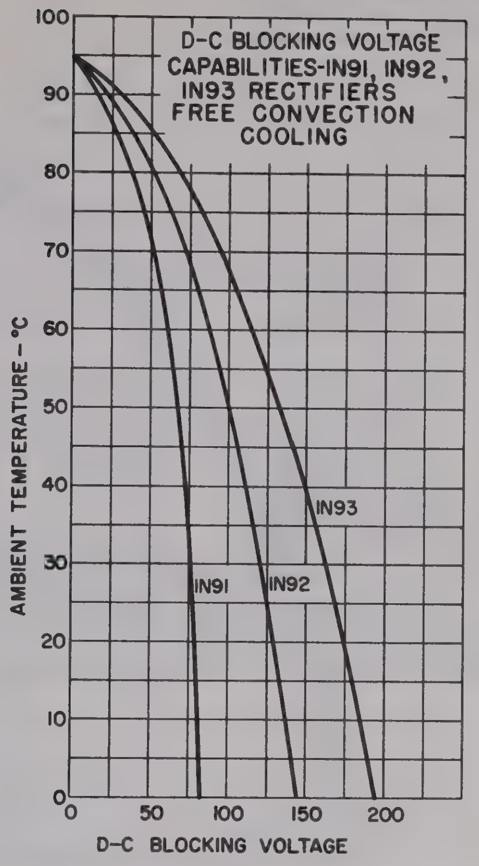


CHART VI

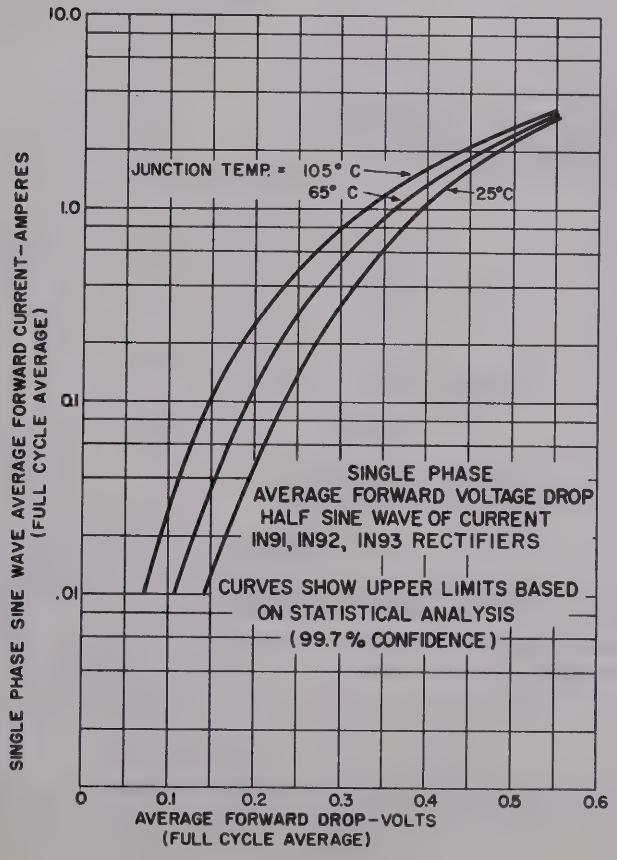


CHART VII

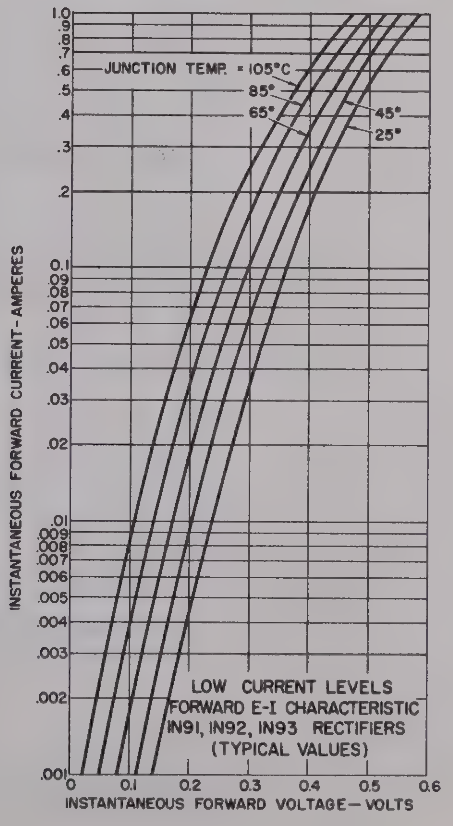


CHART VIII

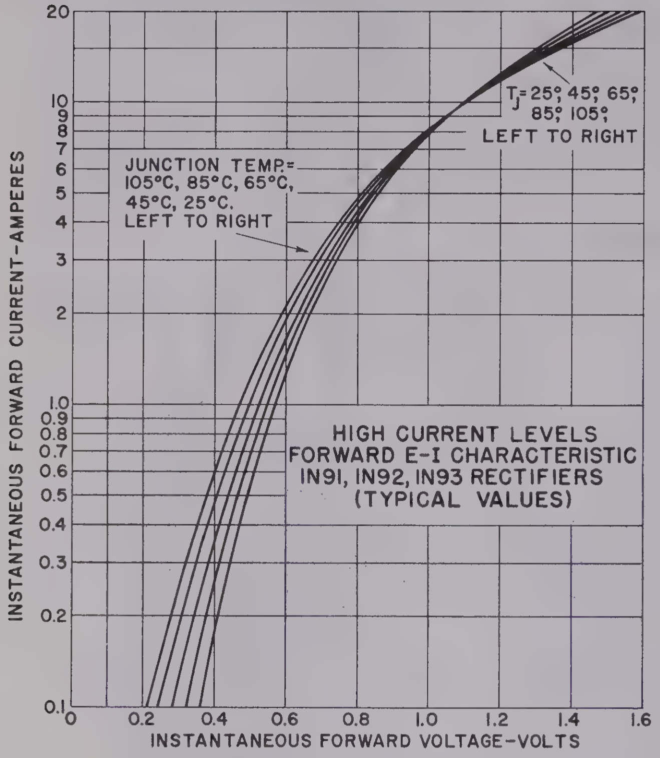


CHART IX

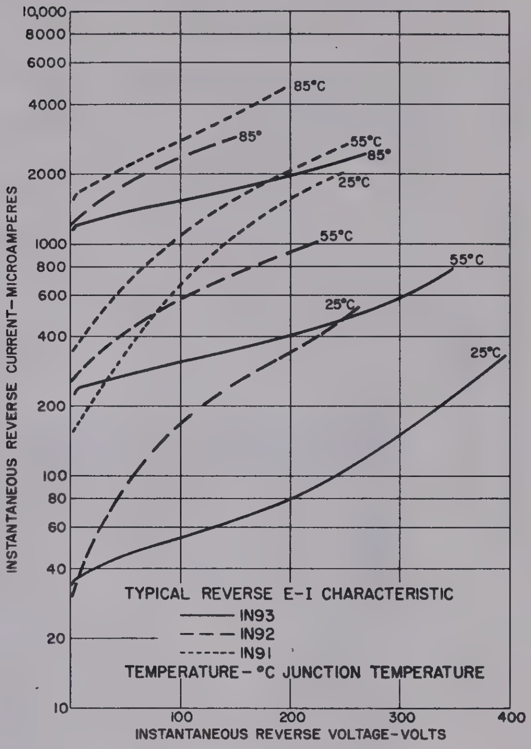


CHART X

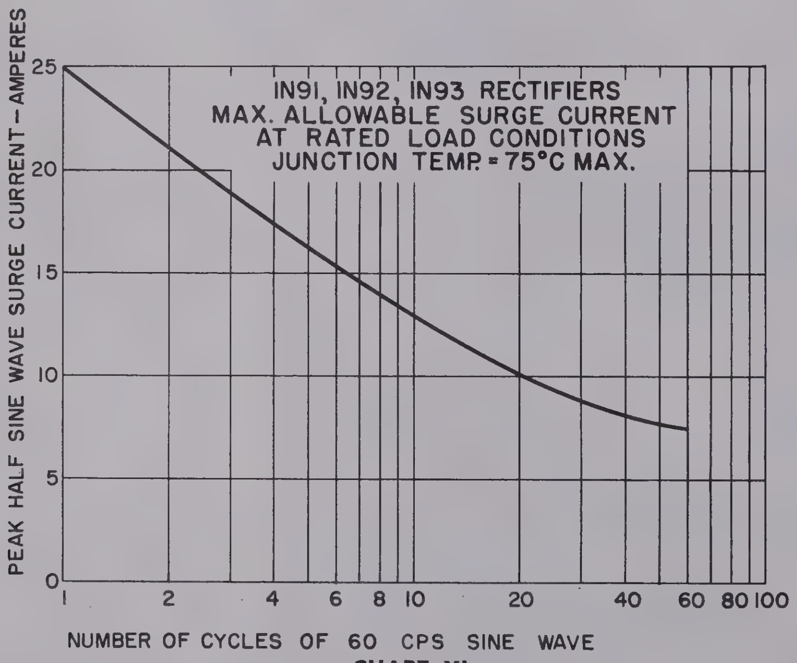


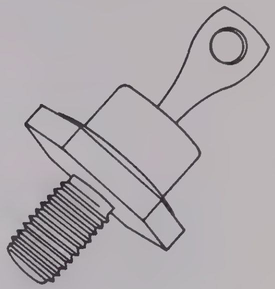
CHART XI

Silicon Rectifier

1N248-50,A,B

10A & 20A Types

These stud mounted diffused junction silicon rectifiers are designed for all rectifier applications in the 10 to 20 ampere range. A high junction temperature rating and an extremely low forward voltage drop and thermal impedance permit high current operation with minimum space requirements. These rectifiers may be mounted directly to a chassis or a fin or may be electrically insulated from the heat sink by using the mica washer insulating kit which is provided with each unit.



General Electric research, advanced development and product design have resulted in a highly efficient rectifying junction. This feature, plus a mechanical design employing high temperature hard solders and welds for all internal and external joints and seals, which eliminates common sources of thermal fatigue failure, has produced a silicon rectifier with outstanding reliability under all operating conditions.

electrical ratings and specifications (60 CPS, Resistive or Inductive Load)

	1N248	1N249	1N250	1N248A	1N249A	1N250A	1N248B	1N249B‡	1N250B‡	
Max. Allow. Peak Reverse Voltage (Repetitive, −65°C to +175°C)*	50	100	200	50	100	200	50	100	200	Volts
Max. Allow. Peak Reverse Voltage (Repetitive at 25°C)*	50	100	200	50	100	200	55	110	220	Volts
Max. Allow. RMS Voltage	35	70	140	35	70	140	35	70	140	Volts
Max. Allow. DC Blocking Voltage†	50	100	200	50	100	200	50	100	200	Volts
Max. Allow. Forward Current (Single Phase or Three Phase 150°C stud temp.)	← 10 Amp DC →			← 20 Amp DC →			← 20 Amp DC →			
Peak Recurrent Forward Current	← 45 Amp →			← 90 Amp →			← 90 Amp →			
Max. Allow. Peak One-Cycle Surge Current	← 200 Amp →			← 350 Amp →			← 350 Amp →			
Max. Full Load Voltage Drop ($T_j = 25°C$)										
At 25A	← 1.5 Volts →									
At 50A				← 1.5 Volts →			← 1.5 Volts →			
Max. Leakage Current at Full Load (Single Phase, Full Cycle Average, 150°C stud temp.)	← 5 milliamp →									
Junction Operating and Storage Temp. Range	← −65°C to +175°C →									
Maximum Stud Torque	30 inch-pounds.									

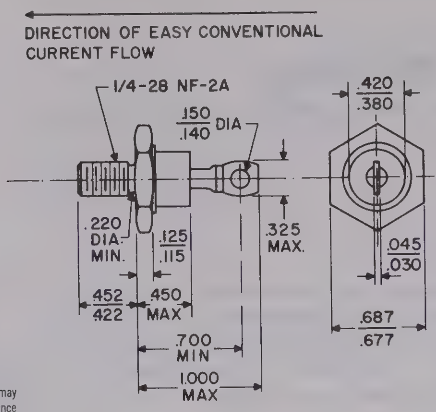
---

*Maximum voltages apply with a heat sink thermal resistance of 12°C/watt or less at maximum rated junction temperature.
†Maximum voltages apply with a heat sink thermal resistance of 5°C/watt or less at maximum rated junction temperature.
‡Available as military units to MIL-S-19500/134.

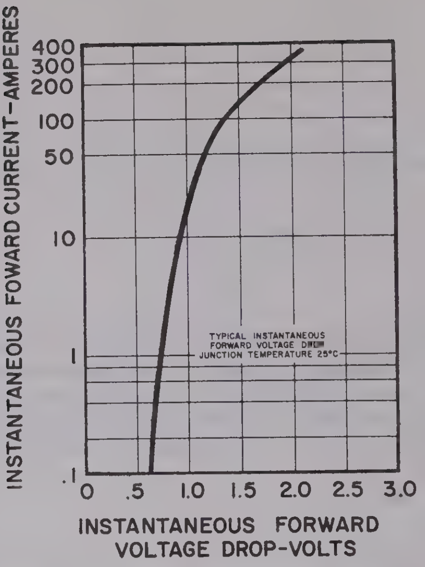
1N248-50,A,B

OUTLINE DRAWING

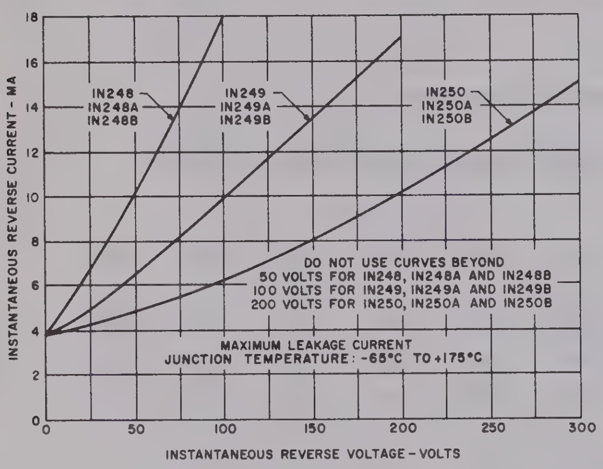
INSULATING HARDWARE KIT*


DIRECTION OF EASY CONVENTIONAL CURRENT FLOW
1/4-28 NF-2A
.150
.140 DIA
.220 DIA MIN.
.125
.115
.325 MAX.
.452
.422
.450 MAX
.700 MIN
1.000 MAX
.420
.380
.045
.030
.687
.677

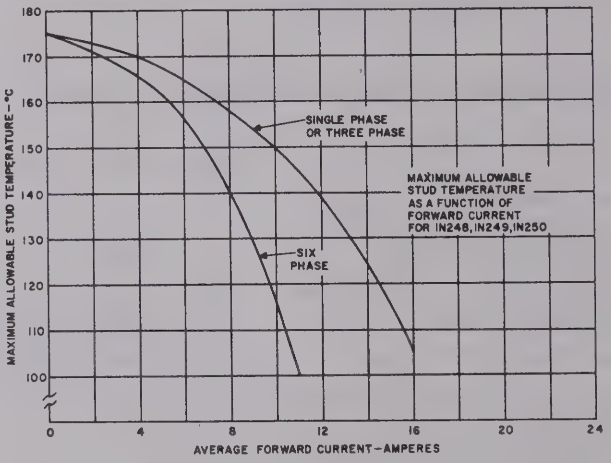
NOTE 1: Unit weight—.5 oz.
NOTE 2: Mica washer in mounting kit may add approx 2.5°C/watt thermal resistance stud to heatsink.
Complies with EIA registered outline **DO-5**
*Available upon request.



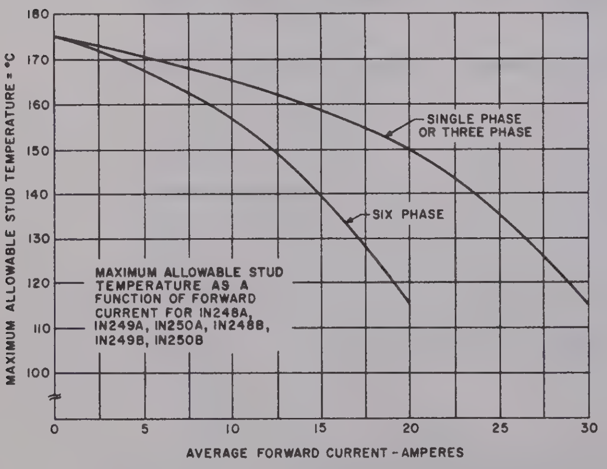
1. TYPICAL FORWARD CHARACTERISTICS



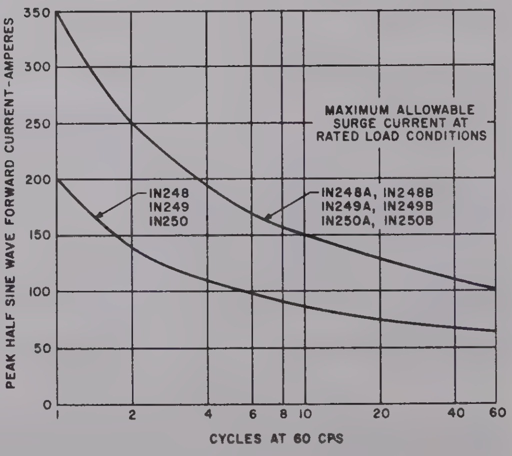
2. REVERSE CHARACTERISTICS



3. MAXIMUM ALLOWABLE STUD TEMPERATURE 1N248, 1N249, 1N250



4. MAXIMUM ALLOWABLE STUD TEMPERATURE 1N248A, 1N249A, 1N250A 1N248B, 1N249B, 1N250B



5. SURGE RATING

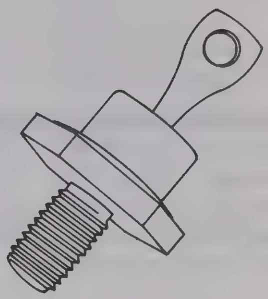
Silicon Rectifier

1N248C-50C
1N1195A-98A

20 A Types

These stud mounted diffused junction silicon rectifiers are designed for all rectifier applications in the 20 ampere range. A high junction temperature rating and an extremely low forward voltage drop and thermal impedance permit high current operation with minimum space requirements. These rectifiers may be mounted directly to a chassis or a fin or may be electrically insulated from the heat sink by using the mica washer insulating kit which is provided with each unit.

General Electric research, advanced development and product design have resulted in a highly efficient rectifying junction. This feature, plus a mechanical design employing high temperature hard solders and welds for all internal and external joints and seals, which eliminates common sources of thermal fatigue failure, has produced a silicon rectifier with outstanding reliability under all operating conditions.



electrical ratings and specifications **(60 cps, Resistive or Inductive Load)**

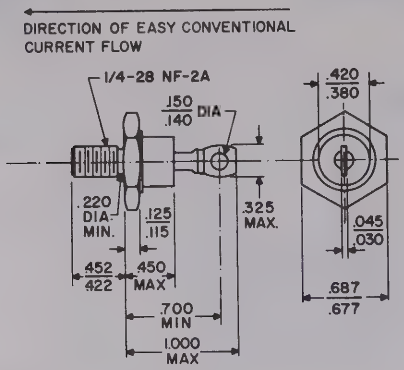
	1N248C	1N249C	1N250C	1N1195A	1N1196A	1N1197A	1N1198A	
Max. Allow. Peak Reverse Voltage (Repetitive)*	55	110	220	300	400	500	600	Volts
Max. Allow. RMS Voltage	39	77	154	212	284	355	424	Volts
Max. Allow. DC Blocking Voltage**	50	100	200	300	400	500	600	Volts
Max. Allow. Forward Current (Single Phase or Three Phase −150°C stud temp.)	← 20 Amp DC →							
Peak Recurrent Forward Current	← 90 Amp →							
Max. Allow. Peak One-Cycle Surge Current	← 350 Amp →							
Max. Full Load Voltage Drop (Full Cycle Average when operated at Max. I_{DC} and PRV)	← 0.6 Volts →							
Max. Leakage Current at Full Load (Single Phase, Full Cycle Average, 150°C stud temp.)	3.8	3.6	3.4	3.2	2.5	2.2	1.5	ma.
Junction Operating and Storage Temp. Range	← −65°C to +175°C →							
Maximum Stud Torque	30 inch-pounds.							

*Maximum voltages apply with a heat sink thermal resistance of 12°C/watt or less at maximum rated junction temperature.

**Maximum voltages apply with a heat sink thermal resistance of 5°C/watt or less at maximum rated junction temperature.

1N248C-50C 1N1195A-98A

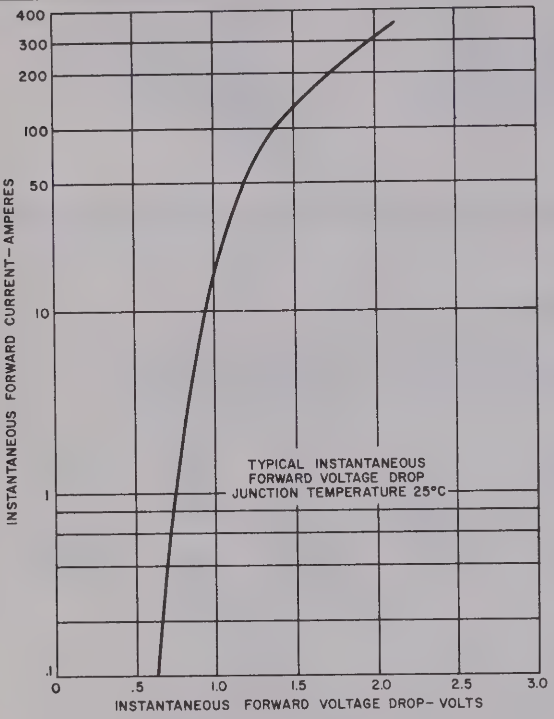
OUTLINE DRAWING


DIRECTION OF EASY CONVENTIONAL CURRENT FLOW
1/4-28 NF-2A
.150 / .140 DIA
.420 / .380
.220 DIA MIN.
.125 / .115
.325 MAX.
.045 / .030
.452 / .422
.450 MAX
.700 MIN
1.000 MAX
.687 / .677

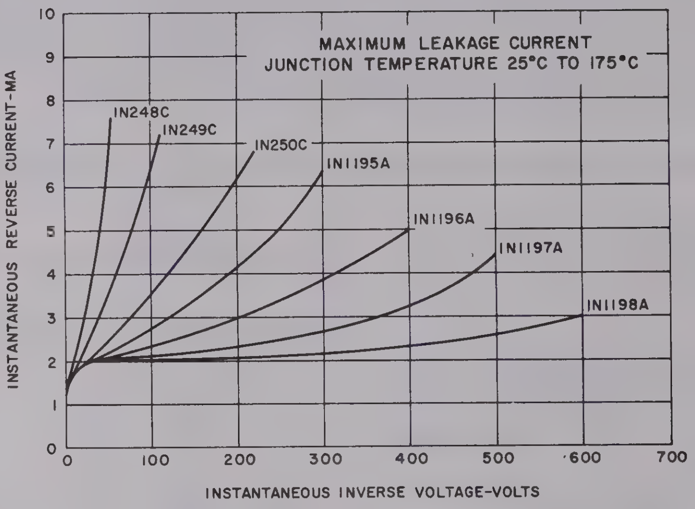
NOTES: (1) UNIT WEIGHT -.5 OZ.
(2) MICA WASHER IN MOUNTING KIT MAY ADD APPROX 2.5°C /WATT THERMAL RESISTANCE STUD TO HEATSINK

*AVAILABLE UPON REQUEST.

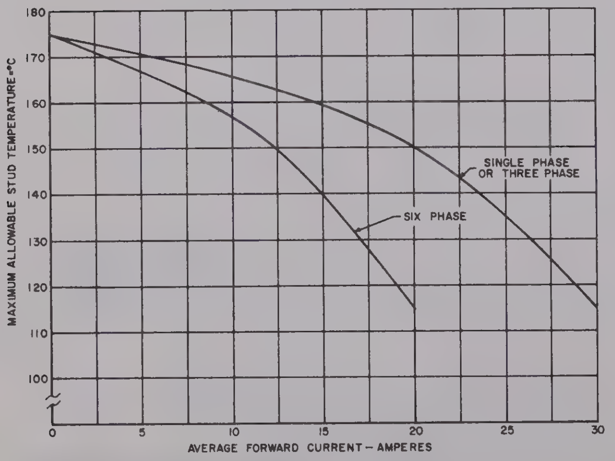
COMPLIES WITH
EIA REGISTERED OUTLINE DO-5



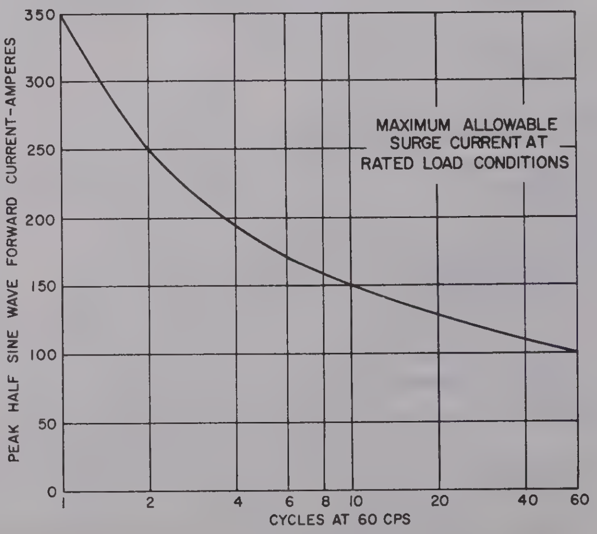
I. TYPICAL FORWARD CHARACTERISTICS



II. REVERSE CHARACTERISTICS



III. MAXIMUM ALLOWABLE STUD TEMPERATURE

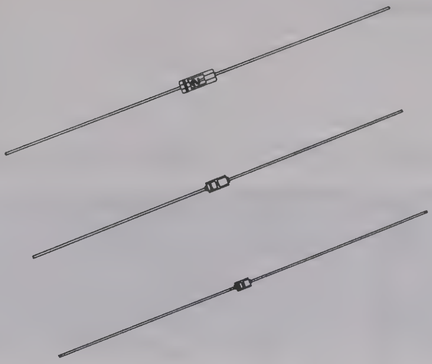


IV. SURGE RATING

Silicon Diodes

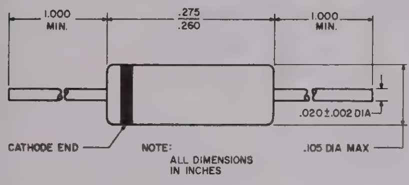
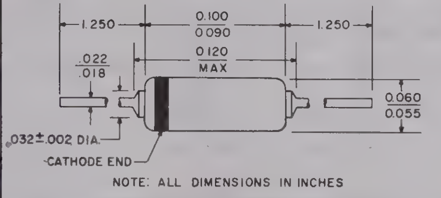
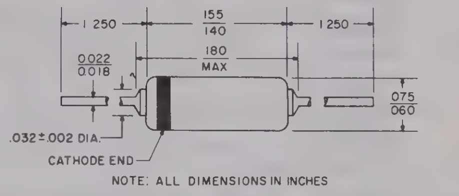
1N914,A,B
1N916,A,B
1N4009
1N4148,49
1N4154
1N4446-49
1N4531
1N4536

This family of General Electric silicon signal diodes are very high speed switching diodes for computer circuits and general purpose applications. These diodes incorporate an oxide passivated planar structure. This structure makes possible a diode having high conductance, fast recovery time, low leakage, and low capacitance combined with improved uniformity and reliability. These diodes are contained in three different packages; DO–7 glass diode package, double heat sink miniature package, milli-heat sink package and are electrically the same as their equivalent types in each of the three different packages (see page two for groupings of electrically equivalent types in each of the three packages).



PLANAR EPITAXIAL PASSIVATED

with Controlled Conductance

DO-7 1N4009	MILLI-HEATSINK DIODE (MHD) 1N4531, 1N4536	DOUBLE HEATSINK DIODE (DHD) 1N914,A,B; 1N916,A,B* 1N4148,49,54; 1N4446—49
		

1.000 MIN.
.275 / .260
1.000 MIN.
.020±.002 DIA
CATHODE END
NOTE: ALL DIMENSIONS IN INCHES
.105 DIA MAX

1.250
0.100 / 0.090
1.250
.022 / .018
0.120 MAX
0.060 / 0.055
.032±.002 DIA.
CATHODE END
NOTE: ALL DIMENSIONS IN INCHES

1 250
155 / 140
1 250
0.022 / 0.018
180 MAX
075 / 060
.032±.002 DIA.
CATHODE END
NOTE: ALL DIMENSIONS IN INCHES

Dissipation: 250mW @ 25° free air
Derate: 1.43mW/°C temp. above 25°C amb. based on max. $T_J = 200°C$

Dissipation: 500mW @ 25°C free air
Derate: 2.85mW/°C for temp. above 25°C amb. based on max. $T_J = 200°C$

Dissipation: 500mW @ 25°C free air
Derate: 2.85mW/°C for temp. above 25°C amb. based on max. $T_J = 200°C$
*When not specified, General Electric retains the option of supplying the 1N914, A, B and 1N916, A, B in the DO-7 package

FEATURES	1N914 1N914A 1N914B	1N4148 1N4446 1N4448 1N4531	1N916 1N916A 1N916B	1N4149 1N4447 1N4449	1N4009	1N4536 1N4154
Reverse Recovery Time of 2 nanoseconds maximum					●	●
Reverse Recovery Time of 4 nanoseconds maximum	●	●	●	●		
Capacitance of 2 pF maximum			●	●		
Capacitance of 4 pF maximum	●	●			●	●
Power Dissipation to 500 mW		●		●		●
Power Dissipation to 250 mW					●	
Meets all MIL-S-19500C requirements	●	●	●	●	●	●

HEATSINK SPACING FROM END OF DIODE BODY	STEADY STATE THERMAL RESISTANCE °C/mW (NOTE 1)			POWER DISSIPATION AT 25°C mW (NOTE 2)		
	MHD	DO-7	DHD	MHD	DO-7	DHD
.062″	.230	.389	.250	760	450	700
.250″	.319	.500	.319	550	350	550
.500″	.438	.700	.438	400	250	400

NOTE 1 See Figure 7 for thermal resistance for short pulses.
NOTE 2 This power rating is based on a maximum junction temperature of 200°C.

Figure 1

absolute maximum ratings: (25°C)

(unless otherwise specified)

	1N914,A,B 1N916,A,B 1N4148–49 1N4446–47 1N4448–49 1N4531	1N4009	1N4154 1N4536	
	MHD & DHD	DO-7	MHD & DHD	
Voltage				
Reverse	75	25	25	Volts
Current				
Average Rectified	150	75	150	mA
Recurrent Peak Forward	450	225	450	mA
Forward Steady-State DC	200	115	200	mA
Peak Forward Surge (1µsec. pulse)	2000	2000	2000	mA
Power				
Dissipation	500	250	500	mW
Temperature				
Operating	←—— −65 to +200 ——→			°C
Storage	←—— −65 to +200 ——→			°C

electrical characteristics: (25°C) (unless otherwise specified)

Type	Minimum Breakdown Voltage @ 100µA	Forward Voltage		Maximum Reverse Current, I_R			C_o(1)	t_{rr}(2)	V_f(3)
		I_F	V_F	20V		75V			
				25°C	150°C	25°C			
	Volts	mA	V	nA	µA	µA	pF	ns	V
1N914 1N4148 1N4531	100	10	1.0	25	50	5	4	4	
1N914A 1N4446	100	20	1.0	25	50	5	4	4	
1N914B 1N4448	100	5 100	0.62–0.72 1.0	25(4)	50	5	4	4	2.5
1N916 1N4149	100	10	1.0	25	50	5	2	4	
1N916A 1N4447	100	20	1.0	25	50	5	2	4	
1N916B 1N4449	100	5 30	0.63–0.73 1.0	25	50	5	2	4	2.5
1N4009 1N4154 1N4536	35 @ 5µA	30	1.0	100 @ 25V	100 @ 25V		4	2	

*Except as noted.

NOTES
(1) Maximum Capacitance is measured on Boonton model 75A capacitance bridge at a signal level of 50 mV at $V_R = 0$
(2) Maximum Reverse Recovery Time, $I_f = 10mA$, $V_R = -6V$, $R_L = 100\Omega$, Recovery to 1.0mA (Figure 6)
(3) Maximum Forward Recovery Voltage, −50mA peak square wave, 0.1 µsec. pulse width, 5 to 100 kHz repetition rate, generator rise time (t_r) $\leq$ 30nsec.
(4) Also 3µA at 20 V at 100°C

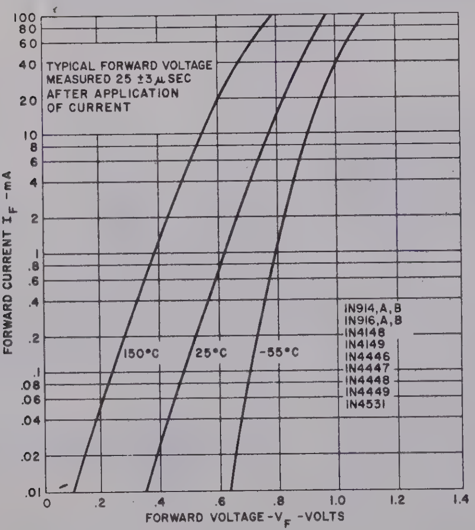


Figure 2

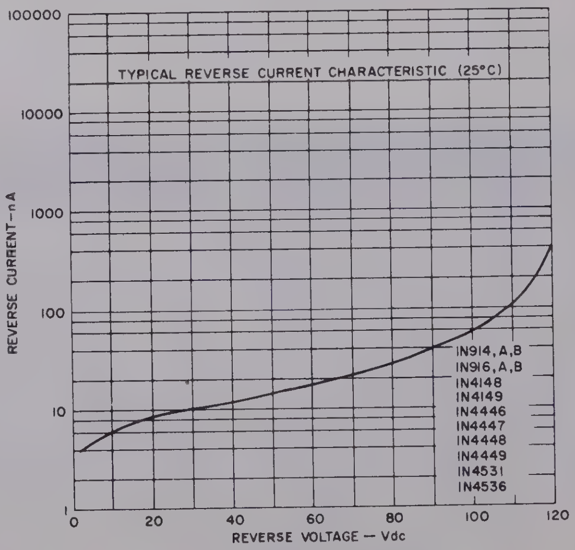


Figure 3

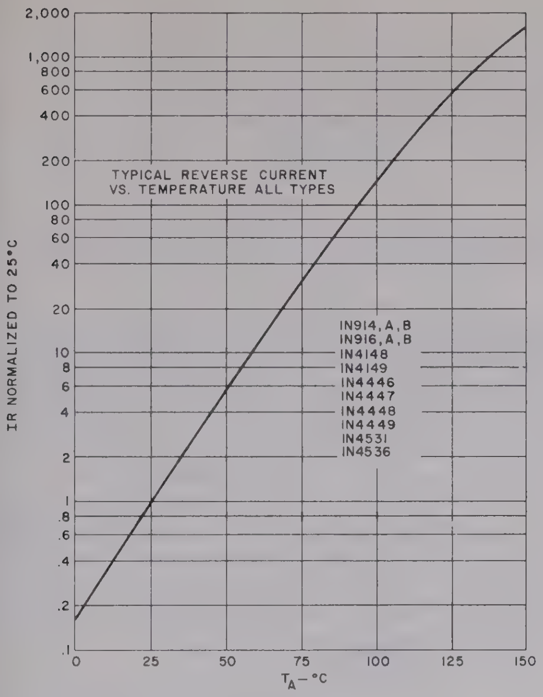


Figure 4

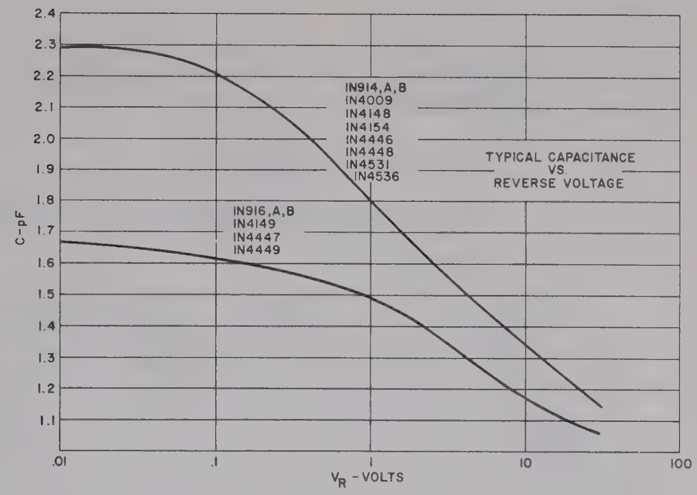
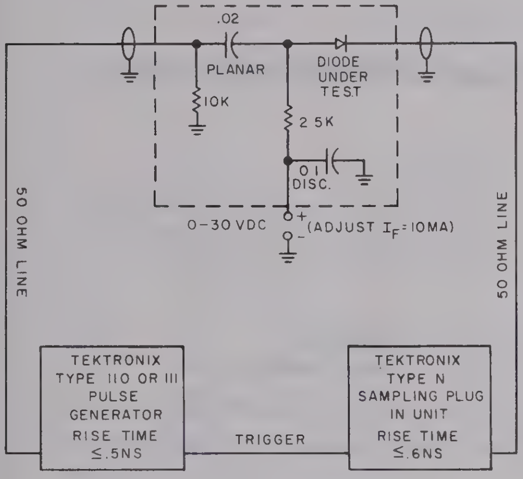


Figure 5



.02
PLANAR
DIODE UNDER TEST
10K
2.5K
.01 DISC.
0-30 VDC
+
-
(ADJUST I_F=10MA)
50 OHM LINE
50 OHM LINE
TEKTRONIX TYPE 110 OR 111 PULSE GENERATOR RISE TIME ≤.5NS
TRIGGER
TEKTRONIX TYPE N SAMPLING PLUG IN UNIT RISE TIME ≤.6NS

LOW CURRENT t_{rr} TEST CIRCUIT

Figure 6

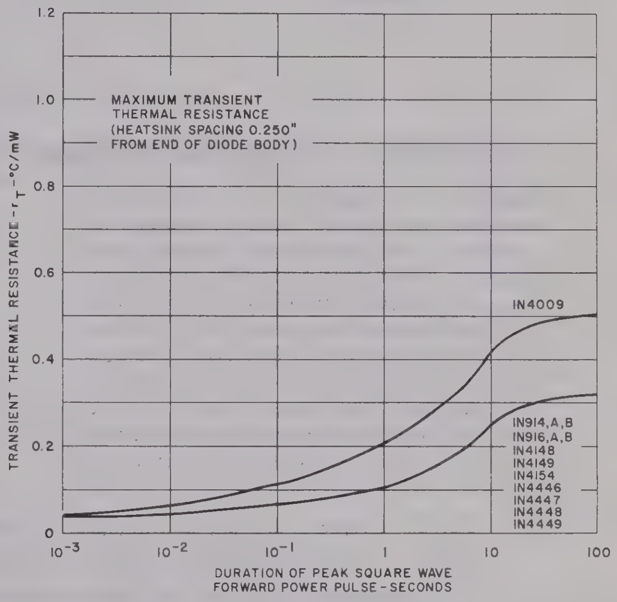


Figure 7

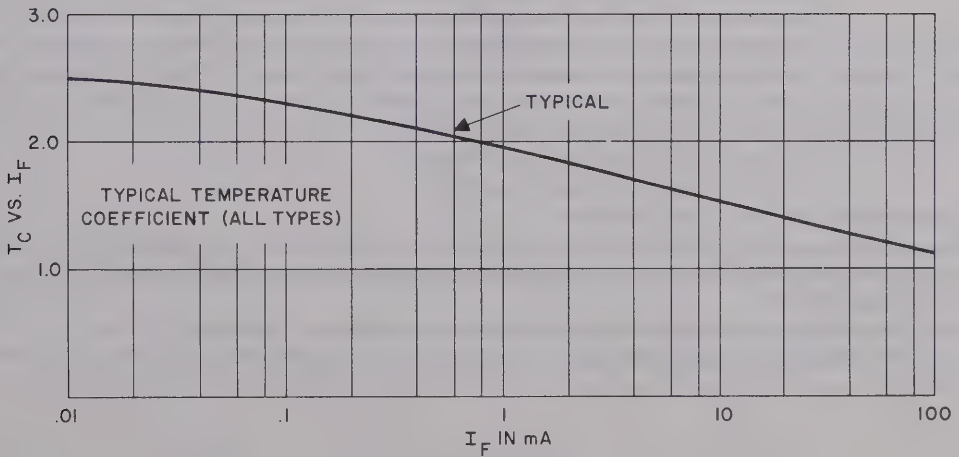


Figure 8

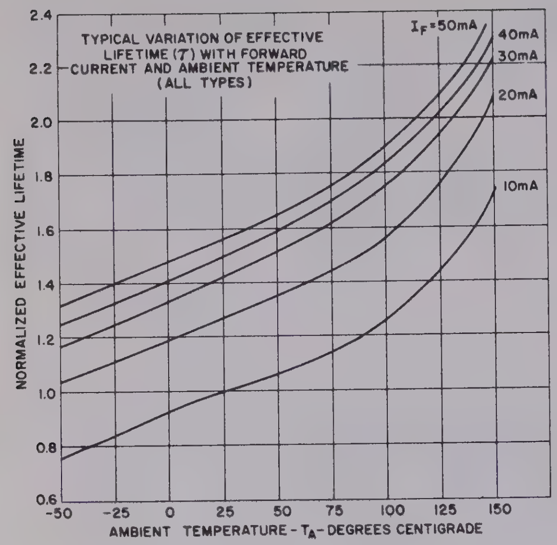


Figure 9

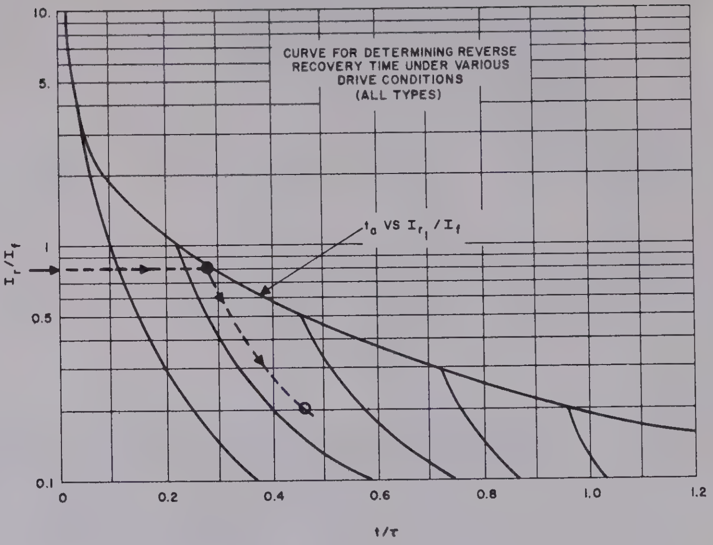
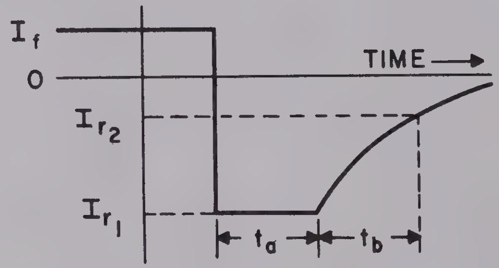


Figure 10

ESTIMATION OF REVERSE RECOVERY TIME UNDER VARIOUS DRIVE CONDITIONS

The reverse recovery time of a silicon signal diode has been shown* to be determined by a quantity called the effective lifetime, τ, and the ratio of forward and reverse current. The exact equations expressing times t_a and t_b (as defined in the sketch at right) are somewhat inconvenient for numerical evalution, but in many cases an estimation of response time is sufficient. Figure 10 is a graphical solution to the response time equations and its use can best be illustrated by the following example:



FIND: Recovery time to 5 mA reverse current when the forward current is 25 mA and the maximum reverse current is 20 mA.

SOLUTION: Enter the left side of Figure 10 at $I_{r1}/I_f = 20/25 = 0.8$ and follow horizontally until the t_a vs. I_{r1}/I_f line is reached (see dotted line). From the t/τ scale of the horizontal axis, it is seen that t_a is 0.28τ. The t_b portion of the recovery curve is estimated by moving downward parallel to the general contour lines until the $I_{r2}/I_f = 5/25 = 0.2$ line is reached. The total switching time is thus 0.46τ. The delay time, t_b, is $0.46\tau - 0.28\tau$ or 0.18τ.

The value of τ on the spec sheet should be corrected for current level. Figure 9 shows the typical variation of effective lifetime with forward current. Since the current level of the example is 25 mA, the maximum effective lifetime is approximately (6.8) (1.35) or 9.3 nsec., therefore:

$t_a \approx (9.3)\ (.28) \approx 2.6$ nsec. maximum

$t_b \approx (9.3)\ (.18) \approx 1.7$ nsec. maximum

Total reverse recovery time ≈ 4.3 nsec. maximum

Additional information on this method of diode recovery time calculation is contained in a paper entitled "Predicting Reverse Recovery Time of High Speed Semiconductor Junction Diodes" by C. H. Chen, (Publication #90.36) available on request.

---

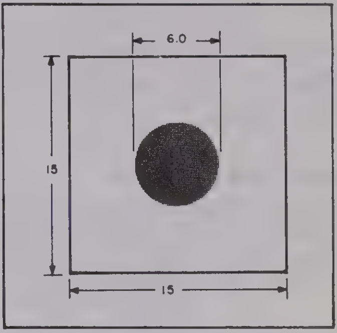
*Ko, W. H., "The Reverse Transient Behavior of Semiconductor Junction Diodes," IRE Trans. ED-8, March 1961, pp. 123-131.

Silicon
Diode Chips

1N914 (Chip)
1N914A (Chip)

(M46P-X503)

These General Electric silicon planar oxide-passivated diode chips are designed primarily for high-speed switching in computer and general purpose applications. The chips feature high conductance, fast recovery time, low leakage and low capacitance.



General specifications:
- Gold cathode contact backing, minimum thickness—3000Å
- Aluminum anode contact metalization
- Maximum conditions for mounting chips—425°C for 5 minutes (Max.) in an inert atmosphere
- Shipping containers: Glass vials sealed with a nitrogen back-fill
  Maximum of 10k chips per vial
  Egg crate containers available at extra cost
- Chip drawing dimensions are in mils
- Chip thickness = 5.0 ±2 mils

absolute maximum ratings: $T_A = 25°C$)

	Symbol		
Voltage			
Reverse	V_R	75	V
Current			
Average Rectified		150	mA
Recurrent Peak Forward		450	mA
Forward Steady State D.C.		200	mA
Peak Forward Surge (1 μsec. pulse)		2000	mA
Temperature			
Storage	T_{STG}	−65°C to +200°C	
Operating	T_J	−65°C to +200°C	

electrical characteristics: 100% Probe ($T_A = 25°C$)

Tested at outgoing acceptance to a 10% LTPD with a maximum accept number of 3.

	Symbol	Min.	Max.	
Reverse Breakdown Voltage ($I_R = 100\ \mu A$)	BV_R	100	—	V
Forward Voltage Drop ($I_F = 20$ mA)	V_F	—	1.05	V
Reverse Current ($V_R = 25V$)	I_R	—	50	nA
Reverse Current ($V_R = 75V$)	I_R	—	5	μA

specifications: ($T_A = 25°C$)

Product yield is at least 93% to each of the following parameters:

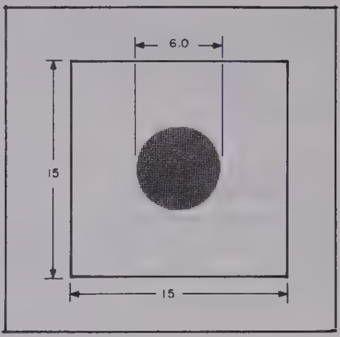
	Symbol	Min.	Max.	
Junction Capacitance ($V_R = 0$, $e_s = 50$ mV)	C_o	—	4	pF
Maximum Reverse Recovery Time ($I_F = 10$ mA, $V_R = -6V$, $R_L = 100\ \Omega$)	t_{rr}	—	4	nsec.

Silicon
Diode Chips

1N914B (Chip)

(M46P-X510)

This General Electric silicon planar oxide-passivated diode chip is designed primarily for high-speed switching in computer and general purpose applications. The chip features high conductance, fast recovery time, low leakage and low capacitance.



General specifications:

- **Gold cathode contact backing, minimum thickness—3000Å**
- **Aluminum anode contact metalization**
- Maximum conditions for mounting chips—425°C for 5 minutes (Max.) in an inert atmosphere
- Shipping containers: Glass vials sealed with a nitrogen back-fill
  Maximum of 10k chips per vial
  Egg crate containers available at extra cost
- Chip drawing dimensions are in mils
- Chip thickness = 5.0 ±2 mils

absolute maximum ratings: (T$_A$ = 25°C)

	Symbol		
Voltage			
Reverse	V_R	75	V
Current			
Average Rectified		150	mA
Recurrent Peak Forward		450	mA
Forward Steady State D.C.		200	mA
Peak Forward Surge (1 μsec. pulse)		2	A
Temperature			
Storage	T_{STG}	−65°C to +200°C	
Operating	T_J	−65°C to +200°C	

electrical characteristics: 100% Probe (T$_A$ = 25°C)

Tested at outgoing acceptance to a 10% LTPD with a maximum accept number of 3.

	Symbol	Min.	Max.	
Reverse Breakdown Voltage ($I_R = 100\ \mu A$)	BV_R	100	—	V
Forward Voltage Drop ($I_F = 20$ mA)	V_F	—	1.05	V
Reverse Current ($V_R = 25V$)	I_R	—	25	nA
Reverse Current ($V_R = 75V$)	I_R	—	5	μA

specifications: (T$_A$ = 25°C)

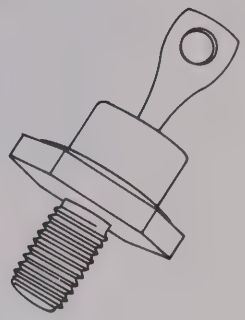
Product yield is at least 93% to each of the following parameters:

	Symbol	Min.	Max.	
Junction Capacitance ($V_R = 0$, $e_s = 50$ mV)	C_o	—	4	pF
Maximum Reverse Recovery Time ($I_F = 10$ mA, $V_r = -6V$, $R_L = 100\ \Omega$)	t_{rr}	—	4	nsec.

Rectifier

1N1183-90
1N3765-68
1N5332

These diffused junction rectifiers are intended to be applied under the most stringent Military environment. The glass seal is specially designed to give a reasonable creepage distance at voltages through 1200 volts. The all hard-solder construction used in the assembly of these devices will promote long thermal fatigue free life even under cyclic load conditions.



Features:
- New High Voltage—Up To 1200V
- Thermal Fatigue Free—Uses Hard-Solders
- Popular JEDEC DO-5 Outline
- Ratings up to 200°C Junction Temperature

ratings & specifications (60 cps, Resistive or Inductive Load)

	1N1183	1N1184	1N1185	1N1186	1N1187	1N1188	1N1189	1N1190	1N3765	1N3766	1N3767	1N3768	1N5332	
*Maximum Allowable Repetitive and Working Peak Reverse Voltage, V_{RM} (rep) & V_{RM} (wkg.)[1]	50	100	150	200	300	400	500	600	700	800	900	1000	1200	volts
Maximum Allowable RMS Voltage, V_r	* 35.5	* 71	* 106	* 142	* 212	* 284	* 355	* 424	495	565	635	710	852	volts
*Maximum Allowable DC Blocking Voltage, V_R[2]	40	80	120	160	240	320	400	480	700	800	900	1000	1200	volts
*Maximum Allowable Average Forward Current (180° conduction angle, 60 cps, half sine wave current at T_C = 140°C), I_O	35 Adc													
*Maximum Allowable Peak One Cycle Surge Current (non-recurrent), I_{FM} (surge)	500								400				500	amperes
I^2t Rating (for t greater than .001 sec. and less than .0083 sec., non-recurrent)	500 (Amp RMS)^{2}Sec min. value, See Chart 6													
*Maximum Peak Forward Voltage Drop (I_O = 35 Adc at T_C = 140°C), $V_{F(AV)}$	1.7								1.8				1.7	Vdc
*Maximum Average Reverse Current (I_O = 35 Adc at T_C = 140°C), $I_{R(AV)}$	10	10	10	10	10	10	10	10	5	4	3	2	2	mA
Maximum Effective Thermal Resistance Junction to Case, $R_{\theta JC}$	* 1.0	* 1.0	* 1.0	* 1.0	* 1.0	* 1.0	* 1.0	* 1.0	1.0	1.0	1.0	1.0	1.0	°c/w
Junction Operating & Storage Temperature Range, T_J & T_{stg}	−65° C to +200°C													
Stud Torque	30 inch pounds (35K_g-cm)													

[1] Maximum voltages apply with a heat sink thermal resistance of 10°C/w or less at maximum rated junction temperature.

[2] Maximum voltages apply with a heat sink thermal resistance of 5°C/w or less at maximum rated junction temperature.

NOTE: Case temperature is measured at the center of any one of the hex flats.

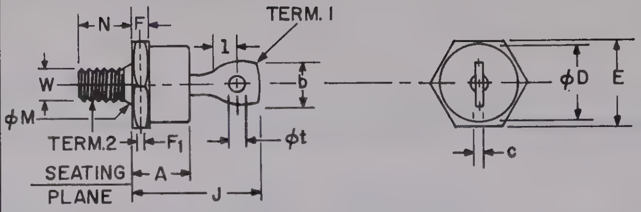
*The asterisk denotes JEDEC (EIA) registered information.

1N1183-90 1N3765-68 1N5332

OUTLINE DRAWING

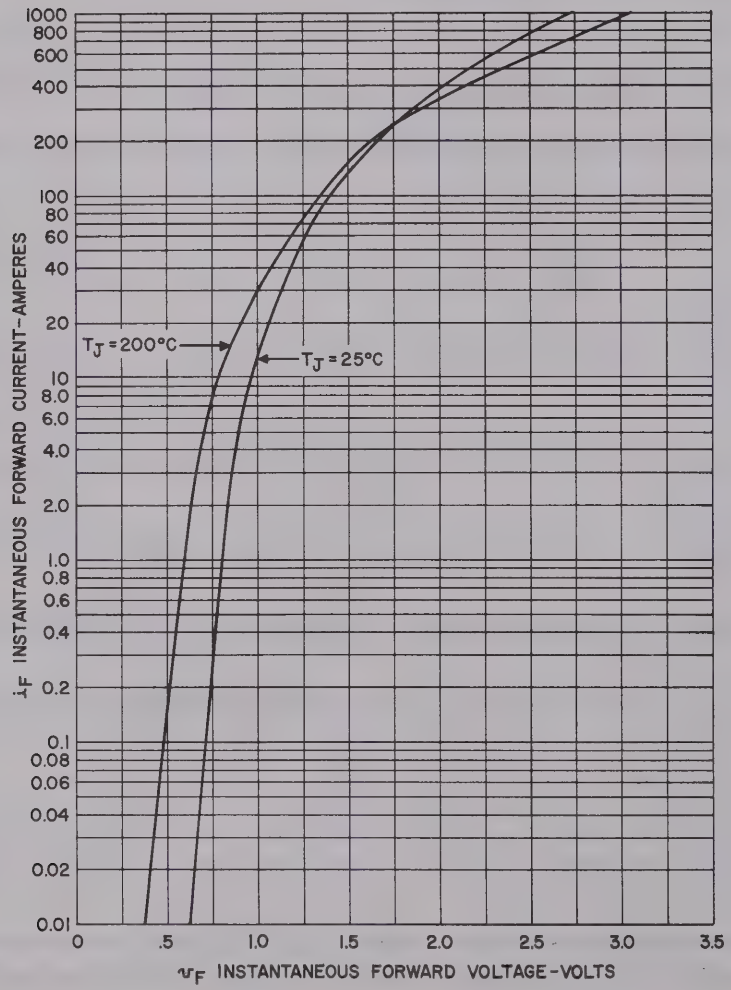
DO-5

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A		.450		11.43	
b		.375		9.53	2
c		.080		2.03	
ϕD		.667		16.94	
E	.667	.687	16.94	17.45	
F	.115	.200	2.92	5.08	
F_1	.060		1.52		
J		1.000		25.40	
l	.156		3.96		4
ϕM	.220	.249	5.59	6.32	1
N	.422	.453	10.72	11.51	
ϕt	.140	.175	3.56	4.45	
W					1,3

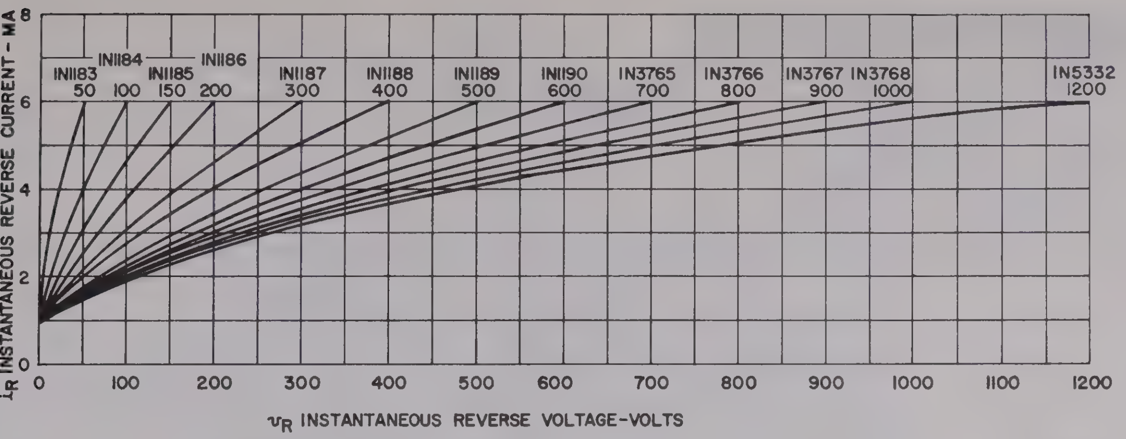


NOTES:
1. COMPLETE THREADS TO EXTEND TO WITHIN 2-1/2 THREADS OF SEATING PLANE.
2. ANGULAR ORIENTATION OF TERMINAL IS UNDEFINED.
3. 1/4-28 UNF-2A. MAXIMUM PITCH DIAMETER OF PLATED THREADS SHALL BE BASIC PITCH DIAMETER (.2268", 5.74 MM) REF. (SCREW THREAD STANDARDS FOR FEDERAL SERVICES 1957) HANDBOOK H28 1957 P1.
4. MINIMUM FLAT.

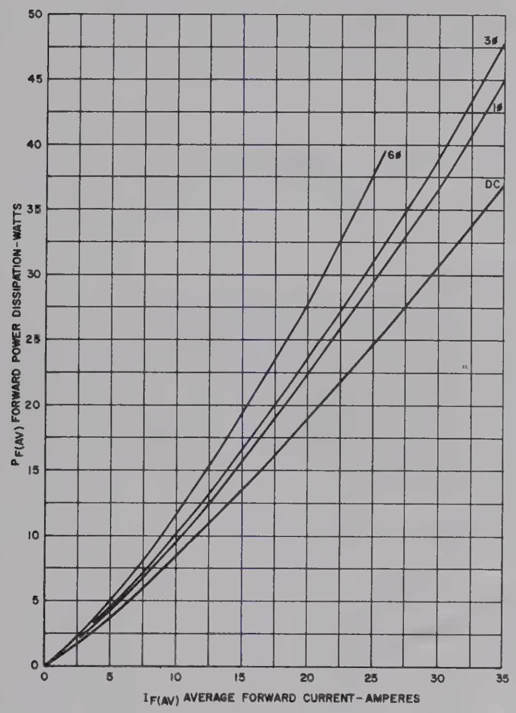
EIA-NEMA STANDARD OUTLINE, NEMA SK-51-EIA RS-241.
INSULATING HARDWARE IS AVAILABLE UPON REQUEST.



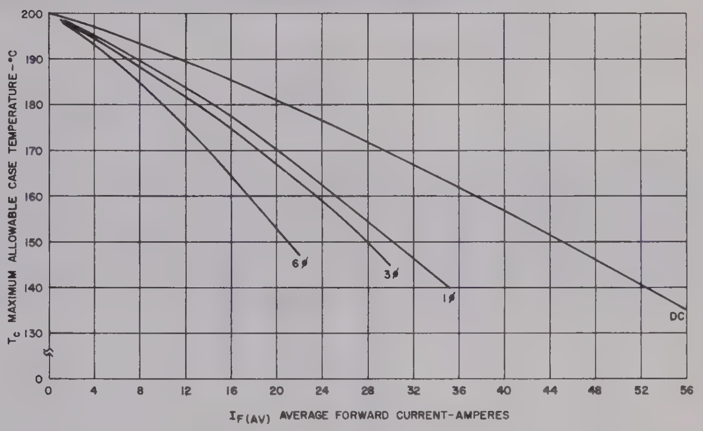
1. MAXIMUM FORWARD CHARACTERISTICS



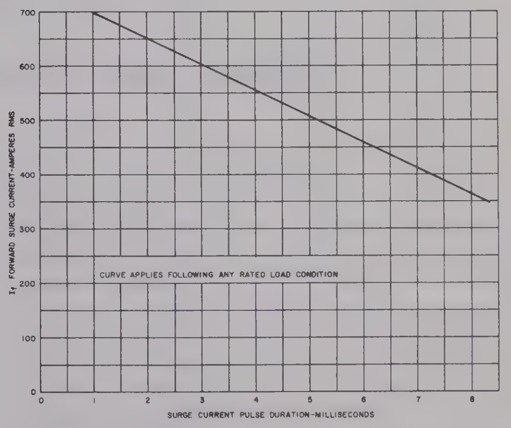
2. TYPICAL REVERSE CHARACTERISTICS $T_J = 200°C$ FOR VARIOUS VOLTAGE GRADES



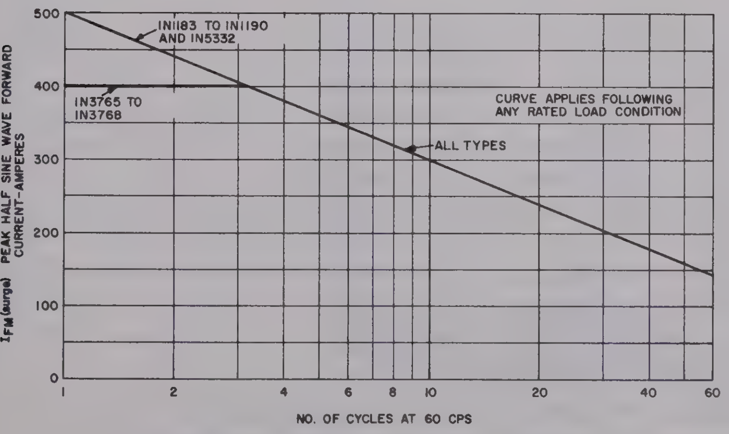
3. AVERAGE FORWARD POWER AS A FUNCTION OF AVERAGE FORWARD CURRENT $T_J = 200°C$



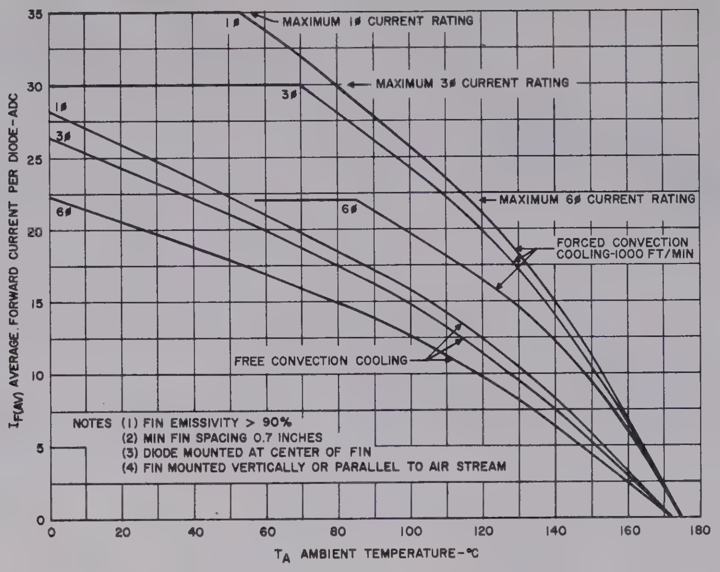
4. AVERAGE CURRENT RATING AS A FUNCTION OF CASE TEMPERATURE



6. NON-RECURRENT FORWARD CURRENT SURGE CURVE, SUBCYCLE

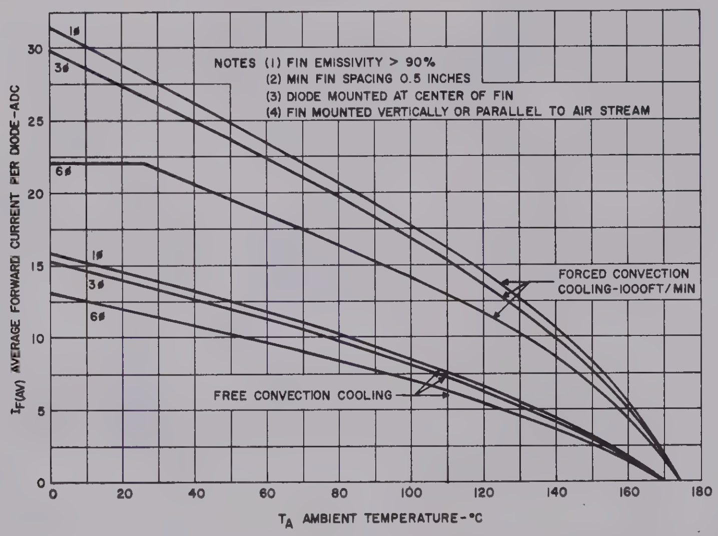


5. NON-RECURRENT FORWARD CURRENT SURGE CURVE, MULTICYCLE



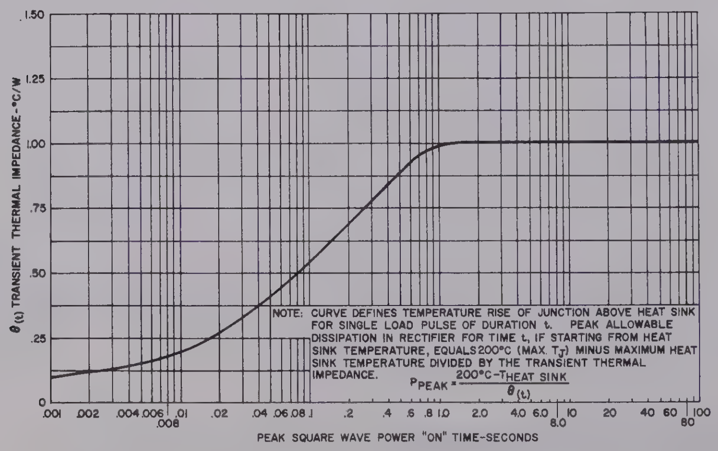
NOTES (1) FIN EMISSIVITY > 90%
(2) MIN FIN SPACING 0.7 INCHES
(3) DIODE MOUNTED AT CENTER OF FIN
(4) FIN MOUNTED VERTICALLY OR PARALLEL TO AIR STREAM

7. CURRENT RATING FOR DEVICE MOUNTED ON 5″ x 5″ x .050″ COPPER FIN



NOTES (1) FIN EMISSIVITY > 90%
(2) MIN FIN SPACING 0.5 INCHES
(3) DIODE MOUNTED AT CENTER OF FIN
(4) FIN MOUNTED VERTICALLY OR PARALLEL TO AIR STREAM

8. CURRENT RATING FOR DEVICE MOUNTED ON 2½″ x 2½″ x .043″ COPPER FIN



NOTE: CURVE DEFINES TEMPERATURE RISE OF JUNCTION ABOVE HEAT SINK FOR SINGLE LOAD PULSE OF DURATION t. PEAK ALLOWABLE DISSIPATION IN RECTIFIER FOR TIME t, IF STARTING FROM HEAT SINK TEMPERATURE, EQUALS 200°C (MAX. T_J) MINUS MAXIMUM HEAT SINK TEMPERATURE DIVIDED BY THE TRANSIENT THERMAL IMPEDANCE.

$$P_{PEAK} = \frac{200°C - T_{HEAT\ SINK}}{\theta_{(t)}}$$

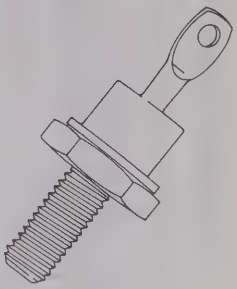
9. TRANSIENT THERMAL IMPEDANCE, JUNCTION TO CASE

Silicon
Rectifiers

1N1199A-1N1206A
1N1199RA-1N1206RA
1N3670A-1N3673A
1N5331

These diffused junction rectifiers are designed specifically to provide high performance for applications up to 22 amperes Average Forward Current in single-phase applications with repetitive peak reverse voltages of 50 through 1200 volts. High junction temperature rating plus low forward drop and thermal impedance permit high current operation with minimum space requirements.

General Electric research, advance development and product design have resulted in a highly efficient rectifying junction. This feature, plus a mechanical design employing high-temperature hard solders and welds for all internal and external joints and seals, which eliminates common sources of thermal fatigue failure, have produced a silicon rectifier with outstanding reliability under all operating conditions.



FEATURES:

- High Voltage
- Ratings up to 200°C Junction Temperature
- Popular DO-4 Outline
- Uses Hard Solders for Thermal Fatigue Protection
- Transient Voltage Ratings 200 Volts Above PRV Ratings

MAXIMUM ALLOWABLE RATINGS

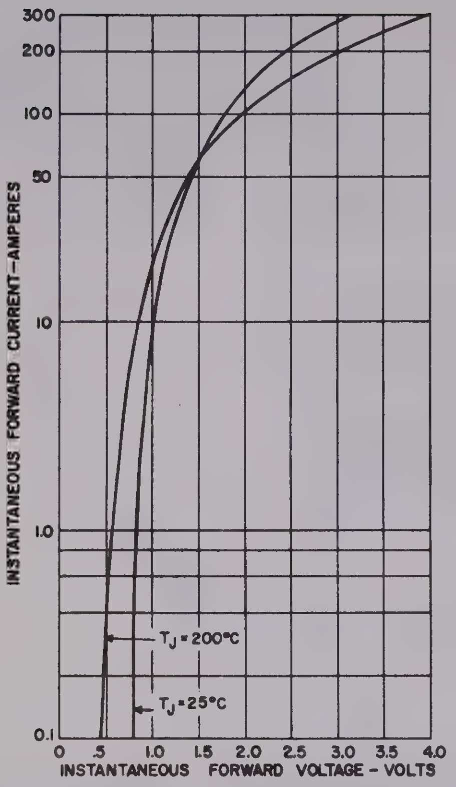
Types	Repetitive Peak Reverse Voltage, $V_{RM}(rep)^{(1)}$	RMS Voltage	DC Blocking Voltage$^{(2)}$	Non-Repetitive Peak Reverse Voltage, $V_{RM}(non\text{-}rep)$	Full-Load Reverse Current (full-cycle avg., 150°C T_C, 1 ϕ), $I_{R(AV)}$
	Volts*	Volts*	Volts*	Volts*	Milliamperes*
1N1199A, RA	50	35	50	100	3.0
1N1200A, RA	100	70	100	200	2.5
1N1201A, RA	150	105	150	300	2.25
1N1202A, RA	200	140	200	350	2.0
1N1203A, RA	300	210	300	450	1.75
1N1204A, RA	400	280	400	600	1.5
1N1205A, RA	500	350	500	700	1.25
1N1206A, RA	600	420	600	800	1.0
1N3670A	700	490	700	900	0.9
1N3671A	800	560	800	1000	0.8
1N3672A	900	650	900	1100	0.7
1N3673A	1000	700	1000	1200	0.6
1N5331	1200	840	1200	1400	0.5

Average Forward Current ($T_C = 150$°C, single-phase) .... 12 Amperes*
Peak One-Cycle Surge Current (non-repetitive), I_{FM} (surge) .... 240 Amperes*
Minimum I^2t Rating (for times $>$ .0008 sec. and $<$ .0083 sec., non-recurrent) .... 60 Ampere^2 seconds
Maximum Full-Load Voltage Drop ($T_C = 150$°C, single-phase, full-cycle avg.) .... 0.55 Volts*
Maximum Thermal Resistance, $\theta_{J\text{-}C}$ .... 2.5°C/Watt
Storage and Operating Junction Temperature, T_J .... −65°C to +200°C*
Stud Torque .... 12 Lb-in (Min), 15 Lb-in (Max)*
14 Kg-cm (Min), 17.5 Kg-cm (Max)*

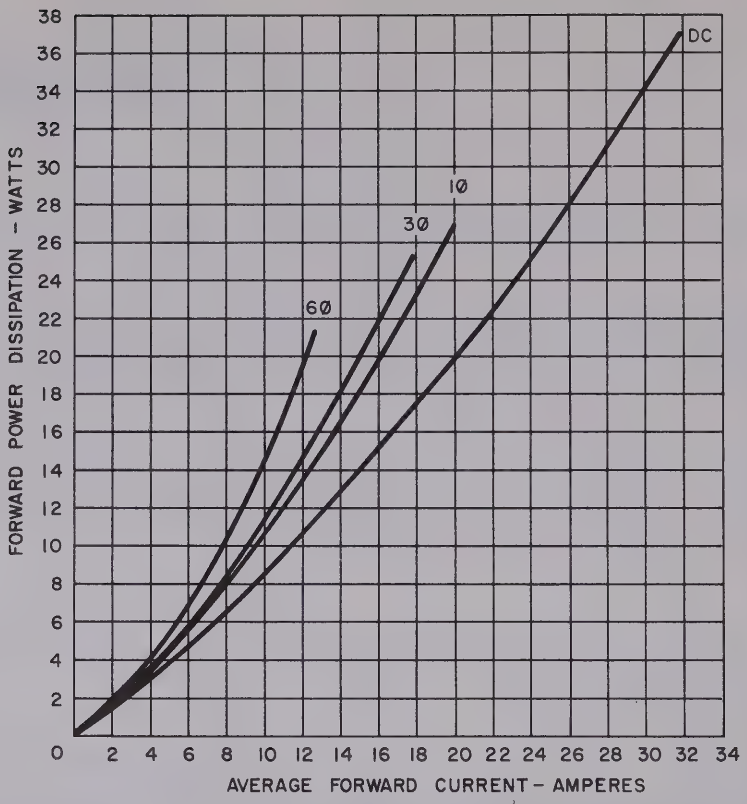
NOTES:

(1) Maximum voltages apply with a heatsink thermal resistance of 22°C/watt, or less, at maximum rated junction temperature.
(2) Maximum voltages apply with a heatsink thermal resistance 7°C/watt, or less, at maximum rated junction temperature.
(3) Case temperature, T_C, is measured at the center of any one of the hex flats.

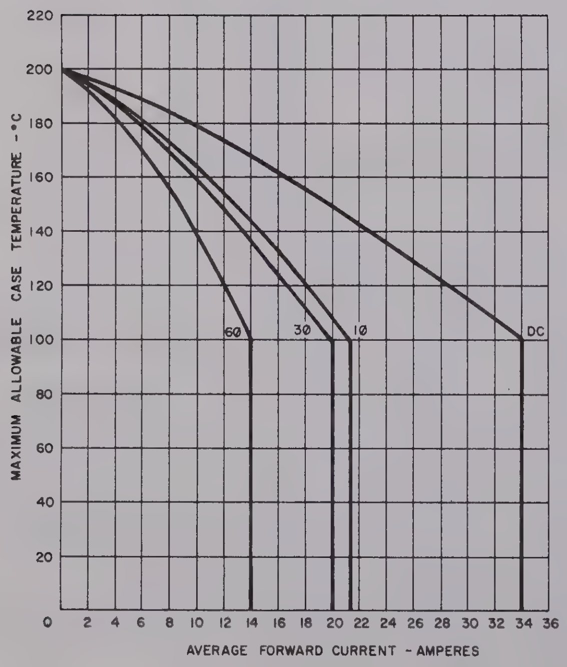
*Indicates values included in JEDEC Type Number Registration.



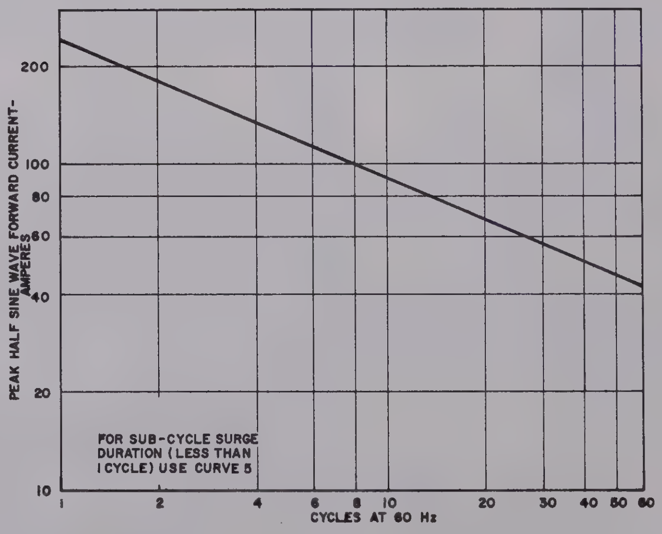
1. MAXIMUM FORWARD CHARACTERISTICS



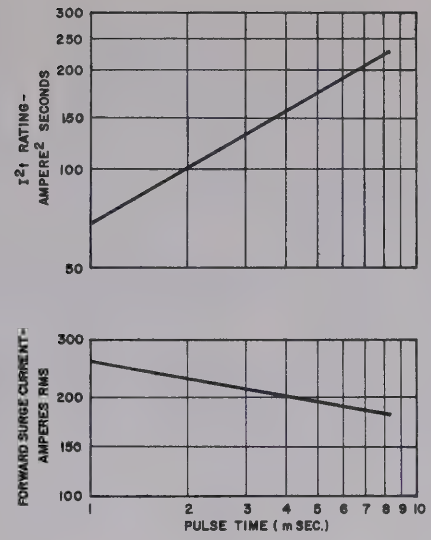
2. FORWARD POWER AS A FUNCTION OF AVERAGE FORWARD CURRENT (T_J = +200°C)



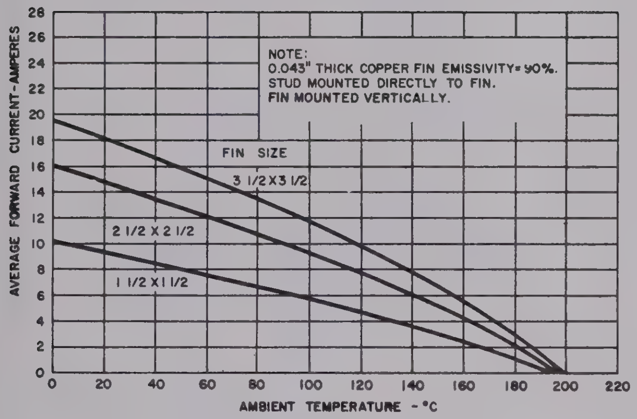
3. MAXIMUM CASE TEMPERATURE VS. AVERAGE FORWARD CURRENT



4. MAXIMUM SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS

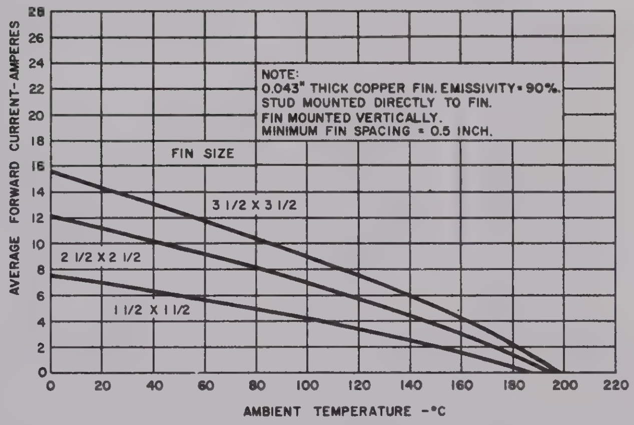


5. SUBCYCLE SURGE FORWARD CURRENT AND I²t RATING FOLLOWING RATED LOAD CONDITIONS



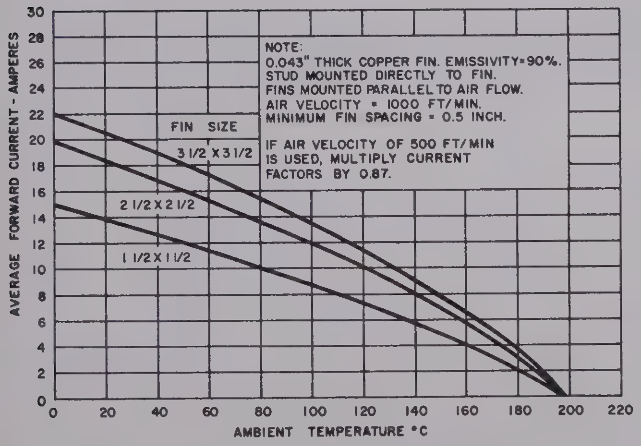
NOTE:
0.043" THICK COPPER FIN EMISSIVITY = 90%.
STUD MOUNTED DIRECTLY TO FIN.
FIN MOUNTED VERTICALLY.

6. REQUIRED FIN SIZE — FREE CONVECTION, SINGLE FIN, UNIMPEDED RADIATION



NOTE:
0.043" THICK COPPER FIN. EMISSIVITY = 90%.
STUD MOUNTED DIRECTLY TO FIN.
FIN MOUNTED VERTICALLY.
MINIMUM FIN SPACING = 0.5 INCH.

7. REQUIRED FIN SIZE — FREE CONVECTION, IMPEDED RADIATION



NOTE:
0.043" THICK COPPER FIN. EMISSIVITY = 90%.
STUD MOUNTED DIRECTLY TO FIN.
FINS MOUNTED PARALLEL TO AIR FLOW.
AIR VELOCITY = 1000 FT/MIN.
MINIMUM FIN SPACING = 0.5 INCH.

IF AIR VELOCITY OF 500 FT/MIN IS USED, MULTIPLY CURRENT FACTORS BY 0.87.

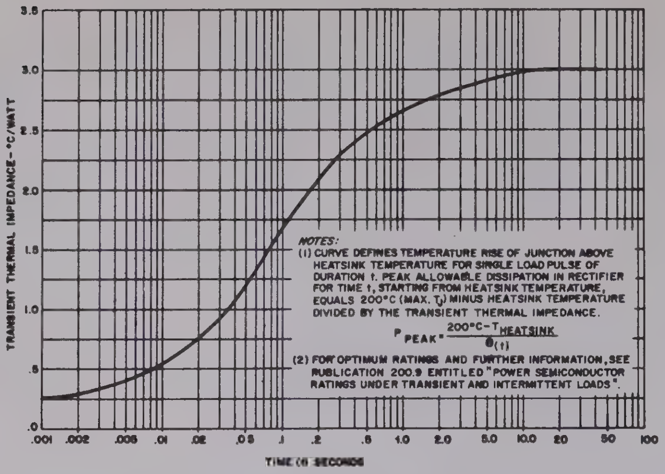
8. REQUIRED FIN SIZE — FORCED CONVECTION, IMPEDED RADIATION

TO USE GRAPHS 6, 7 AND 8

1. Enter graph at vertical axis with desired current multiplied by proper current factor:

DC-0.80	3φ-1.15
1φ-1.00	6φ-1.40

2. Intercept desired fin curve
3. Read on horizontal axis the maximum allowable ambient temperature



NOTES:
(1) CURVE DEFINES TEMPERATURE RISE OF JUNCTION ABOVE HEATSINK TEMPERATURE FOR SINGLE LOAD PULSE OF DURATION t. PEAK ALLOWABLE DISSIPATION IN RECTIFIER FOR TIME t, STARTING FROM HEATSINK TEMPERATURE, EQUALS 200°C (MAX. T_J) MINUS HEATSINK TEMPERATURE DIVIDED BY THE TRANSIENT THERMAL IMPEDANCE.

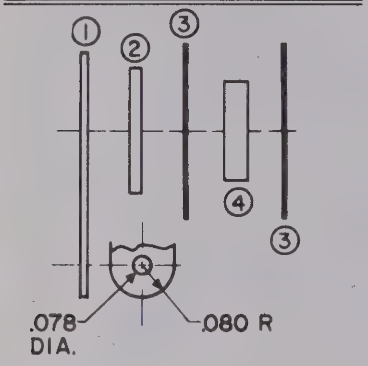
$$P_{PEAK} = \frac{200°C - T_{HEATSINK}}{\theta_{(t)}}$$

(2) FOR OPTIMUM RATINGS AND FURTHER INFORMATION, SEE PUBLICATION 200.9 ENTITLED "POWER SEMICONDUCTOR RATINGS UNDER TRANSIENT AND INTERMITTENT LOADS".

9. MAXIMUM TRANSIENT THERMAL IMPEDANCE — JUNCTION TO HEATSINK

OUTLINE DRAWING

INSULATING HARDWARE KIT *



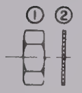
① COPPER TERMINAL, .016 THICK, TIN PLATED

② BRASS WASHER, .035 THICK NICKEL PLATED

③ MICA WASHERS, TWO, .625 O.D., .204 I.D., .005 THICK

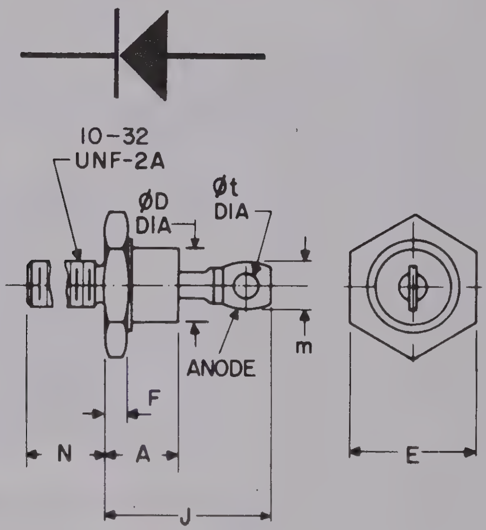
④ TEFLON WASHER, .270 O.D. .204 I.D., .050 THICK

* AVAILABLE UPON REQUEST



① 10-32 STEEL NUT CADMIUM PLATED

② LOCKWASHER, CADMIUM PLATED STEEL



COMPLIES WITH
EIA REGISTERED OUTLINE DO-4

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A		.405		10.29	
ϕD		.424		10.77	
E	.424	.437	10.77	11.10	
F	.075	.175	1.91	4.45	
J		.800		20.32	
m		.250		6.35	1
N	.422	.453	10.72	11.51	
ϕt	.060		1.52		
W					2

NOTES:

1. Angular orientation of this terminal is undefined.
2. 10-32 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter (.1697", 4.29 MM). Ref: (Screw thread standards for Federal Services 1957) Handbook H28, P1.

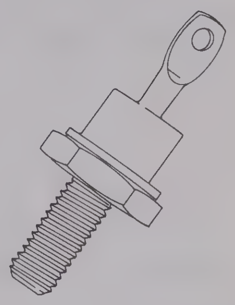
Silicon Rectifiers

IN1341A-48A
IN1341RA-48RA

MEDIUM CURRENT JUNCTION 6A TYPE

These stud mounted diffused junction silicon rectifiers, (designed to meet MIL-E-1/1108) are recommended for all rectifier applications in the 2 to 8 ampere range. A high junction temperature rating and an extremely low forward voltage drop and thermal impedance permit high current operation with minimum space requirements. These rectifiers may be mounted directly to a chassis or a fin or may be electrically insulated from the heat sink by using the mica washer insulating kit which is provided with each unit. Versatility is further increased by the availability of a negative polarity unit (stud is anode), described by the suffix "R" appearing after the type number. The use of positive and negative polarity units facilitates the construction of bridge circuits and permits the use of either a positive or negative heat sink in half-wave and center-tap applications.

General Electric research, advanced development and product design have resulted in a highly efficient rectifying junction. This feature, plus a mechanical design employing high temperature hard solders and welds for all internal and external joints and seals, which eliminates common sources of thermal fatigue failure, have produced a silicon rectifier with outstanding reliability under all operating conditions.



electrical ratings and specifications (60 cps, Resistive or Inductive Load)

	1N1341A 1N1341RA	1N1342A 1N1342RA	1N1343A 1N1343RA	1N1344A 1N1344RA	1N1345A 1N1345RA	1N1346A 1N1346RA	1N1347A 1N1347RA	1N1348A 1N1348RA
Max. Allow. Transient Peak Reverse Voltage (Non-recurrent, 5 millisec. max. duration, $T_j = 0$ to 200°C)	100	200	300	350	450	600	700	800 Volts
Max. Allow. Peak Reverse Voltage (Repetitive)*	50	100	150	200	300	400	500	600 Volts
Max. Allow. RMS Voltage	35	70	105	140	210	280	350	420 Volts
Max. Allow. DC Blocking Voltage**	50	100	150	200	300	400	500	600 Volts
Max. Allow. Forward Current (Single Phase —150°C stud temp.)	← 6 amperes →							
Max. Allow. Peak One Cycle Surge Current (non-recurrent)	← 150 amperes →							
I²t Rating (for t greater than .0008 sec. and less than .0083 sec. (non-recurrent)	← 25 ampere² sec. — min. rating (T_j =–65°C to +200°C) →							
Max. Full Load Voltage Drop (Single Phase, Full Cycle Average —150°C stud temp.)	← .64 Volts →							
Max. Leakage Current at Full Load (Single Phase, Full Cycle Average —150°C stud temp.)	3.0	2.5	2.25	2.0	1.75	1.5	1.25	1.0 ma
Max. Thermal Resistance (junction to stud)	← 4.25°C/Watt →							
Junction Operating and Storage Temp. Range	← —65°C to +200°C →							
Stud Torque	Minimum 12 in.-lbs.; Maximum 15 in.-lbs.							

*Maximum voltages apply with a heat sink thermal resistance of 22°C/ Watt or less at maximum rated junction temperature.
**Maximum voltages apply with a heat sink thermal resistance of 7°/Watt or less at maximum rated junction temperature.

IN1341A-48A
IN1341RA-48RA

**INSULATING
HARDWARE
KIT***

OUTLINE DRAWING

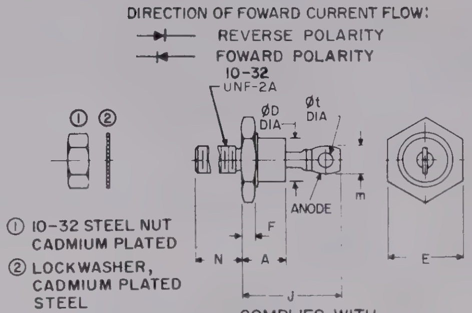
DIRECTION OF EASY CONVENTIONAL
CURRENT FLOW—IN1199A-IN1206A

DIRECTION OF EASY CONVENTIONAL
CURRENT FLOW—IN1199RA-IN1206RA

OUTLINE DRAWING

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A		.405		10.29	
φD		.424		10.77	
E	.424	.437	10.77	11.10	
F	.075	.175	1.91	4.45	
J		.800		20.32	
m		.250		6.35	1
N	.422	.453	10.72	11.51	
φt	.060		1.52		
W					2

NOTES:
1. Angular orientation of this terminal is undefined.
2. 10-32 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter (.1697", 4.29 MM). Ref: (Screw thread standards for Federal Services 1957) Handbook H28, P1

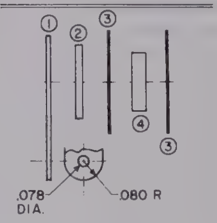

DIRECTION OF FOWARD CURRENT FLOW:
REVERSE POLARITY
FOWARD POLARITY
① ②
10-32
UNF-2A
ØD
DIA
Øt
DIA
ANODE
m
F
N
A
E
J

① 10-32 STEEL NUT CADMIUM PLATED

② LOCKWASHER, CADMIUM PLATED STEEL

COMPLIES WITH
EIA REGISTERED OUTLINE DO-4

INSULATING HARDWARE
KIT*


①
②
③
④
③
.078
DIA.
.080 R

① COPPER TERMINAL, .016 THICK, TIN PLATED

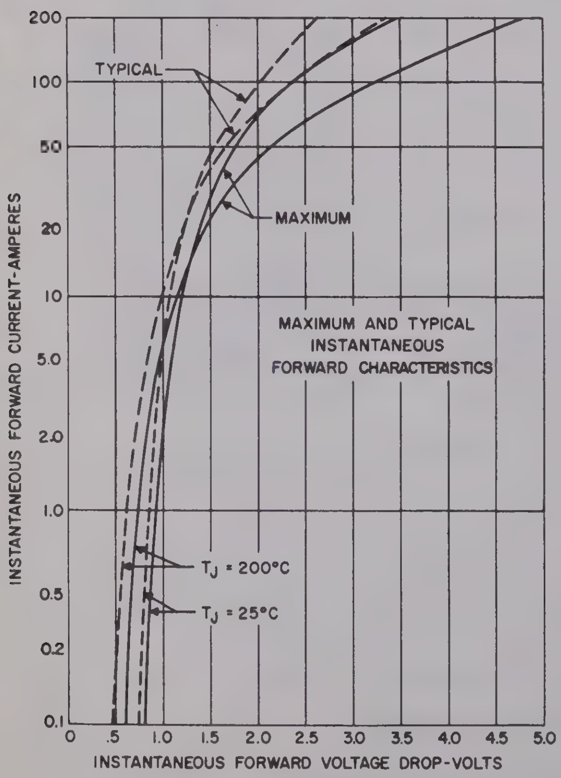
② BRASS WASHER, .035 THICK NICKEL PLATED

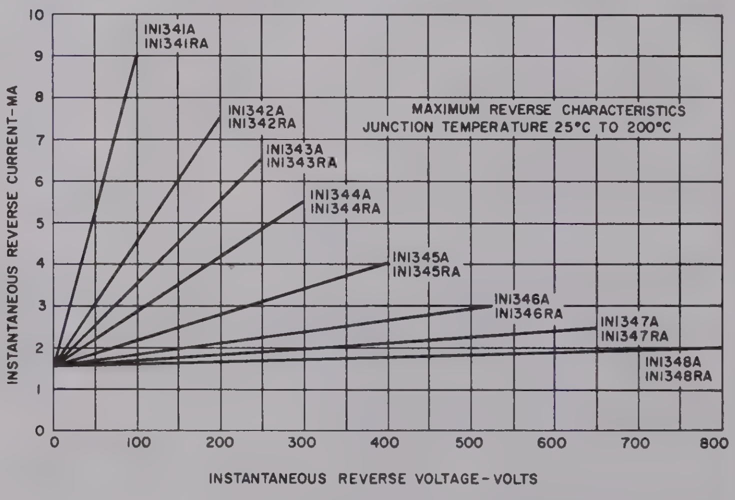
③ MICA WASHERS, TWO, .625 O.D., .204 I.D., .005 THICK

④ TEFLON WASHER, .270 O.D. .204 I.D., .050 THICK

* AVAILABLE UPON REQUEST

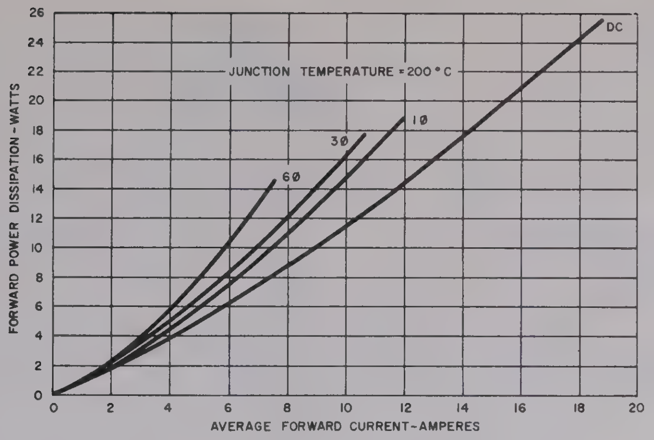
NOTES: (1) UNIT WEIGHT — .25 OZ
(2) MICA WASHER IN MOUNTING KIT MAY ADD APPROX 6.5°C/WATT THERMAL RESISTANCE STUD TO HEAT SINK



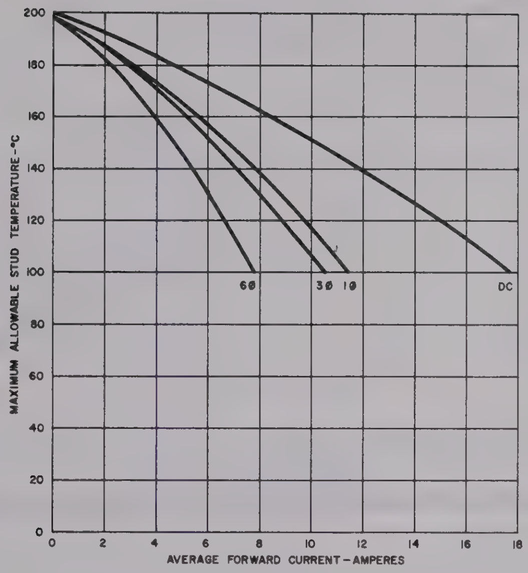


2. REVERSE CHARACTERISTICS

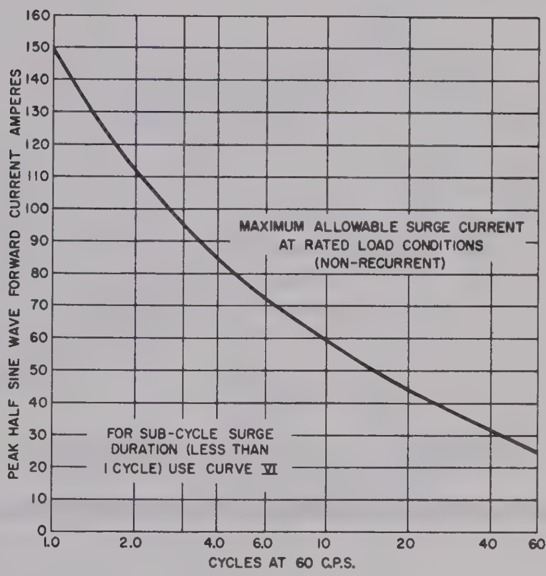
1. MAXIMUM AND TYPICAL FORWARD CHARACTERISTICS



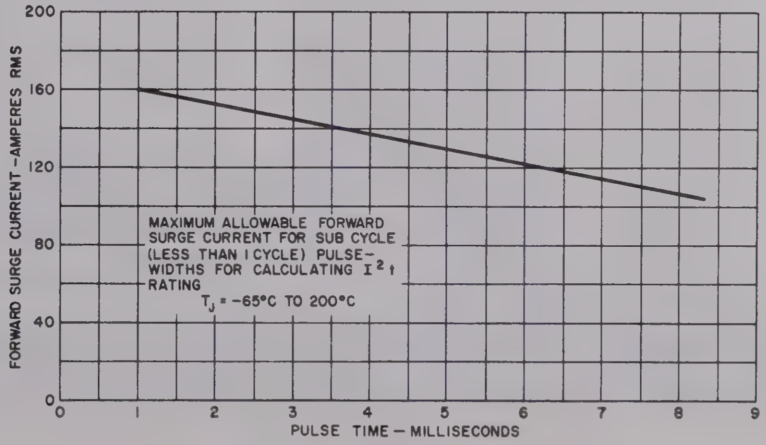
3. FORWARD POWER DISSIPATION



4. MAXIMUM ALLOWABLE STUD TEMPERATURE



5. SURGE RATING (1-60 cycles)



6. SUB-CYCLE SURGE RATING

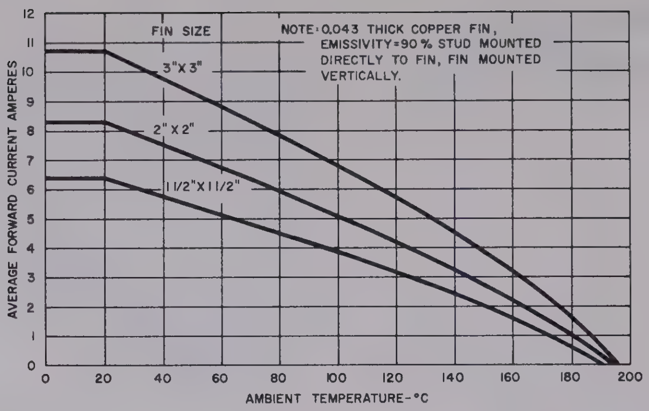
IN1341A-48A
IN1341RA-48RA

TO USE GRAPHS 7, 8, 9

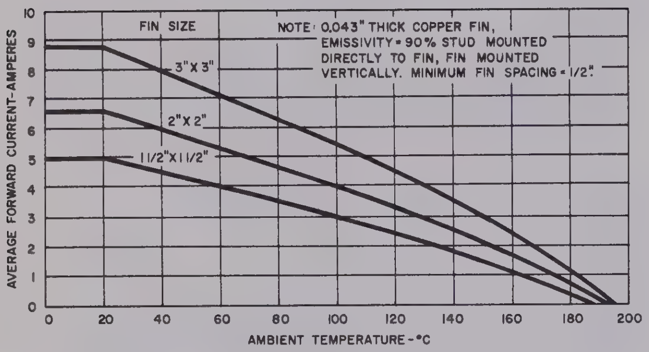
1. Enter graph at vertical axis with desired current multiplied by proper current factor:

DC-0.80	3ϕ-1.15
1ϕ-1.00	6ϕ-1.40

2. Intercept desired fin curve
3. Read on horizontal axis the maximum allowable ambient temperature.

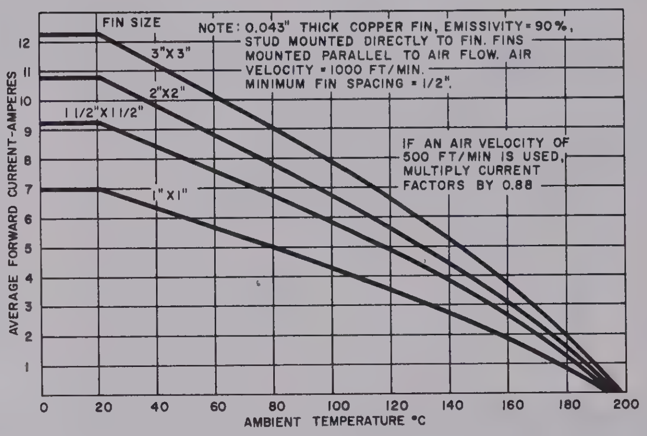


NOTE: 0.043 THICK COPPER FIN, EMISSIVITY=90 % STUD MOUNTED DIRECTLY TO FIN, FIN MOUNTED VERTICALLY.



NOTE: 0.043" THICK COPPER FIN, EMISSIVITY = 90% STUD MOUNTED DIRECTLY TO FIN, FIN MOUNTED VERTICALLY. MINIMUM FIN SPACING = 1/2".

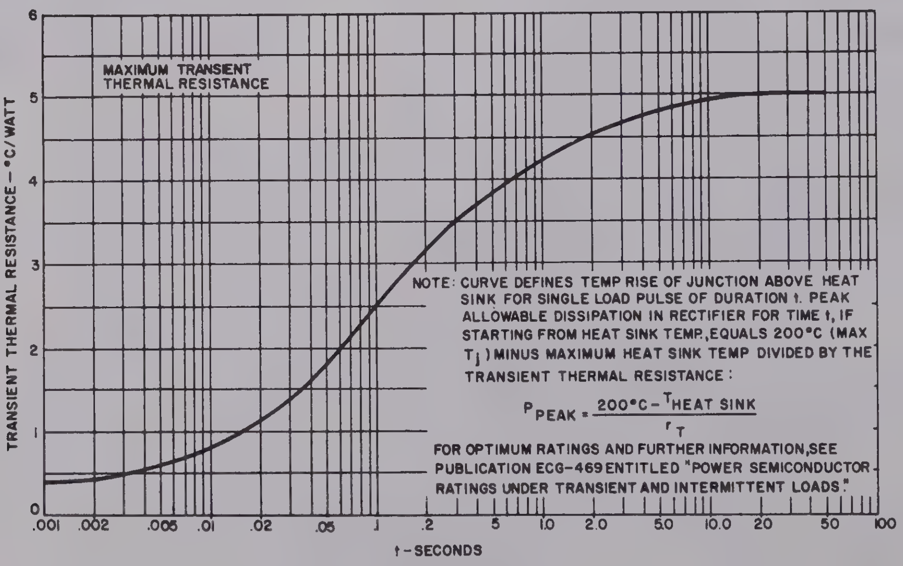
8. REQUIRED FIN SIZE—FREE CONVECTION, IMPEDED RADIATION



NOTE: 0.043" THICK COPPER FIN, EMISSIVITY = 90%, STUD MOUNTED DIRECTLY TO FIN. FINS MOUNTED PARALLEL TO AIR FLOW. AIR VELOCITY = 1000 FT/MIN. MINIMUM FIN SPACING = 1/2".

IF AN AIR VELOCITY OF 500 FT/MIN IS USED, MULTIPLY CURRENT FACTORS BY 0.88

9. REQUIRED FIN SIZE—FORCED CONVECTION, IMPEDED RADIATION



NOTE: CURVE DEFINES TEMP RISE OF JUNCTION ABOVE HEAT SINK FOR SINGLE LOAD PULSE OF DURATION t. PEAK ALLOWABLE DISSIPATION IN RECTIFIER FOR TIME t, IF STARTING FROM HEAT SINK TEMP., EQUALS 200°C (MAX T_j) MINUS MAXIMUM HEAT SINK TEMP DIVIDED BY THE TRANSIENT THERMAL RESISTANCE:

$$P_{PEAK} = \frac{200°C - T_{HEAT\ SINK}}{r_T}$$

FOR OPTIMUM RATINGS AND FURTHER INFORMATION, SEE PUBLICATION ECG-469 ENTITLED "POWER SEMICONDUCTOR RATINGS UNDER TRANSIENT AND INTERMITTENT LOADS."

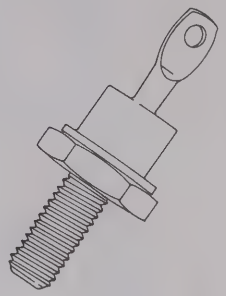
10. MAXIMUM TRANSIENT THERMAL RESISTANCE

Silicon
Rectifier

IN1612-16,R

MEDIUM CURRENT JUNCTION 5A TYPE

These popular stud mounted 5 ampere rectifiers are the commercial version of the MIL-19500/162 rectifiers. They were designed specifically to meet this military specification. Hermetic seals, one piece terminals, and all-hard-solder construction are the major features of this design. The all-hard-solder or welded construction is an important feature for the designer to consider. Temperature excursions caused by heating and cooling when the rectifier is used intermittently at maximum rating will cause thermal fatigue in a soft-solder construction. The hard-solder and welded construction provides freedom from thermal fatigue failures.



The major features of this design are:

- Hard-Solder, Thermal Fatigue Free
- Solid One-Piece Terminal
- Low Thermal Impedance
- Transient PRV Ratings

electrical ratings and specifications (60 cps, Resistive or Inductive Load)

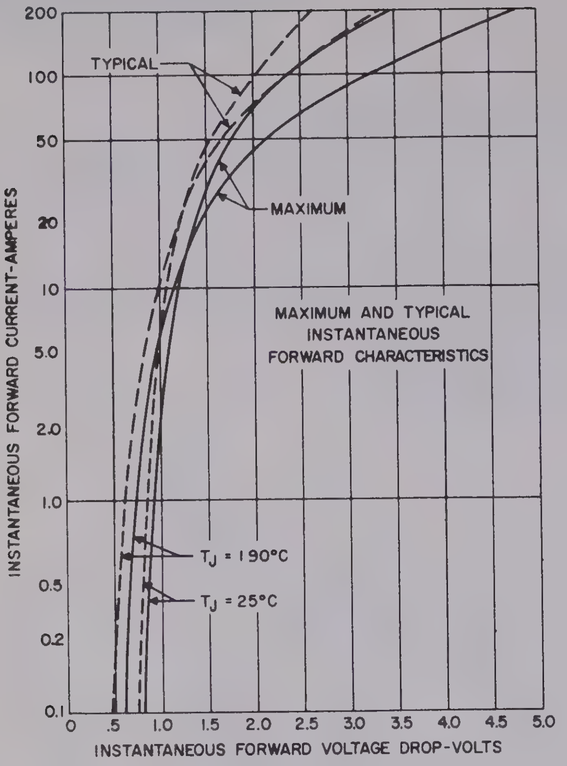
	1N1612 1N1612R	1N1613 1N1613R	1N1614‡ 1N1614R	1N1615‡ 1N1615R	1N1616‡ 1N1616R	
Max. Allow. Transient Peak Reverse Voltage (Non-recurrent, 5 millisec. max. duration, $T_j = 0$ to 190°C)	100	200	350	600	800	Volts
Max. Allow. Peak Reverse Voltage (Repetitive)*	50	100	200	400	600	Volts
Max. Allow. RMS Voltage	35	70	140	280	420	Volts
Max. Allow. DC Blocking Voltage**	50	100	200	400	600	Volts
Max. Allow. Forward Current (Single Phase +150°C stud temp.)	← 5 amperes →					
Max. Allow. Peak One Cycle Surge Current (non-recurrent)	← 150 amperes →					
I^2t Rating [for t greater than .0008 sec. and less than .0083 sec. (non-recurrent)]	← 25 ampere^2 sec. — min. rating ($T_j = -65$°C to +190°C) →					
Max. Full Load Voltage Drop (Single Phase, Full Cycle Average +150°C stud temp.)	← .64 Volts →					
Max. Leakage Current at Full Load (Single Phase, Full Cycle Average 150°C stud temp.)	1.0	1.0	1.0	1.0	1.0	ma
Max. Thermal Resistance (junction to stud)	← 7.0°C/Watt →					
Junction Operating and Storage Temp. Range	← −65°C to +190°C →					
Stud Torque	Minimum 12 in.-lbs.; Maximum 15 in.-lbs.					

---

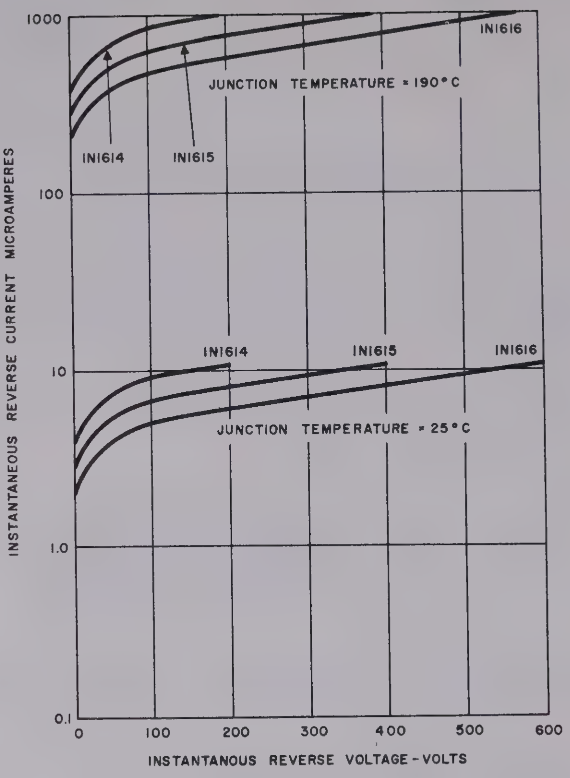
*Maximum voltages apply with a heat sink thermal resistance of 22°C/Watt or less at maximum rated junction temperature.

**Maximum voltages apply with a heat sink thermal resistance of 7°/Watt or less at maximum rated junction temperature.

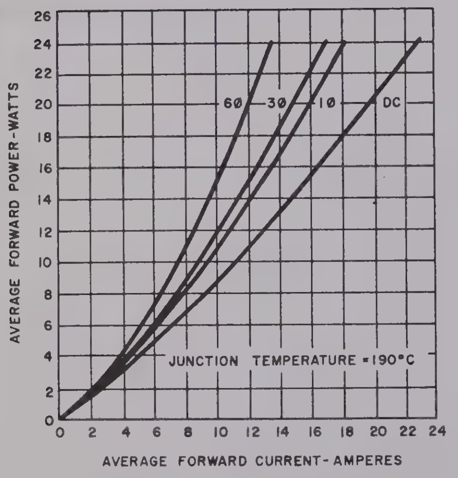
‡Available as MIL-S-19500/162 devices.



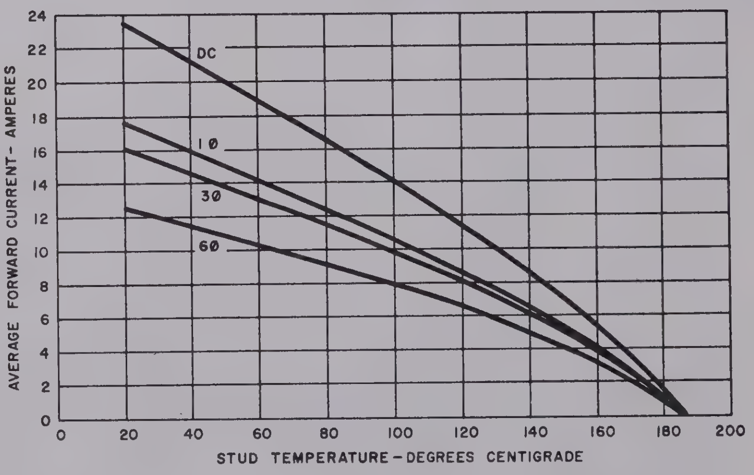
1. MAXIMUM AND TYPICAL FORWARD CHARACTERISTICS



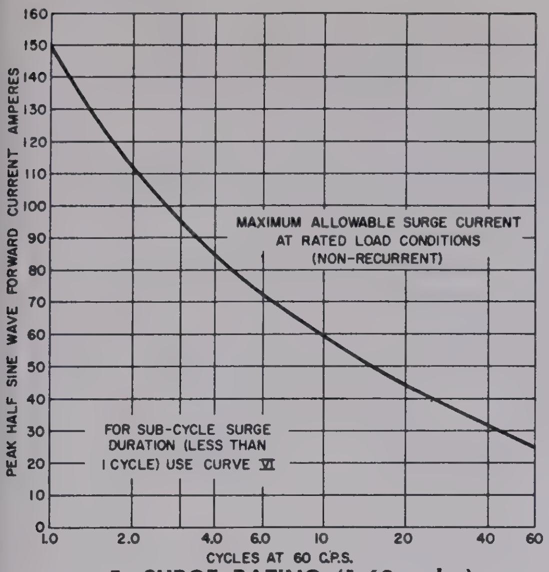
2. REVERSE CHARACTERISTICS



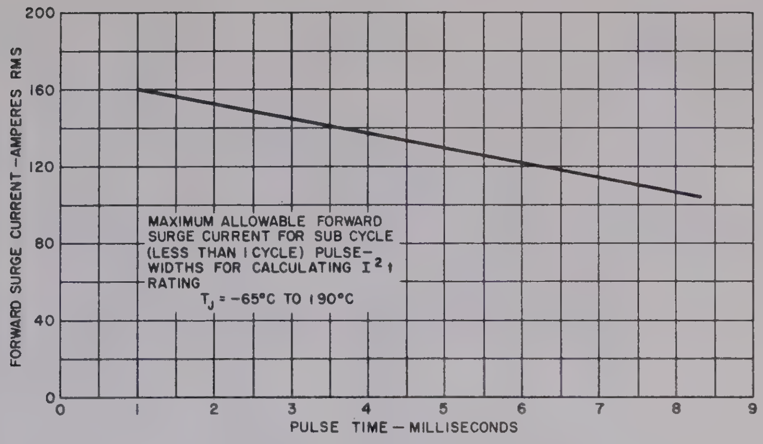
3. FORWARD POWER DISSIPATION



4. MAXIMUM ALLOWABLE STUD TEMPERATURE



5. SURGE RATING (1-60 cycles)



6. SUB-CYCLE SURGE RATING

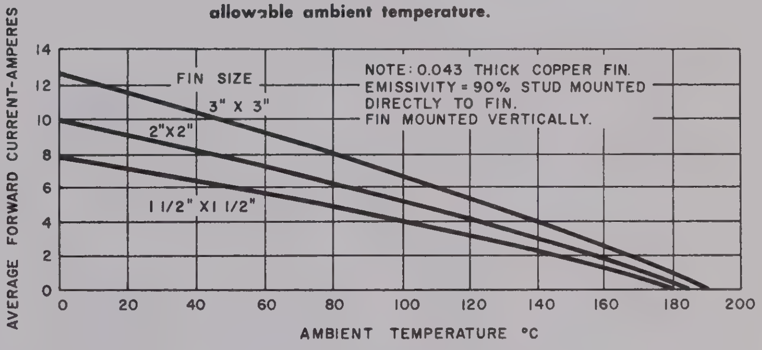
*** TO USE GRAPHS 7, 8, 9**

1. Enter graph at vertical axis with desired current multiplied by proper current factor:

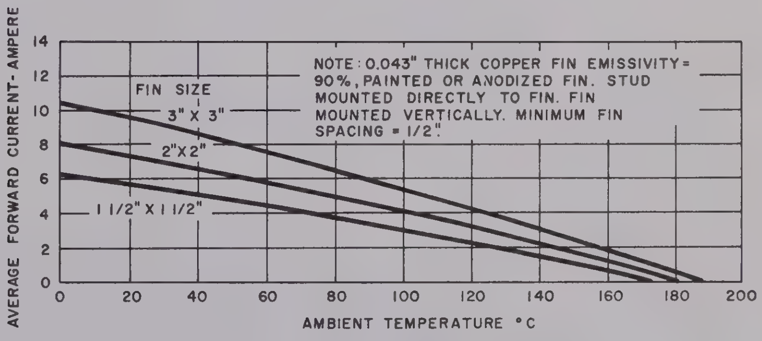
DC-0.80	3ϕ-1.15
1ϕ-1.00	6ϕ-1.40

2. Intercept desired fin curve
3. Read on horizontal axis the maximum allowable ambient temperature.

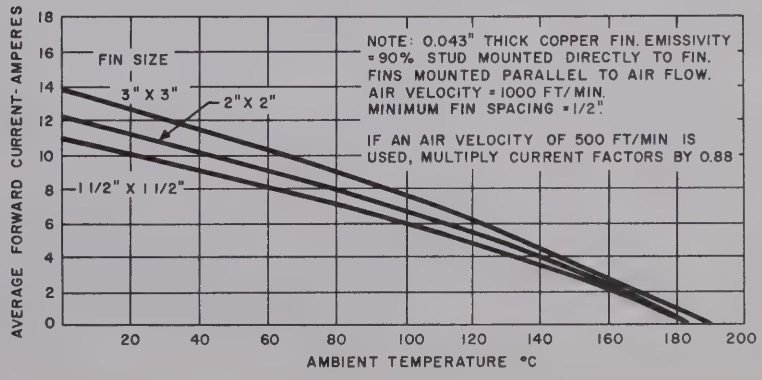
*7. REQUIRED FIN SIZE—FREE CONVECTION, SINGLE FIN, UNIMPEDED RADIATION

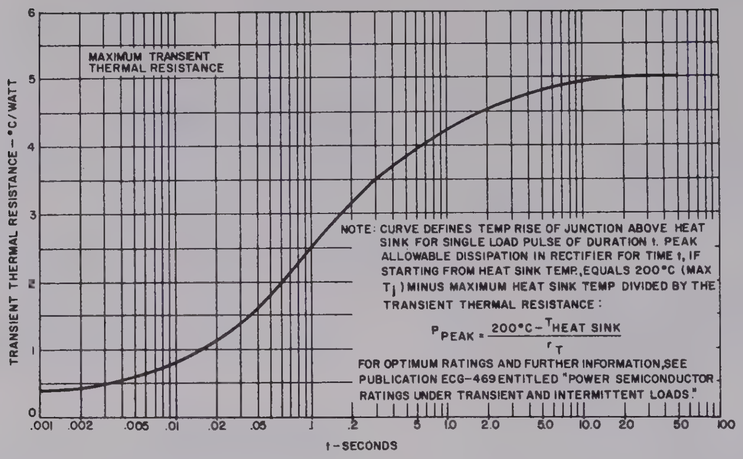


*8. REQUIRED FIN SIZE—FREE CONVECTION, IMPEDED RADIATION



*9. REQUIRED FIN SIZE—FORCED CONVECTION, IMPEDED RADIATION





NOTE: CURVE DEFINES TEMP RISE OF JUNCTION ABOVE HEAT SINK FOR SINGLE LOAD PULSE OF DURATION t. PEAK ALLOWABLE DISSIPATION IN RECTIFIER FOR TIME t, IF STARTING FROM HEAT SINK TEMP, EQUALS 200°C (MAX T_j) MINUS MAXIMUM HEAT SINK TEMP DIVIDED BY THE TRANSIENT THERMAL RESISTANCE:

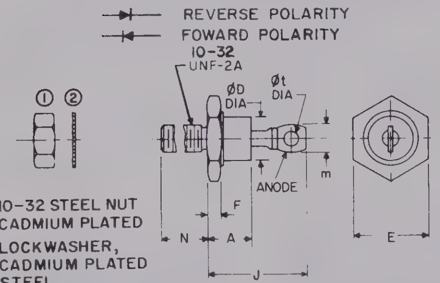
$$P_{PEAK} = \frac{200°C - T_{HEAT\ SINK}}{r_T}$$

FOR OPTIMUM RATINGS AND FURTHER INFORMATION, SEE PUBLICATION ECG-469 ENTITLED "POWER SEMICONDUCTOR RATINGS UNDER TRANSIENT AND INTERMITTENT LOADS."

10. MAXIMUM TRANSIENT THERMAL RESISTANCE

OUTLINE DRAWING

DIRECTION OF FOWARD CURRENT FLOW:

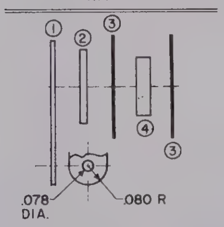


① 10-32 STEEL NUT CADMIUM PLATED

② LOCKWASHER, CADMIUM PLATED STEEL

COMPLIES WITH
EIA REGISTERED OUTLINE DO-4

INSULATING HARDWARE KIT *



① COPPER TERMINAL, .016 THICK, TIN PLATED

② BRASS WASHER, .035 THICK NICKEL PLATED

③ MICA WASHERS, TWO, .625 O.D., .204 I.D., .005 THICK

④ TEFLON WASHER, .270 O.D. .204 I.D., .050 THICK

* AVAILABLE UPON REQUEST

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A		.405		10.29	
ϕD		.424		10.77	
E	.424	.437	10.77	11.10	
F	.075	.175	1.91	4.45	
J		.800		20.32	
m		.250		6.35	1
N	.422	.453	10.72	11.51	
ϕt	.060		1.52		
W					2

NOTES:
1. Angular orientation of this terminal is undefined.
2. 10-32 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter (.1697", 4.29 MM). Ref: (Screw thread standards for Federal Services 1957) Handbook H28, P1

Silicon Rectifier Modules

"Avalanche Protected"

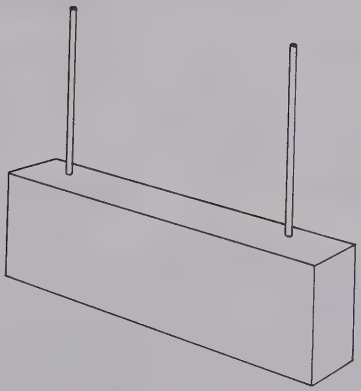
Up to 12,000 Volts Up to 3.0 Amps

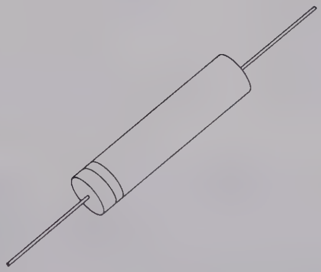
General Electric now offers silicon rectifiers in modules up to 12000 volts, up to 2080 mA.

Standard modules are offered in single-phase, fullwave bridges, 3-phase bridges, center tap or voltage-doublers, and half-wave series strings, in addition any other circuit configuration desired may be built upon special order.

TYPICAL APPLICATIONS

- Power Supplies
- High Voltage Rectification
- Applicances and Tools
- Business Machines





FEATURES:

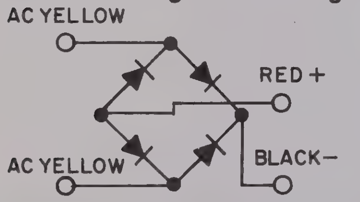
- A14 and MPR Avalanche Protected Rectifiers used for Improved Reliability, In Series Connected Arrays, and For Self-Protection Against Normal Voltage Transients.
- Small Size.
- Axial-Lead Cartridge Type and Rectanglar Blocks Available.
- Uses Only Hermetic-Sealed Devices.
- Wide Variety of Standard and Special Assemblies Available.
- Wide Range of Operating and Storage Temperatures, (−65°C to +150°C) (−65°C to +175°C).
- Functionally Replace A723, A725 and A420, 421, 422.

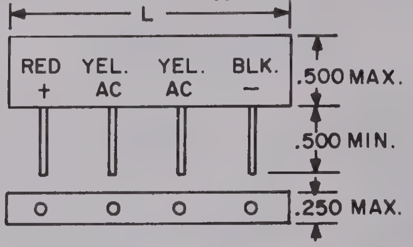
FULLWAVE SINGLE-PHASE BRIDGES

A14 SINGLE-PELLET TYPES

Type	Wkg. Pk. Rev. Volts & Rev. DC Volts, V_{RWM} & V_R Volts	Avg. Fwd. Current $I_{F(AV)}$ mA		Max. DC Forward Voltage Drop @ 100mA V_F Volts	Max. DC Rev. Current I_R @ V_{RWM} μA		Min. Brkdn. Volts, $V_{(BR)R}$ @ 50μA Volts	Max. Brkdn. Volts, $V_{(BR)R}$ @ 500μA Volts	Cells Per Leg	Outline L Inches Max.
		T_A = 50°C	T_A = 100°C		T_A = 25°C	T_A = 150°C				
A1423FB1AB1	50	1500	1000	0.9	5	100	480	1200	1	.650
A1423AB1AB1	100	1500	1000	0.9	5	100	480	1200	1	.650
A1423BB1AB1	200	1500	1000	0.9	5	100	480	1200	1	.650
A1423DB1AB1	400	1500	1000	0.9	5	100	720	1200	1	.650
A1423MB1AB1	600	1500	1000	0.9	5	100	720	1200	1	.650
A1423NB1AB1	800	1500	1000	0.9	5	100	960	1300	1	.650
A1423MB2AB1	1200	840	500	1.8	5	100	1440	2400	2	1.200
A1423MB3AB1	1800	650	430	2.7	5	100	2160	3600	3	1.750
MPR MULTI-PELLET TYPES										
A1423PBB1AB1	1200	620	370	1.8	5	100	1440	2400	1	.650
A1423PBB2AB1	2400	350	180	3.6	5	100	2880	4800	2	.925
A1423PBB3AB1	3600	290	140	5.4	5	100	4320	7200	3	1.750

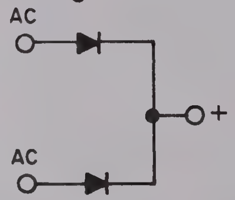
Fullwave Single-Phase Bridge





Rectangular Type

Single-Phase



Center Tap

SINGLE-PHASE CENTER TAP

A14 SINGLE-PELLET TYPES*

A1423BC1AB1	200	2080	1360	0.9	5	100	480	1200	1	.370
A1423DC1AB1	400	2080	1360	0.9	5	100	720	1200	1	.370
A1423MC1AB1	600	2080	1360	0.9	5	100	720	1200	1	.370
A1423MC2AB1	1200	1340	840	1.8	5	100	1440	2400	2	.650
A1423MC3AB1	1800	1040	640	2.7	5	100	2160	3600	3	.925
A1423MC4AB1	2400	840	500	3.6	5	100	2880	4800	4	1.200
A1423MC5AB1	3000	780	460	4.5	5	100	3600	6000	5	1.750
A1423MC6AB1	3600	750	430	5.4	5	100	4320	7200	6	1.750
MPR MULTI-PELLET TYPES*										
A1423PBC1AB1	1200	1060	660	1.8	5	100	1440	2400	1	.370
A1423PBC2AB1	2400	620	370	3.6	5	100	2880	4800	2	.650
A1423PBC3AB1	3600	440	240	5.4	5	100	4320	7200	3	.650
A1423PBC4AB1	4800	350	180	7.2	5	100	5760	9600	4	.925
A1423PBC5AB1	6000	320	150	9.0	5	100	7200	12000	5	1.200
A1423PBC6AB1	7200	290	140	10.8	5	100	8640	14400	6	1.750

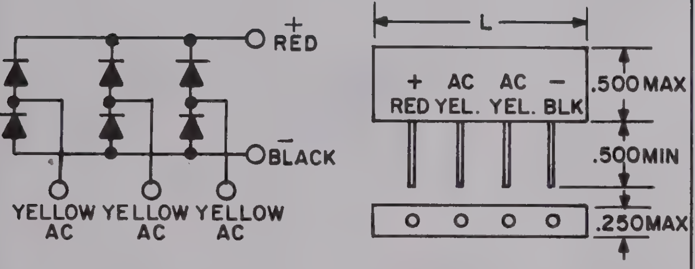
*Negative connections available.

THREE-PHASE FULLWAVE BRIDGES

A14 SINGLE-PELLET TYPES

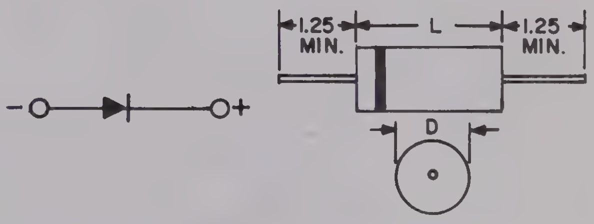
Type	Wkg. Pk. Rev. Volts & Rev. DC Volts, V_{RWM} & V_R Volts	Avg. Fwd. Current $I_{F(AV)}$ mA T_A = 50°C	Avg. Fwd. Current $I_{F(AV)}$ mA T_A = 100°C	Max. DC Forward Voltage Drop @ 100mA V_F Volts	Max. DC Rev. Current I_R @ V_{RWM} μA T_A = 25°C	Max. DC Rev. Current I_R @ V_{RWM} μA T_A = 150°C	Min. Brkdn. Volts, $V_{(BR)R}$ @ 50μA Volts	Max. Brkdn. Volts, $V_{(BR)R}$ @ 500μA Volts	Cells Per Leg	Outline L Inches Max.
A1423FF1AB1	50	1425	840	0.9	5	100	480	1200	1	.925
A1423AF1AB1	100	1425	840	0.9	5	100	480	1200	1	.925
A1423BF1AB1	200	1425	840	0.9	5	100	480	1200	1	.925
A1423DF1AB1	400	1425	840	0.9	5	100	720	1200	1	.925
A1423MF1AB1	600	1425	840	0.9	5	100	720	1200	1	.925
A1423DF2AB1	800	1020	555	1.8	5	100	1440	2400	2	1.750
A1423EF2AB1	1000	1020	555	1.8	5	100	1440	2400	2	1.750
A1423MF2AB1	1200	1020	555	1.8	5	100	1440	2400	2	1.750
MPR MULTI-PELLET TYPES										
A1423PBF1AB1	1200	650	330	1.8	5	100	1440	2400	1	.825
A1423PBF2AB1	2400	350	120	3.6	5	100	2880	4800	2	1.750

Fullwave Three-Phase Bridge



Rectangular Type

Single-Phase Series



Cartridge Type

JEDEC SERIES STRINGS

CARTRIDGE TYPES

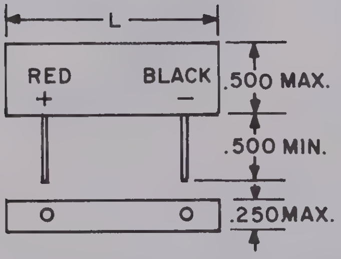
Type	Wkg. Pk. Rev. Volts & Rev. DC Volts, V_{RWM} & V_R Volts	Avg. Fwd. Current $I_{F(AV)}$ mA T_A = 50°C	Avg. Fwd. Current $I_{F(AV)}$ mA T_A = 100°C	Max. DC Forward Voltage Drop @ 100mA V_F Volts	Max. DC Rev. Current I_R @ V_{RWM} μA T_A = 25°C	Max. DC Rev. Current I_R @ V_{RWM} μA T_A = 100°C	Min. Brkdn. Volts, $V_{(BR)R}$ @ 50μA Volts	Max. Brkdn. Volts, $V_{(BR)R}$ @ 500μA Volts	Cells Per Leg	Outline D Inches	Outline L Inches
1N1730	1000	200	100	5	10	100	1200	2400	1	.375	.500
1N1731	1500	200	100	5	10	100	1800	3600	1	.375	.500
1N1732	2000	200	100	9	10	100	2400	4800	2	.375	1.000
1N1733	3000	150	75	12	10	100	3600	7200	3	.375	1.000
1N1734	4000	150	75	18	10	100	4800	9600	4	.500	1.000
1N2382	5000	100	50	18	10	100	6000	12000	5	.500	1.000
1N2383	6000	100	50	27	10	100	7200	12000	5	.500	1.500
1N2384	8000	70	35	27	10	100	9600	16800	7	.500	1.500
1N2385	10000	70	35	39	10	100	12000	21600	9	.500	2.000

HALFWAVE SERIES STRINGS

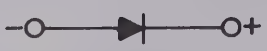
RECTANGULAR TYPES

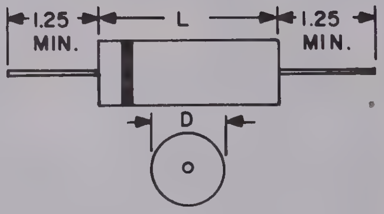
Type	Wkg. Pk. Rev. Volts & Rev. DC Volts, V_{RWM} & V_R Volts	Avg. Fwd. Current $I_{F(AV)}$ mA		Max. DC Forward Voltage Drop @ 100mA V_F Volts	Max. DC Rev. Current I_R @ V_{RWM} µA		Min. Brkdn. Volts, $V_{(BR)R}$ @ 50µA Volts	Max. Brkdn. Volts, $V_{(BR)R}$ @ 500µA Volts	Cells Per Leg	Outline	
		T_A = 50°C	T_A = 100°C		T_A = 25°C	T_A = 150°C				D Inches	L Inches
A1423MH2AB1	1200	1040	680	1.8	5	100	1440	2400	2	.250	.370
A1423MH3AB1	1800	880	570	2.7	5	100	2160	3600	3	.250	.650
A1423MH4AB1	2400	670	420	3.6	5	100	2880	4800	4	.250	.650
A1423MH5AB1	3000	580	360	4.5	5	100	3600	6000	5	.250	.925
A1423MH6AB1	3600	520	320	5.4	5	100	4320	7200	6	.250	.925
A1423MH7AB1	4200	490	300	6.3	5	100	5040	8400	7	.250	1.200
A1423MH8AB1	4800	420	250	7.2	5	100	5760	9600	8	.250	1.200
A1423MH9AB1	5400	450	270	8.1	5	100	6480	10800	9	.250	1.750
A1423MH10AB1	6000	390	230	9.0	5	100	7200	12000	10	.250	1.750
A1423MH11AB1	6600	390	230	9.9	5	100	7920	13200	11	.250	1.750
A1423MH12AB1	7200	375	215	10.8	5	100	8640	14400	12	.250	1.750

Single-Phase Series



Rectangular Type





Cartridge Type

CARTRIDGE TYPE

A1425MH2AB1	1200	1150	770	1.8	5	100	1440	2400	2	.375	.500
A1425MH3AB1	1800	850	550	2.7	5	100	2160	3600	3	.375	.500
A1425MH4AB1	2400	650	410	3.6	5	100	2880	4800	4	.375	1.000
A1425MH6AB1	3600	475	290	5.4	5	100	4320	7200	6	.375	1.000
A1425MH8AB1	4800	410	240	7.2	5	100	5760	9600	8	.500	1.000
A1425MH10AB1	6000	340	195	9.0	5	100	7200	12000	10	.500	1.000
A1425MH12AB1	7200	320	180	10.8	5	100	8640	14400	12	.500	1.000
A1425MH14AB1	8400	285	155	12.6	5	100	10080	16800	14	.500	1.500
A1425MH16AB1	9600	275	150	14.4	5	100	11520	19200	16	.500	1.500
A1425MH18AB1	10800	245	130	16.2	5	100	12960	21600	18	.500	1.500
A1425MH20AB1	12000	230	115	18.0	5	100	14400	24000	20	.500	1.500

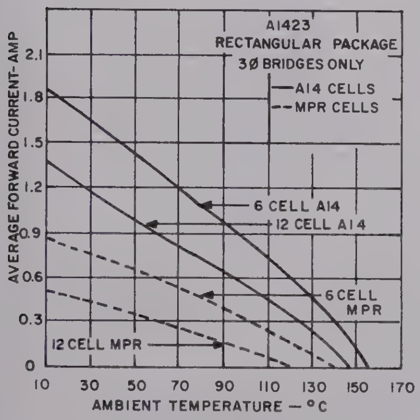
HALFWAVE SERIES STRINGS

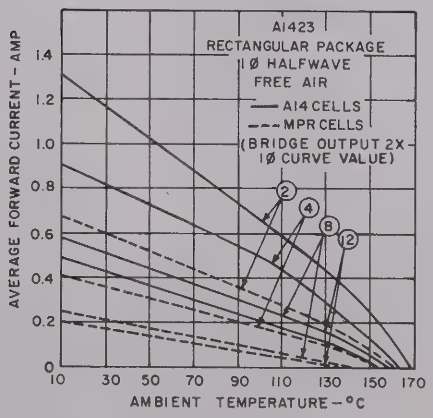
A14 SINGLE-PELLET TYPES (RECTANGULAR)

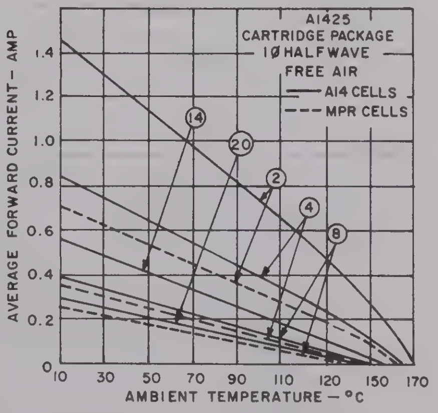
Type	Wkg. Pk. Rev. Volts & Rev. DC Volts, V_{RWM} & V_R Volts	Avg. Fwd.* Current $I_{F(AV)}$ mA $T_A = 50°C$	Avg. Fwd.* Current $I_{F(AV)}$ mA $T_A = 100°C$	Max. DC Forward Voltage Drop @ 100mA V_F Volts	Max. DC Rev. Current I_R @ V_{RWM} μA $T_A = 25°C$	Max. DC Rev. Current I_R @ V_{RWM} μA $T_A = 150°C$	Min. Brkdn. Volts, $V_{(BR)R}$ @ 50μA Volts	Max. Brkdn. Volts, $V_{(BR)R}$ @ 500μA Volts	Cells Per Leg	Outline D Inches	Outline L Inches
A1423PBH2AB1	2400	530	330	3.6	5	100	2880	4800	2	.250	.370
A1423PBH3AB1	3600	375	225	5.4	5	100	4320	7200	3	.250	.370
A1423PBH4AB1	4800	310	185	7.2	5	100	5760	9600	4	.250	.650
A1423PBH5AB1	6000	260	145	9.0	5	100	7200	12000	5	.250	.650
A1423PBH6AB1	7200	220	120	10.8	5	100	8640	14400	6	.250	.650
A1423PBH7AB1	8400	220	120	12.6	5	100	10080	16800	7	.250	.925
A1423PBH8AB1	9600	175	90	14.4	5	100	11520	19200	8	.250	.925
A1423PBH9AB1	10800	175	90	16.2	5	100	12960	21600	9	.250	1.200
A1423PBH10AB1	12000	160	75	18.0	5	100	14400	24000	10	.250	1.200

MPR MULTI-PELLET TYPES (CARTRIDGE)

Type	Wkg. Pk. Rev. Volts & Rev. DC Volts, V_{RWM} & V_R Volts	Avg. Fwd.* Current $I_{F(AV)}$ mA $T_A = 50°C$	Avg. Fwd.* Current $I_{F(AV)}$ mA $T_A = 100°C$	Max. DC Forward Voltage Drop @ 100mA V_F Volts	Max. DC Rev. Current I_R @ V_{RWM} μA $T_A = 25°C$	Max. DC Rev. Current I_R @ V_{RWM} μA $T_A = 150°C$	Min. Brkdn. Volts, $V_{(BR)R}$ @ 50μA Volts	Max. Brkdn. Volts, $V_{(BR)R}$ @ 500μA Volts	Cells Per Leg	Outline D Inches	Outline L Inches
A1425PBH2AB1	2400	540	340	3.6	5	100	2880	4800	2	.375	.500
A1425PBH3AB1	3600	395	240	5.4	5	100	4320	7200	3	.375	.500
A1425PBH4AB1	4800	280	160	7.2	5	100	5760	9600	4	.375	.500
A1425PBH5AB1	6000	230	130	9.0	5	100	7200	12000	5	.375	1.000
A1425PBH6AB1	7200	200	110	10.8	5	100	8640	14400	6	.375	1.000
A1425PBH7AB1	8400	190	100	12.6	5	100	10080	16800	7	.375	1.000
A1425PBH8AB1	9600	165	85	14.4	5	100	11520	19200	8	.375	1.000
A1425PBH9AB1	10800	185	95	16.2	5	100	12960	21600	9	.500	1.500
A1425PBH10AB1	12000	165	85	18.0	5	100	14400	24000	10	.500	1.500





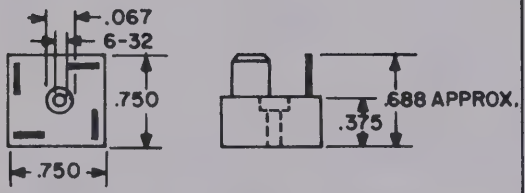


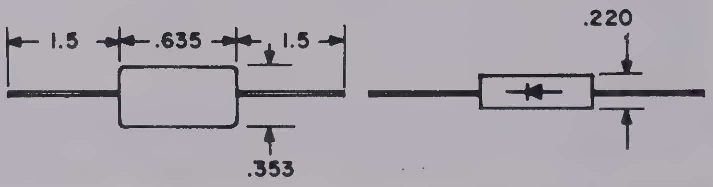
*Average forward current rating based on .500 lead length for A1423 series and .750 lead length for A1425 series.

SPECIAL POTTED ASSEMBLIES

A14 SINGLE-PELLET TYPE CELL IN ¾" SQ. BLOCK WITH ¼" FASTON TABS

Type	Wkg. Pk. Rev. Volts & Rev. DC Volts, V_{RWM} & V_R Volts	Avg. Fwd. Current $I_{F(AV)}$ mA		Max. DC Forward Voltage Drop @ 100mA V_F Volts	Max. DC Rev. Current I_R @ V_{RWM} µA		Min. Brkdn. Volts, $V_{(BR)R}$ @ 50µA Volts	Max. Brkdn. Volts, $V_{(BR)R}$ @ 500µA Volts	Cells Per Leg	Outline	
		T_A = 50°C	T_A = 100°C		T_A = 25°C	T_A = 150°C				D Inches	L Inches
A1423FB1AE1	50	3.0	2.0	0.9	5	100	480	1200	1	.375	.750
A1423AB1AE1	100	3.0	2.0	0.9	5	100	480	1200	1	.375	.750
A1423BB1AE1	200	3.0	2.0	0.9	5	100	480	1200	1	.375	.750
A1423DB1AE1	400	3.0	2.0	0.9	5	100	720	1200	1	.375	.750
A1423MB1AE1	600	3.0	2.0	0.9	5	100	720	1200	1	.375	.750
A1423NB1AE1	800	3.0	2.0	0.9	5	100	960	1200	1	.375	.750

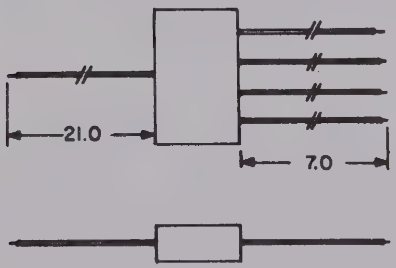




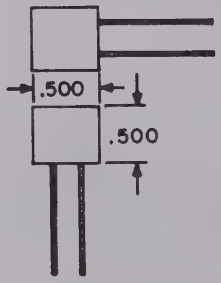
MPR MULTI-PELLET TYPE CELL IN THIN PACKAGE

A1423PM4AC1	6000	300	180	7.2	5	100	6600	9600	4	.220	.635
A1423PE4AC1	5000	300	180	7.2	5	100	5700	9600	4	.220	.635
A1423PD4AC1	4000	300	180	7.2	5	100	4600	9600	4	.220	.635
A1423PC4AC1	3000	300	180	7.2	5	100	3600	9600	4	.220	.635

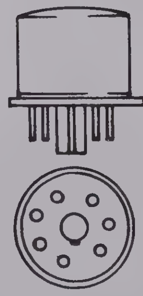
ADDITIONAL PACKAGE DESIGNS AVAILABLE BY SPECIAL REQUEST



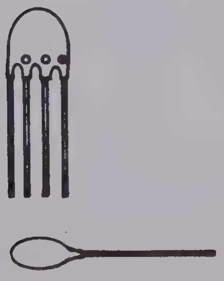
Extra Length in Leads



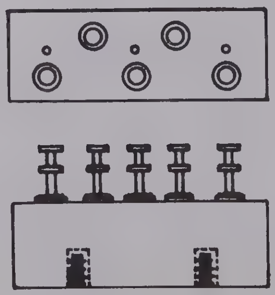
Cube



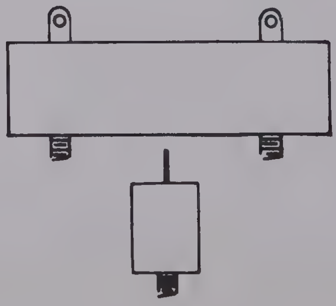
1420 Series



Dip-Type Bridge



Special Terminal Bridge

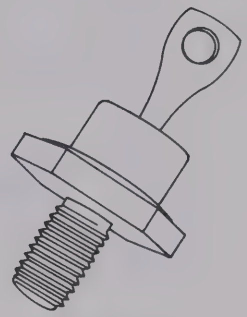


1421/1422 Type

Silicon
Rectifiers
Medium Current
Junction Rectifier

1N2154-60,R

These stud mounted diffused junction silicon rectifiers are designed for all rectifier applications in the 2 to 30 ampere range. A high junction temperature rating and an extremely low forward voltage drop and thermal impedance permit high current operation with minimum space requirements. These rectifiers may be mounted directly to a chassis or a fin or may be electrically insulated from the heat sink by using the mica washer insulating kit which is provided with each unit. Versatility is further increased by the availability of a negative polarity unit (stud is anode), described by the suffix "R" appearing after the type number. The use of positive and negative polarity units facilitates the construction of bridge circuits and permits the use of either a positive or negative heat sink in half-wave and center-tap applications. Stacked fin assemblies (4JA3511 series) are also available.



General Electric research, advance development and product design have resulted in a highly efficient rectifying junction. This feature, plus a mechanical design employing high temperature hard solders and welds for all internal and external joints and seals, which eliminates common sources of thermal fatigue failure, has produced a silicon rectifier with outstanding reliability under all operating conditions.

electrical ratings and specifications (60 cps, Resistive or Inductive Load)

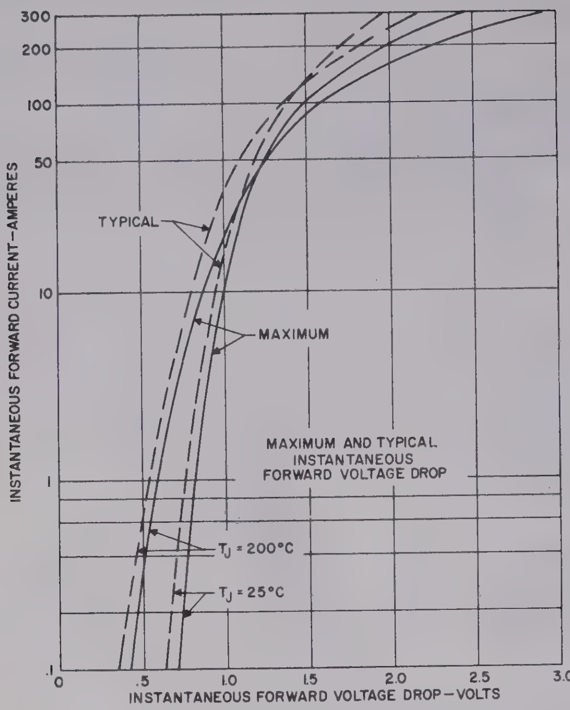
	1N2154 1N2154R	1N2155 1N2155R	1N2156 1N2156R	1N2157 1N2157R	1N2158 1N2158R	1N2159 1N2159R	1N2160 1N2160R
Max. Allow. Transient Peak Reverse Voltage (Non-Recurrent 5 millisec. max. duration)	100	200	350	450	600	700	800 volts
Max. Allow. Peak Reverse Voltage* (Repetitive)	50	100	200	300	400	500	600 volts
Max. Allow. RMS Voltage	35	70	140	210	280	350	420 volts
Max. Allow. DC Blocking Voltage**	50	100	200	300	400	500	600 volts
Max. Allow. Forward Current (Single Phase — 145°C stud temp.)	← 25 amperes →						
Max. Allow. Peak One-Cycle Surge Current	← 400 amperes →						
I²t Ratings (for fusing) (for t = .0008 < t < .0083 seconds)	← 250 ampere² sec. →						
Max. Full Load Voltage Drop (Full Cycle Average — 145°C stud temp.)	← 0.60 volts →						
Max. Leakage Current at Full Load (Full Cycle Average, Single Phase 145°C stud temp.)	5	4.5	4	3.5	3	2.5	2 ma
Max. Thermal Resistance (junction to stud)	← 1.5°C/watt →						
Junction Operating and Storage Temperature Range	← −65°C to +200°C →						

*Maximum voltages apply with a heat sink thermal resistance of 12°C/watt or less at maximum rated junction temperature.
**Maximum voltages apply with a heat sink thermal resistance of 5°C/watt or less at maximum rated junction temperature.
***For RMS surge current ratings in sub-cycle region (less than one cycle) as a function of t, see Curve IX.

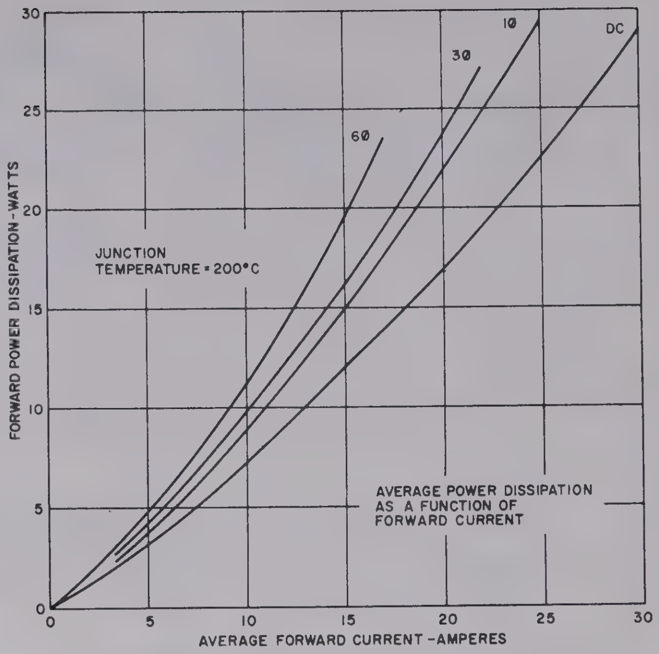
mechanical specifications

Maximum Stud Torque	30 inch-pounds
Mechanical Shock	MIL-STD-202, Method 202 500G for 1 millisec. 5 times in each of 3 directions
Vibration (Fatigue)	Any frequency between 45-100 cps with constant peak acceleration of 10G
Vibration (High Acceleration)	100 to 1000 cps with constant peak of 10G
Centrifuge	5000G
Moisture Resistance	MIL-STD-202, Method 106
Temperature Cycling	5 cycles, −65°C to +175°C

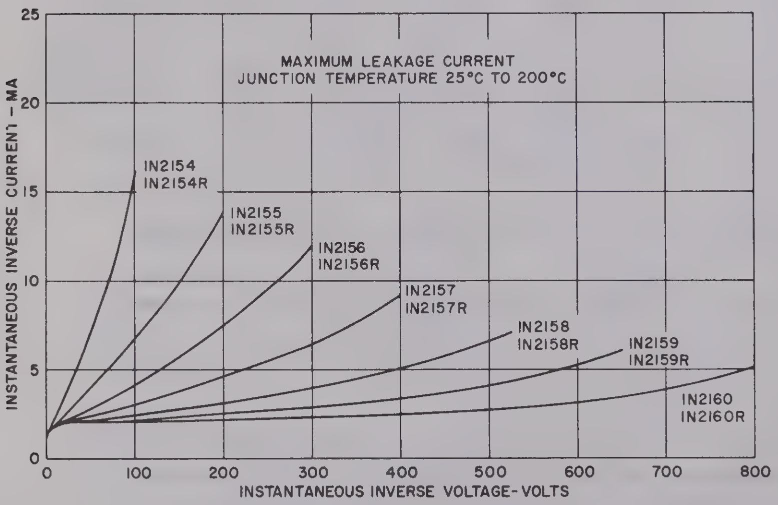
1N2154-60,R



1. MAXIMUM AND TYPICAL FORWARD CHARACTERISTICS

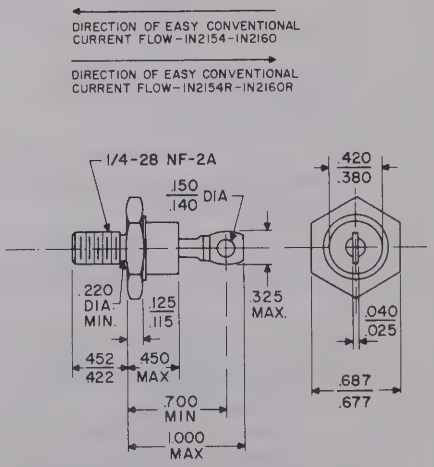


3. FORWARD POWER DISSIPATION

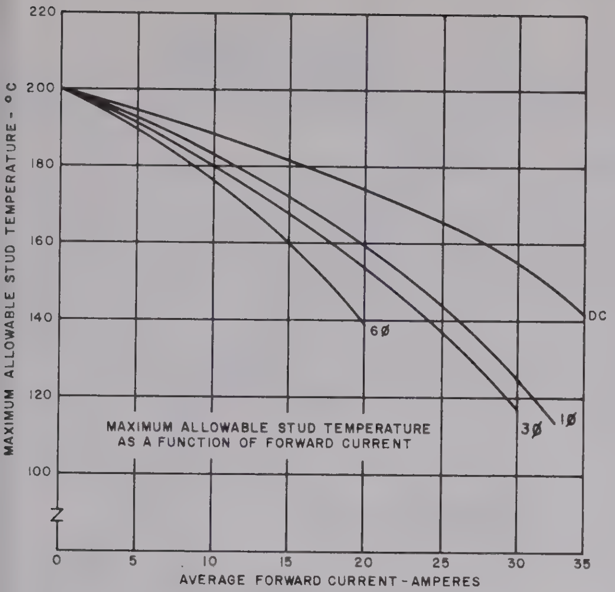


2. REVERSE CHARACTERISTICS

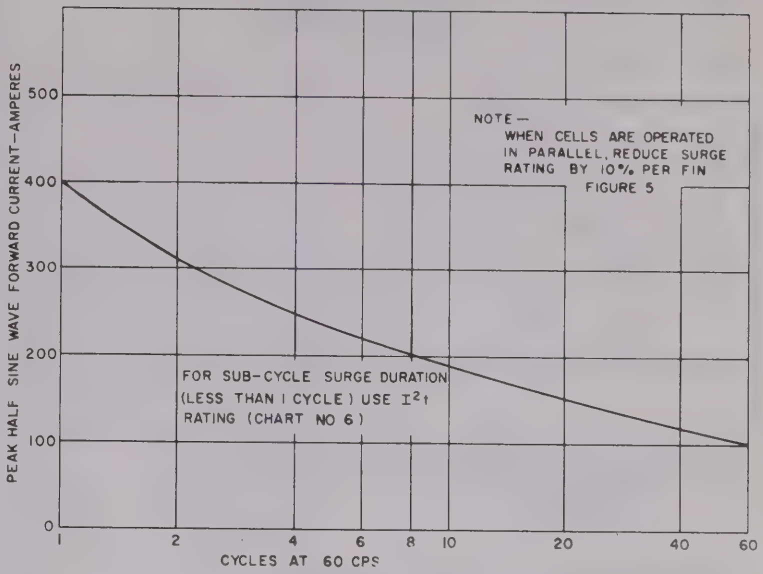
OUTLINE DRAWING


DIRECTION OF EASY CONVENTIONAL CURRENT FLOW–IN2154–IN2160
DIRECTION OF EASY CONVENTIONAL CURRENT FLOW–IN2154R–IN2160R
1/4-28 NF-2A
.150 .140 DIA
.420 .380
.220 DIA. MIN.
.125 .115
.325 MAX.
.040 .025
.452 .422
.450 MAX
.687 .677
.700 MIN
1.000 MAX

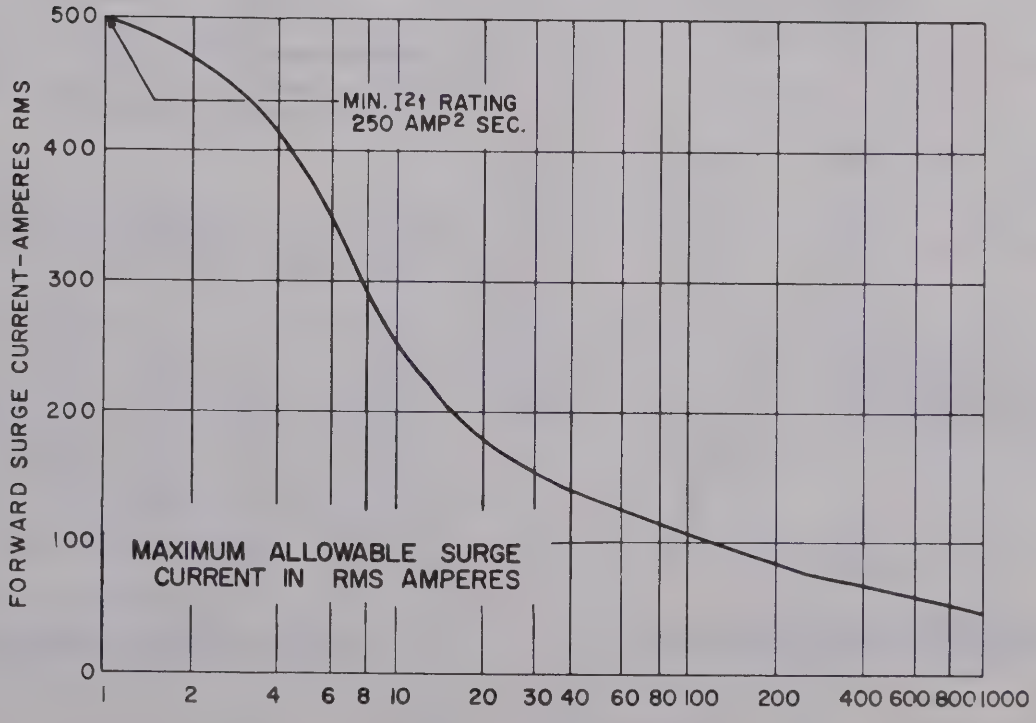
COMPLIES WITH
EIA REGISTERED OUTLINE DO-5



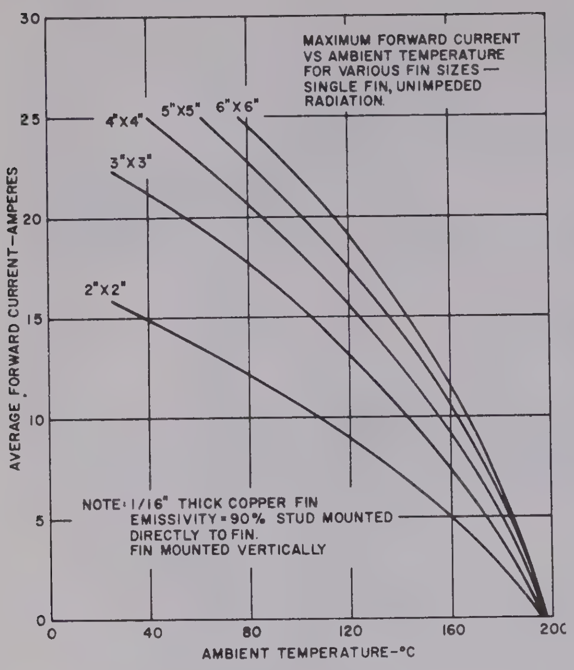
4. MAXIMUM ALLOWABLE STUD TEMPERATURE



5. MAXIMUM ALLOWABLE NON-RECURRENT SURGE CURRENT AT RATED LOAD CONDITIONS



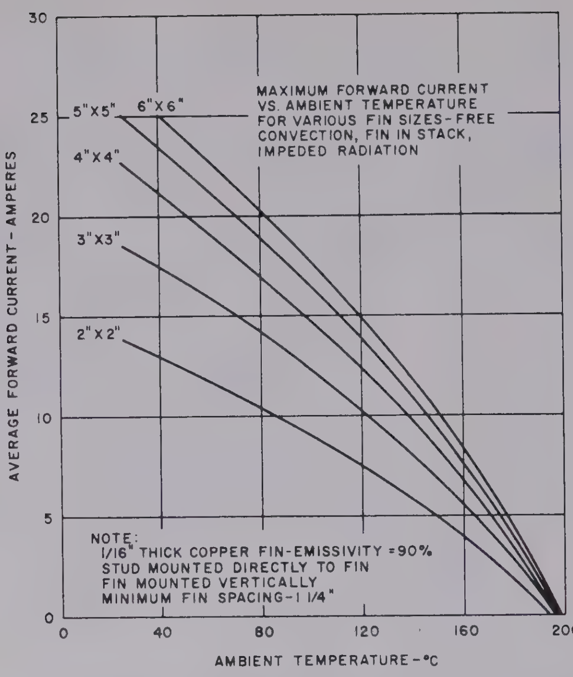
6. SUB-CYCLE SURGE RATING



MAXIMUM FORWARD CURRENT VS AMBIENT TEMPERATURE FOR VARIOUS FIN SIZES— SINGLE FIN, UNIMPEDED RADIATION.

NOTE: 1/16" THICK COPPER FIN EMISSIVITY = 90% STUD MOUNTED DIRECTLY TO FIN. FIN MOUNTED VERTICALLY

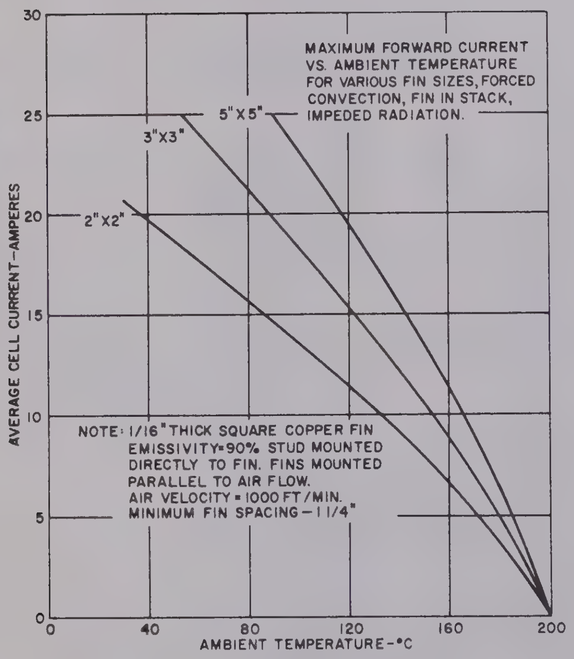
7. *REQUIRED FIN SIZE—FREE CONVECTION SINGLE FIN, UNIMPOSED RADIATION



MAXIMUM FORWARD CURRENT VS. AMBIENT TEMPERATURE FOR VARIOUS FIN SIZES-FREE CONVECTION, FIN IN STACK, IMPEDED RADIATION

NOTE:
1/16" THICK COPPER FIN-EMISSIVITY = 90%
STUD MOUNTED DIRECTLY TO FIN
FIN MOUNTED VERTICALLY
MINIMUM FIN SPACING-1 1/4"

8. *REQUIRED FIN SIZE— FREE CONVECTION, IMPEDED RADIATION



MAXIMUM FORWARD CURRENT VS. AMBIENT TEMPERATURE FOR VARIOUS FIN SIZES, FORCED CONVECTION, FIN IN STACK, IMPEDED RADIATION.

NOTE: 1/16" THICK SQUARE COPPER FIN EMISSIVITY=90% STUD MOUNTED DIRECTLY TO FIN. FINS MOUNTED PARALLEL TO AIR FLOW.
AIR VELOCITY = 1000 FT/MIN.
MINIMUM FIN SPACING—1 1/4"

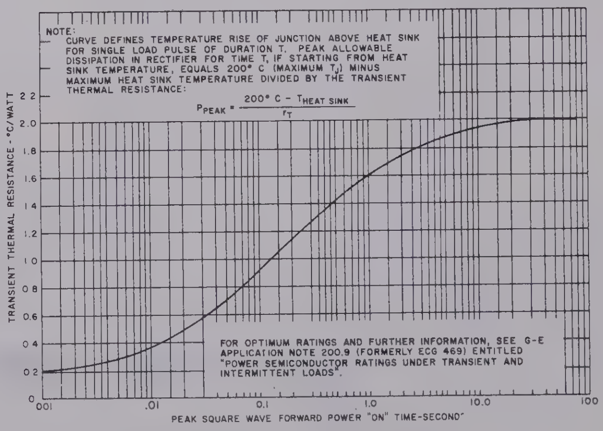
9. *REQUIRED FIN SIZE— FORCED CONVECTION, IMPEDED RADIATION

*TO USE GRAPHS 7, 8 AND 9

1. **Enter graph at vertical axis with desired current multiplied by proper current factor:**

DC-0.80	**3ϕ-1.15**
1ϕ -1.00	**6ϕ-1.40**

2. **Intercept desired fin curve**
3. **Read on horizontal axis the maximum allowable ambient temperature**



NOTE:
CURVE DEFINES TEMPERATURE RISE OF JUNCTION ABOVE HEAT SINK FOR SINGLE LOAD PULSE OF DURATION T. PEAK ALLOWABLE DISSIPATION IN RECTIFIER FOR TIME T, IF STARTING FROM HEAT SINK TEMPERATURE, EQUALS 200° C (MAXIMUM T_J) MINUS MAXIMUM HEAT SINK TEMPERATURE DIVIDED BY THE TRANSIENT THERMAL RESISTANCE:

$$P_{PEAK} = \frac{200° C - T_{HEAT\ SINK}}{r_T}$$

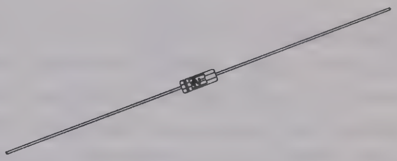
FOR OPTIMUM RATINGS AND FURTHER INFORMATION, SEE G-E APPLICATION NOTE 200.9 (FORMERLY ECG 469) ENTITLED "POWER SEMICONDUCTOR RATINGS UNDER TRANSIENT AND INTERMITTENT LOADS".

10. TRANSIENT THERMAL RESISTANCE

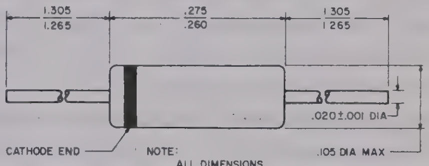
Silicon Diodes

IN3063
IN4305

The 1N3063 and 1N4305 are very high speed silicon switching diodes for computer circuits and general purpose applications. These oxide passivated planar diodes feature fast recovery time, low leakage and low capacitance. The maximum and minimum forward voltages are specified at four forward currents from 250 uamps to 10 ma. This guaranteed, closely controlled conductance is necessary for the design of clamping circuits, logic circuits and other types of circuits that require tolerances on voltage levels. The double heatsink 1N4305 offers springless construction, 500 mw dissipation, reduced package size, and is recommended for new design.



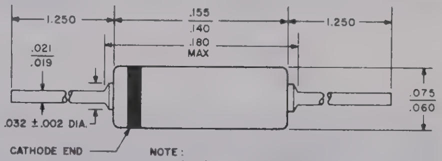
DO-7 1N3063



NOTE:
ALL DIMENSIONS
IN INCHES

	1N3063	1N4305	
Reverse Voltage	50	50	volts
Average Rectified Current	150	150	ma
Forward Steady-State DC Current	200	200	ma
Recurrent Peak Forward Current	225	225	ma
Peak Forward Surge Current (1 usec. pulse)	2000	2000	ma
Power Dissipation (25°C free air)	250	500	mw
Operating Temperature	-65 to	+200	°C
Storage Temperature	-65 to	: 200	°C

Double Heatsink Diode (DHD) 1N4305



NOTE:
ALL DIMENSIONS
IN INCHES

electrical characteristics: (25°C) (unless otherwise specified)

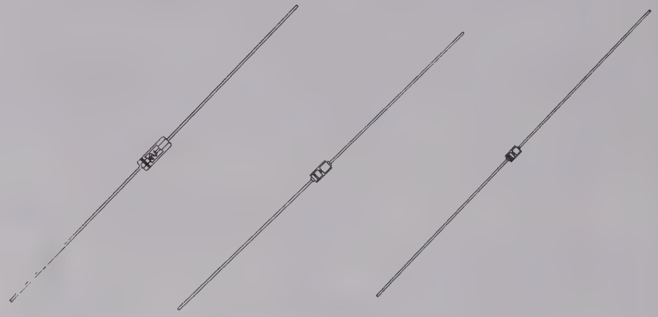
		1N3063 1N4305		
		Min.	Max.	
Breakdown Voltage (I_R =5 ua)	B_V	75		volts
Forward Voltage (I_F=250 uamps)	V_{F1}	.505	.575	volts
(I_F =1 ma)	V_{F2}	.550	.650	volts
(I_F =2 ma)	V_{F3}	.610	.710	volts
(I_F =10 ma)	V_{F4}	.700	.850	volts
Reverse Current (V_R = -50 v)	I_R		.1	uamps
Reverse Current (150°C) (V_R = -50v)	I_R		100	uamps
Reverse Recovery Time (I_f=10 ma, I_r=10 ma) (Note 1)	t_{rr}		4	nsec.
Reverse Recovery Time (I_f=10 ma, V_r= -6V, R_L=100) (Note 1)	t_{rr}		2	nsec.
Capacitance (V_R =0 v) (Note 2)	C_o		2	pf
Rectification Efficiency (100 mc) (Note 3)	R_E	45		%

Note 1: Recovery time to 1 ma.
2: Capacitance as measured on Boonton Model 75A Capacitance Bridge at a signal level of 50 mv and a frequency of 1 mc.
3: Rectification Efficiency is defined as the ratio of DC load voltage to peak rf input voltage to the detector circuit, measured with 2.0 v rms input to the circuit. Load resistance 5K , load capacitance 20 uuf.

Silicon
Diodes

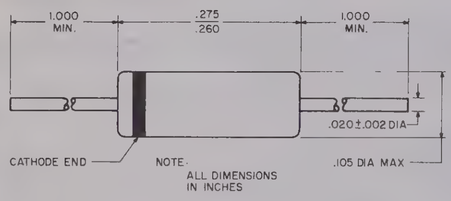
1N3064
1N3604,5,6
1N4151,2,3
1N4454
1N4532,3,4

This family of General Electric silicon signal diodes are very high speed switching diodes for computer circuits and general purpose applications. These diodes incorporate an oxide passivated planar structure. This structure makes possible a diode having high conductance, fast recovery time, low leakage, and low capacitance combined with improved uniformity and reliability. These diodes are contained in three different packages; DO-7 glass diode package, double heat sink miniature package, milli-heat sink package and are electrically the same as their equivalent types in each of the three different packages (see page two for groupings of electrically equivalent types in each of the three packages).



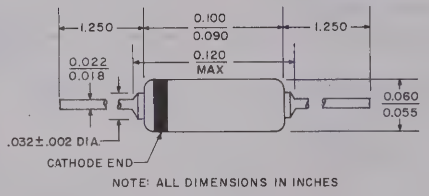
PLANAR EPITAXIAL PASSIVATED
with Controlled Conductance

DO-7
1N3064, 1N3604-1N3606


1.000 MIN.
.275 / .260
1.000 MIN.
.020±.002 DIA
CATHODE END
NOTE· ALL DIMENSIONS IN INCHES
.105 DIA MAX

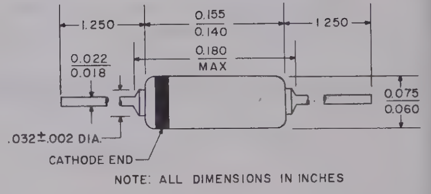
Dissipation: 250mW @ 25° free air
Derate: 1.43mW/°C temp. above 25°C amb. based on max. $T_J = 200°C$

MILLI-HEATSINK DIODE (MHD)
1N4532-1N4534


1.250
0.100 / 0.090
1.250
0.022 / 0.018
0.120 / MAX
0.060 / 0.055
.032±.002 DIA.
CATHODE END
NOTE: ALL DIMENSIONS IN INCHES

Dissipation: 500mW @ 25°C free air
Derate: 2.85mW/°C for temp. above 25°C amb. based on max. $T_J = 200°C$

DOUBLE HEATSINK DIODE (DHD)
1N4151-1N4153
1N4454


1.250
0.155 / 0.140
1 250
0.022 / 0.018
0.180 / MAX
0.075 / 0.060
.032±.002 DIA.
CATHODE END
NOTE: ALL DIMENSIONS IN INCHES

Dissipation: 500mW @ 25°C free air
Derate: 2.85mW/°C for temp. above 25°C amb. based on max. $T_J = 200°C$

FEATURES	1N3064 1N3604	1N3605 1N3606	1N4151 1N4454 MHD618 1N4532	1N4152 1N4153 1N4533 1N4534
Reverse Recovery Time of 4 nanoseconds maximum	●	●	●	●
Min.-Max. V_F specified at 6 Forward Current Levels				●
Capacitance of 2 pF maximum	●	●	●	●
Power Dissipation to 500 mW			●	●
Power Dissipation to 250 mW	●	●		
Meets all MIL-S-19500 requirements	●	●	●	●

HEATSINK SPACING FROM END OF DIODE BODY	STEADY STATE THERMAL RESISTANCE °C/mW*			POWER DISSIPATION AT 25°C mW†		
	MHD	DO-7	DHD	MHD	DO-7	DHD
.062″	.230	.389	.250	760	450	700
.250″	.319	.500	.319	550	350	550
.500″	.380	.700	.380	460	250	460

*See Figure 5 for thermal resistance for short pulses.

†This power rating is based on a maximum junction temperature 200°C.

Figure 1

absolute maximum ratings: (25°C) (unless otherwise specified)

	1N3064 **1N4454** **1N4532**	**1N3604** **1N4151** **MHD618**	**1N3605** **1N4152** **1N4533**	**1N3606** **1N4153** **1N4534**	**DO-7** **DHD** **MHD**
Voltage					
Reverse	50	50	30	50	Volts
	MHD & DHD Units			**DO-7 Units**	
Current					
Average Rectified	150			75	mA
Recurrent Peak Forward	450			225	mA
Forward Steady State DC	200			115	mA
Peak Forward Surge (1 µsec. pulse)	2000			200	mA
Power					
Dissipation	500			250	
Temperature					
Operating	←	−65 to +200		→	°C
Storage	←	−65 to +200		→	°C

electrical characteristics: (25°C) (unless otherwise specified)

		1N3064* **1N4454*** **1N4532**		**1N3604** **1N4151** **MHD618**		**1N3605** **1N4152** **1N4533**		**1N3606** **1N4153** **1N4534**		
Breakdown Voltage		**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	
($I_R = 5\mu A$)	B_V	75		75		40		75		Volts
Forward Voltage										
($I_F = 100\mu A$)	V_F					0.490	0.550	0.490	0.550	Volts
($I_F = 250\mu A$)	V_F					0.530	0.590	0.530	0.590	Volts
($I_F = 1mA$)	V_F					0.590	0.670	0.590	0.670	Volts
($I_F = 2mA$)	V_F					0.620	0.700	0.620	0.700	Volts
($I_F = 10mA$)	V_F		1.00			0.700	0.810	0.700	0.810	Volts
($I_F = 20mA$)	V_F					0.740	0.880	0.740	0.880	Volts
($I_F = 50mA$)	V_F				1.00					Volts
Reverse Current										
($V_R = 30V$)	I_R						50			nA
($V_R = 30V$, $T_A = +150°C$)	I_R						50			µA
($V_R = 50V$)	I_R		100		50				50	nA
($V_R = 50V$, $T_A = +150°C$)	I_R		100		50				50	µA
Reverse Recovery Time										
($I_F = I_R = 10mA$, $I_{rr} = 1mA$, Figs. 9 & 10)	t_{rr}		4		4		4		4	nsec.
($I_F = 10mA$, $V_R = 6V$, $I_{rr} = 1mA$, $R_L = 100$ ohms, Figs. 9 & 10)	t_{rr}		2		2		2		2	nsec.
Peak Forward Voltage†	V_{peak}		3.0							Volts
Capacitance										
($V_R = 0V$)‡	C_o		2		2		2		2	pF
Stored Charge (Note 1)										
($I_F = 10mA$)§	Q_S		32		32		32		32	pC

*MIL type available

†50mV peak square wave, 0.1 usec. pulse width, 5 to 100 kHz repetitive rate, generator $t_r = 30$ nsec.

‡Capacitance as measured on Boonton Model 75A capacitance bridge at a signal level of 50 mV and a frequency of 1 MHz at $V_R = 0$ volts.

§Stored Charge as measured on B-Line Electronics Model QS-3 stored charge meter. Pulse amplitude = 5 volts, pulse width = 50 nsec., rise time = 0.4 nsec., source impedance = 10 ohms.

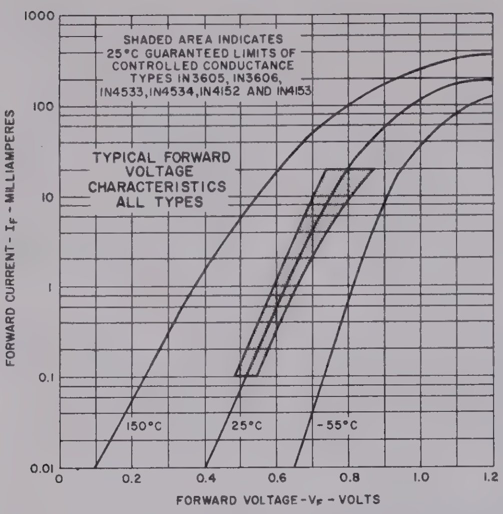


Figure 2

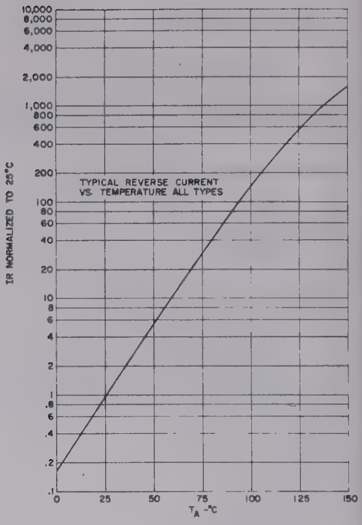


Figure 3

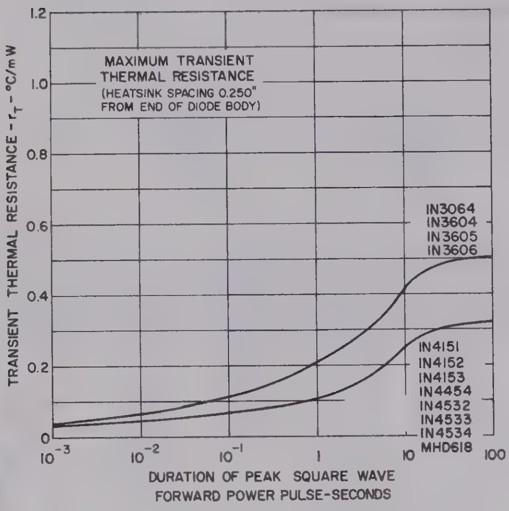


Figure 4

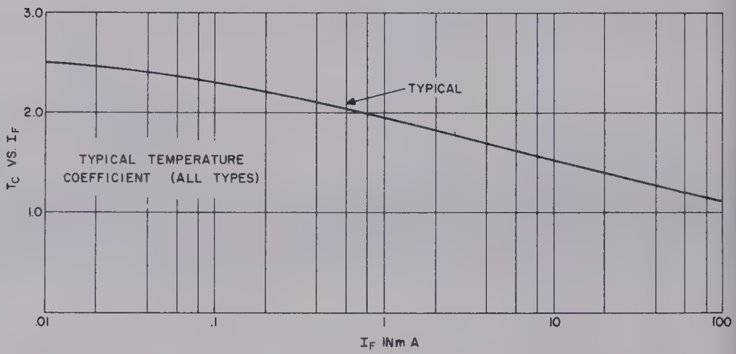


Figure 5

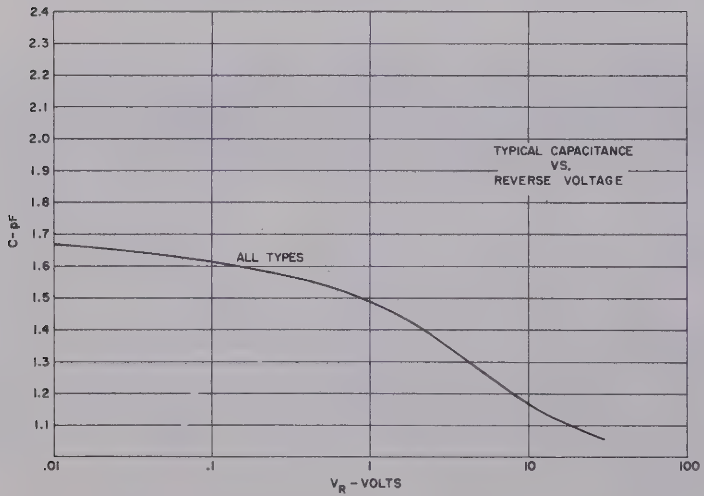


Figure 6

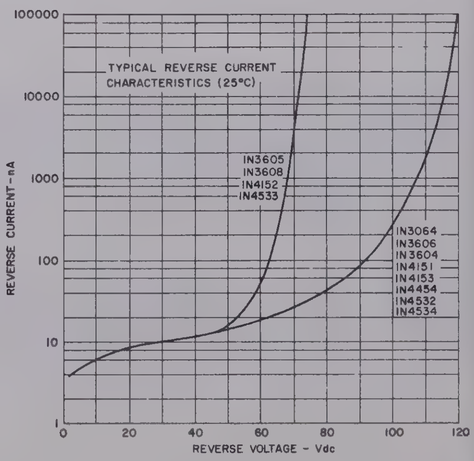
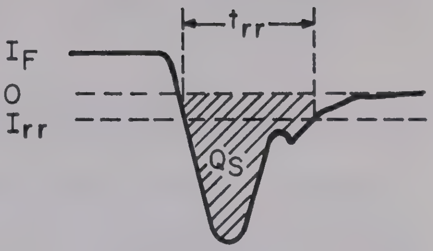


Figure 7

NOTE 1: STORED CHARGE

When a forward biased diode is subjected to a reverse voltage step a reverse current will flow for a short time as a result of the stored charge consisting of minority carriers in the vicinity of the junction. The typical waveform of reverse current vs time for a diode subjected to a large reverse voltage is shown in Figure 8. The time required for the diode to recover its reverse blocking condition will depend on the quantity of charge stored and the rate at which the charge is removed by recombination inside the diode and by current flowing in the external circuit. Conventionally, the speed of a diode is characterized by the reverse recovery time, t_{rr}, measured to some arbitrary current level as in Figure 8. However, for higher speed diodes reverse recovery time is not a satisfactory parameter for characterizing the speed of the diode since it is dependent on arbitrary circuit conditions and is very dependent on the construction of the test circuit. Stored charge, on the other hand, is measured by integrating the reverse current of the diode (as shown by the shaded area in Figure 8), and is consequently much less dependent on the construction of the test circuit and on arbitrary circuit conditions. Stored charge is a more ideal parameter for characterizing the speed of a diode since it represents an intrinsic characteristic of the diode and can be measured with good reproducibility on low cost instruments which have direct meter readout.

Stored charge can be correlated with reverse recovery time measurements on a specific t_{rr} test jig. Typical correlation curves are shown on the graph below.



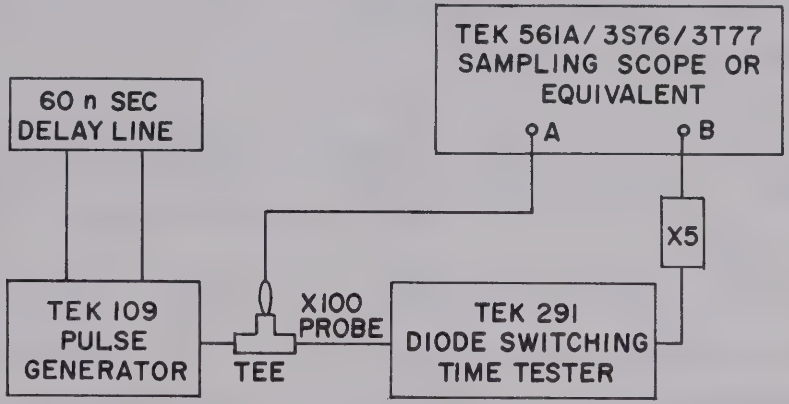
TYPICAL REVERSE RECOVERY WAVEFORM FOR A HIGH SPEED DIODE

Figure 8

References:

(1) JEDEC Proposed Method for Direct Measurement of Diode Stored Charge, JS-2-65-11

(2) "Measurement of Stored Charge in High Speed Diodes," T. P. Sylvan Application Note #90.30 (available on request)



TEK 561A/3S76/3T77 SAMPLING SCOPE OR EQUIVALENT
A
B
60 n SEC DELAY LINE
X5
TEK 109 PULSE GENERATOR
TEE
X100 PROBE
TEK 291 DIODE SWITCHING TIME TESTER

Figure 9

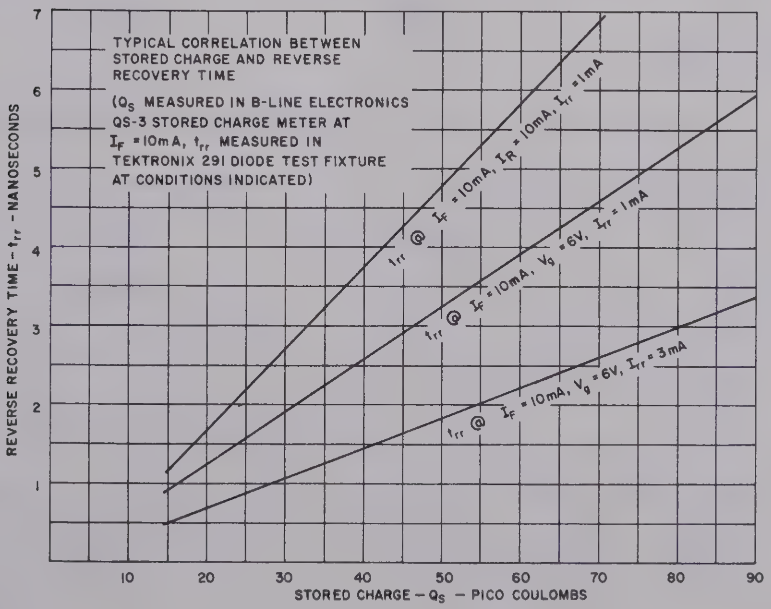


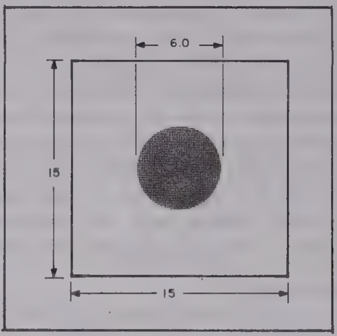
Figure 10

Silicon Diode Chips

1N3064 (Chip)
1N4454 (Chip)
1N4532 (Chip)

(M46P-X507)

These General Electric silicon planar oxide-passivated diode chips are designed primarily for very high-speed switching in computer circuits and general purpose applications. The chips feature high conductance, fast recovery time, low leakage and low capacitance.



General specifications:
- Gold cathode contact backing, minimum thickness—3000Å
- Aluminum anode contact metalization
- Maximum conditions for mounting chips—425°C for 5 minutes (Max.) in an inert atmosphere
- Shipping containers: Glass vials sealed with a nitrogen back-fill
  Maximum of 10k chips per vial
  Egg crate containers available at extra cost
- Chip drawing dimensions are in mils
- Chip thickness = 5.0 ±2 mils

absolute maximum ratings: (T$_A$ = 25°C)

	Symbol		
Voltage			
Reverse	V_R	75	V
Current			
Average Rectified		150	mA
Recurrent Peak Forward		450	mA
Forward Steady State D.C.		200	mA
Peak Forward Surge (1 μsec. pulse)		2	A
Temperature			
Storage	T_{STG}	−65°C to +200°C	
Operating	T_J	−65°C to +200°C	

electrical characteristics: 100% Probe (T$_A$ = 25°C)

Tested at outgoing acceptance to a 10% LTPD with a maximum accept number of 3.

	Symbol	Min.	Max.	
Reverse Breakdown Voltage (I_R = 5 mA)	BV_R	75	—	V
Forward Voltage Drop (I_F = 10 mA)	V_F	—	1.05	V
Reverse Current (V_R = 50V)	I_R	—	100	nA

specifications: (T$_A$ = 25°C)

Product yield is at least 93% to each of the following parameters:

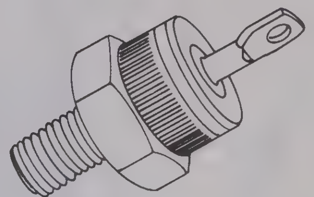
	Symbol	Min.	Max.	
Junction Capacitance (V_R = 0, e_s = 50 mV, f = 1 MHz)	C_o	—	2	pF
Maximum Reverse Recovery Time (I_F = 10 mA, V_r = 6V, R_L = 100 Ω)	t_{rr}	—	2	nsec.

Silicon
Rectifiers

A40F,M
A41F,M

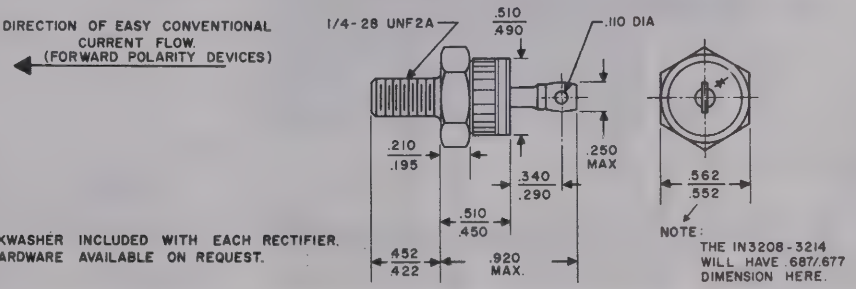
1N3208 -1N3214
1N3208R-1N3214R

General Electric has designed this 20 Ampere rectifier specifically for the normal industrial and consumer low ambient temperature applications. The design utilizes the smallest practical size for the rating with particular attention to rigidity and rugged construction. The solid one-piece terminal and the case-to-hex solder mounting technique provides good mechanical strength, minimizes breakage problems, and promotes stability of heat transfer characteristics from the diffused junction to the stud.



- **High Surge Current Capabilities (Up to 300 Amperes)**
- **One-piece Terminal**
- **Positive Solder Case-to-hex Mounting**
- **Small Size— 9/16" Hex, 1/2" Diameter Barrel**
- **Reverse Polarity Devices Available**

OUTLINE DRAWING



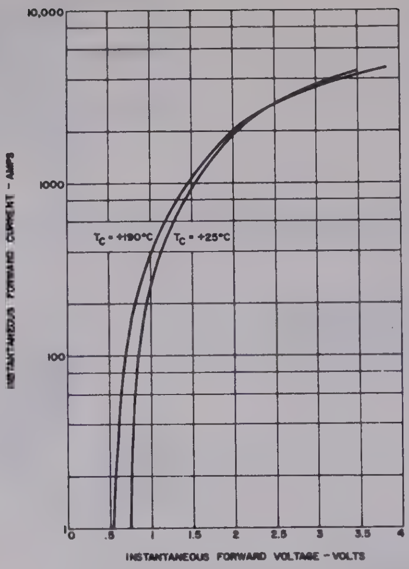
NOTE:
NUT AND LOCKWASHER INCLUDED WITH EACH RECTIFIER.
INSULATING HARDWARE AVAILABLE ON REQUEST.

NOTE:
THE IN3208-3214
WILL HAVE .687/.677
DIMENSION HERE.

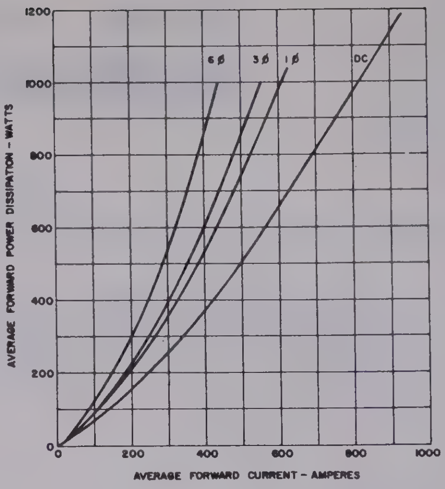
RATINGS AND CHARACTERISTICS (Single Phase Resistive Load)

Forward Polarity	A40F	A40A	A40B	A40C	A40D	A40E	A40M	
Reverse Polarity	A41F	A41A	A41B	A41C	A41D	A41E	A41M	
Max. Peak Reverse Voltage	50	100	200	300	400	500	600	volts
Max. Continuous D-C Reverse Voltage	50	100	200	300	400	500	600	volts
Max. Sine Wave RMS Voltage	35	70	140	210	280	350	420	volts
Max. Avg. D-C Forward Current								
At 110°C Stud	← 20 amps →							
At 150°C Stud	← 15 amps →							
Peak One-Cycle Forward Surge Current (60 cps, $T_J = 25°C$)	← 300 amps →							
I^2t Rating for Fusing or Capacitor Inrush	← 100 amp^2 sec →							
Max. Forward Voltage at 20 Amps D-C Forward Current ($T_J = 25°C$)	← 1.2 volts →							
Max. Avg. Forward Voltage Drop (15 amps d-c single phase, $T_J = 150°C$)	← 0.75 volts →							
Max. Reverse Current at Rated D-C Reverse Voltage ($T_J = 25°C$)	← 1.0 ma →							
Max. Full Load Reverse Current (full cycle avg., single phase)	10	9	8	6	5	4.5	4.0	ma
Typical Thermal Resistance (junction to stud)	← 1.5°C/watt →							
Operating Junction Temperature Range	← −65°C to +175°C →							
Storage Temperature Range	← −65°C to +175°C →							
Maximum Stud Torque	← 25 in.-lbs →							

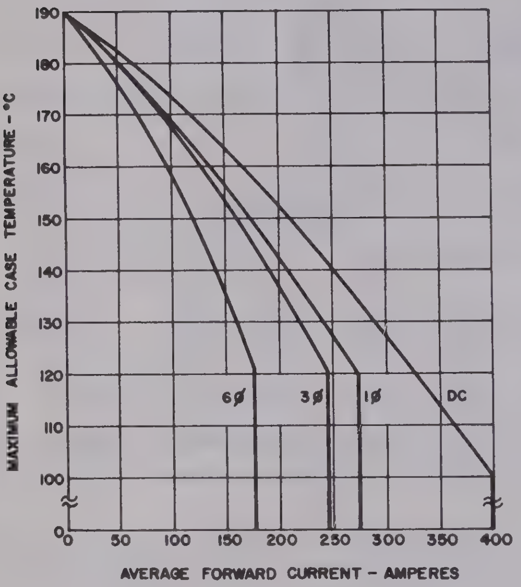
NOTE: 1N3208-1N3214 or 1N3208R-1N3214R are available when desired and are identical to A40F-A40M or A41F-A41M respectively, except that hex size will be 11/16" across the flats on the 1N3208 series.



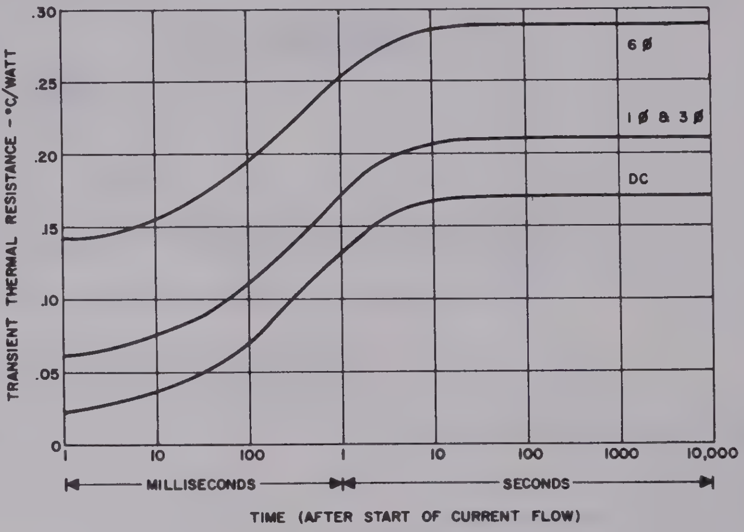
1. MAXIMUM FORWARD CHARACTERISTICS



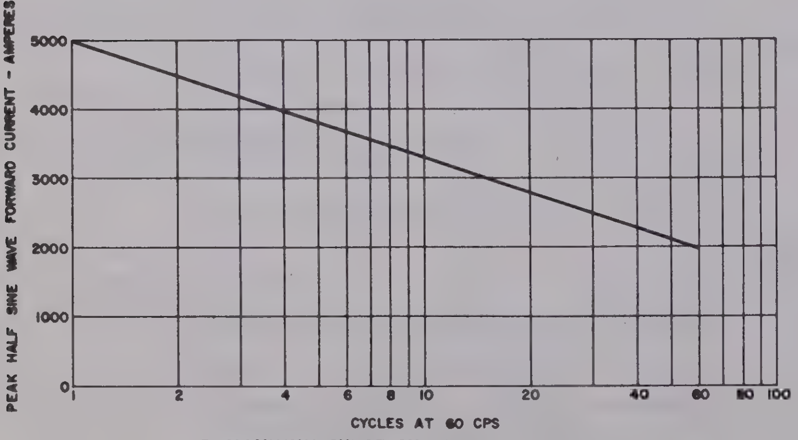
2. AVERAGE FORWARD POWER DISSIPATION VS. AVERAGE FORWARD CURRENT (Tj = +190°C)



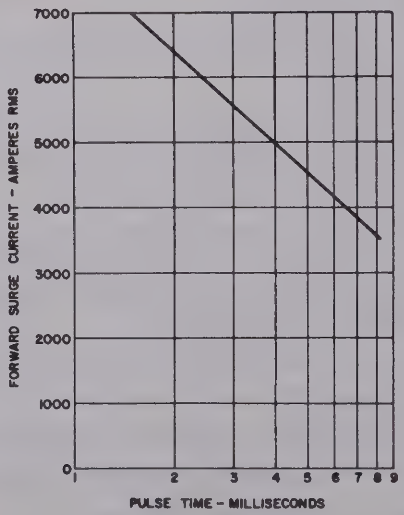
3. MAXIMUM CASE TEMPERATURE VS. AVERAGE FORWARD CURRENT



4. TRANSIENT THERMAL RESISTANCE — JUNCTION TO CASE



5. MAXIMUM SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS (Tj = −65°C TO +190°C)



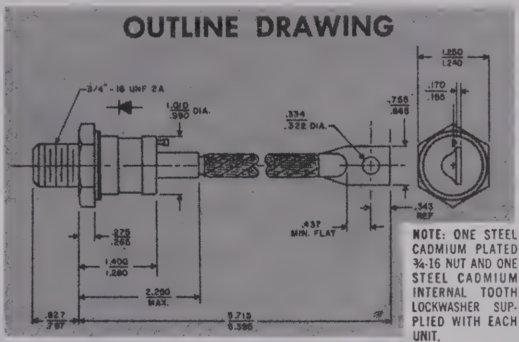
6. SUBCYCLE SURGE FORWARD CURRENT FOLLOWING RATED LOAD CONDITIONS (Tj = −65°C TO +190°C)

Silicon
Rectifier

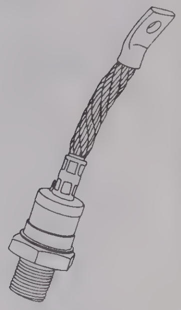
1N3260-73,R

General Electric now offers 160 ampere silicon rectifier diodes of the EIA Types 1N3260 through 1N3273.

This product features:
- Choice of stud anode or stud cathode types
- Thermal fatigue resistant
- Low reverse current
- Great uniformity of product
- High surge current capabilities


OUTLINE DRAWING

NOTE: ONE STEEL CADMIUM PLATED ¾-16 NUT AND ONE STEEL CADMIUM INTERNAL TOOTH LOCKWASHER SUPPLIED WITH EACH UNIT.



RATINGS AND SPECIFICATIONS:(1)

	1N3260	1N3261	1N3262	1N3263	1N3264	1N3265	1N3266	1N3267	1N3268	1N3269	1N3270	1N3271	1N3272	1N3273
*Maximum Allowable Repetitive Peak Reverse Voltage, V_{RM}(rep) (2)	50	100	150	200	250	300	350	400	500	600	700	800	900	1000
*Maximum Allowable DC Blocking Voltage, V_R(3)	40	80	120	160	200	240	280	320	400	480	560	640	720	800
*Maximum Allowable Average Forward Current, I_O (single phase, 125°C case temperature)	← 160 amperes →													
*Maximum Allowable Peak One-Cycle Surge Current, I_{FM}(surge) (60 cps single-phase basis, non-repetitive)	← 2000 amperes →													
Minimum I^2t Rating (non-repetitive)	← 8,250 amperes² seconds (see Chart 7) →													
*Maximum Peak Forward Voltage Drop, V_{FM} (I_O=160 amps DC, T_C=125°C)	← 1.6 volts →													
*Maximum Full Load Reverse Current, $I_{R(AV)}$ (full-cycle average, 125°C case temperature, single phase)	← 12 milliamperes →													
*Maximum Thermal Resistance, Θ_{J-C} (junction to case)	← 0.3°C/watt →													
*Storage Temperature, T_{stg}	← 65°C to +175°C →													
*Operating Temperature, T_J	← 55°C to +190°C →													
Stud Torque(4)—Maximum	← 325 inch-pounds (375 kg-cm) →													
—Minimum	← 275 inch-pounds (320 kg-cm) →													

NOTES: (1) Models listed are stud cathode (forward polarity) types. Order 1N32__R for stud anode (reverse polarity) types. Ratings and specifications are for frequencies from 50 up to 400 cycles/second, except where noted differently.

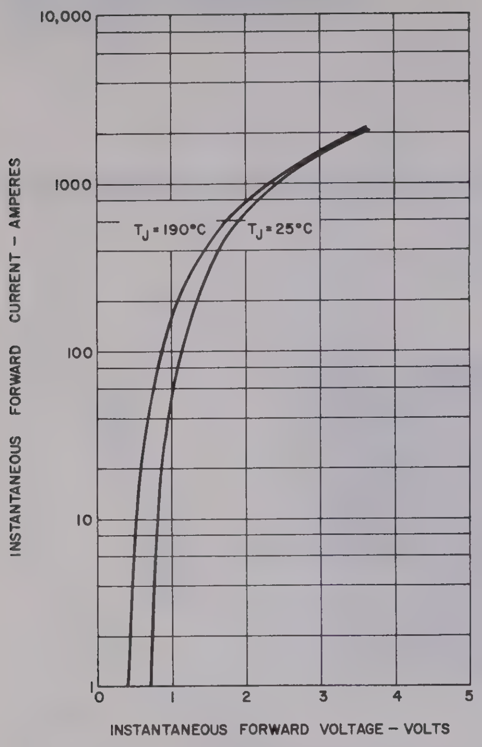
(2) Rating assumes a rectifier diode heat sink dissipation of 2.0°C/watt, or less.

(3) Rating assumes a rectifier diode heat sink dissipation of 1.0°C/watt, or less.

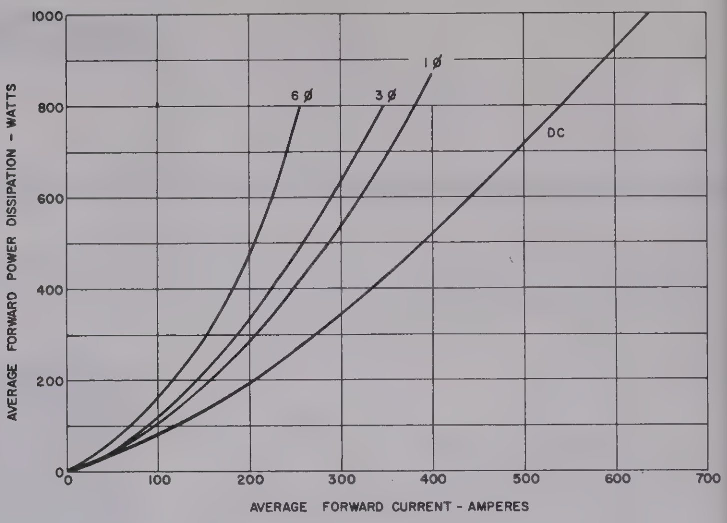
(4) Use of a silicone grease (G-E #G623) between the rectifier base and heat sink is recommended.

***Indicates JEDEC Registration Parameters.**

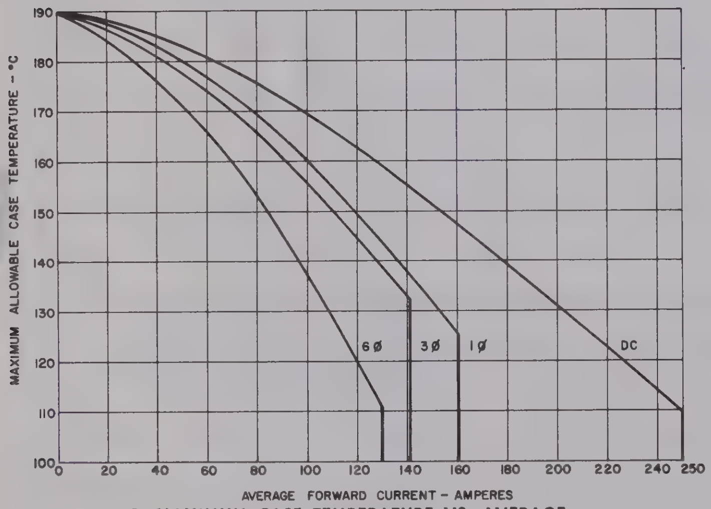
1N3260-73,R



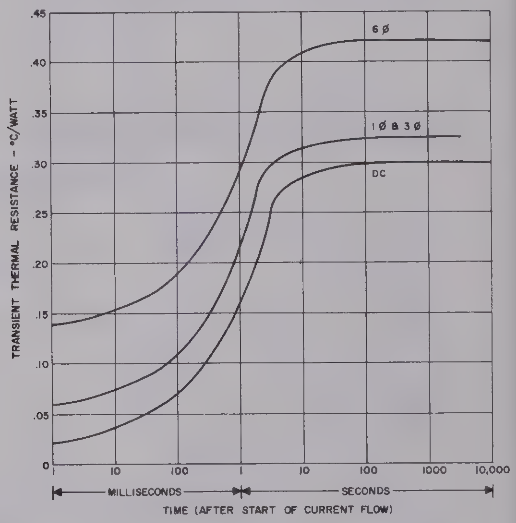
1. MAXIMUM FORWARD CHARACTERISTICS



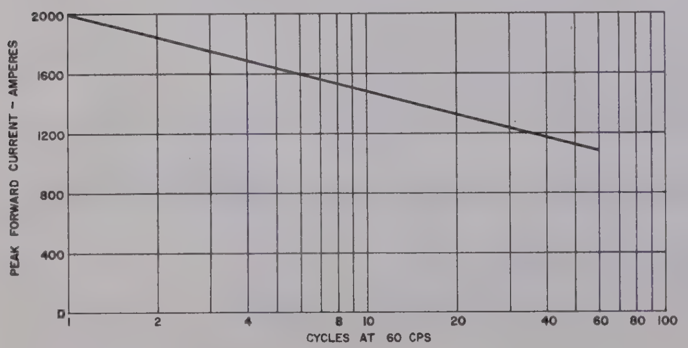
2. AVERAGE FORWARD POWER DISSIPATION VS. AVERAGE FORWARD CURRENT ($T_J = +190°C$)



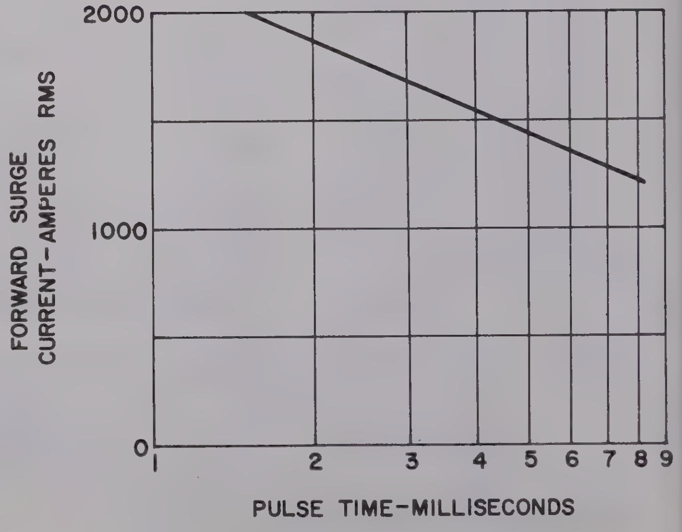
3. MAXIMUM CASE TEMPERATURE VS. AVERAGE FORWARD CURRENT



4. TRANSIENT THERMAL RESISTANCE — JUNCTION TO CASE



5. MAXIMUM SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS ($T_J = -55°C$ TO $+190°C$)

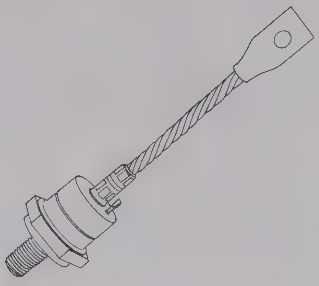


6. SUBCYCLE SURGE FORWARD CURRENT FOLLOWING RATED LOAD CONDITIONS ($T_J = -55°C$ TO $+190°C$)

Silicon
Rectifier

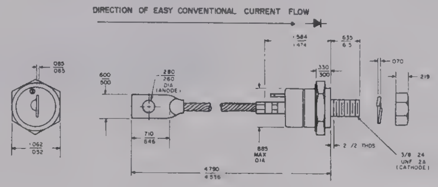
1N3289-96,R
A70S,A70T
A71S,A71T

The 1N3289-1N3296 Series is the ultimate in today's High Current Silicon Rectifier field. By taking full advantage of the most advanced semiconductor component manufacturing techniques, General Electric now offers the industry's first double diffused, all hard solder 100-ampere rectifier in PRV ratings up to 1,200 volts. As a result, circuit designers now receive:



Features:

- Freedom from Thermal Fatigue Failure
- Higher Surge Current Capabilities
- NEMA Overload Ratings
- Forward and Reverse Polarities



CONFORMS TO JEDEC OUTLINE DO-8

RATINGS AND SPECIFICATIONS

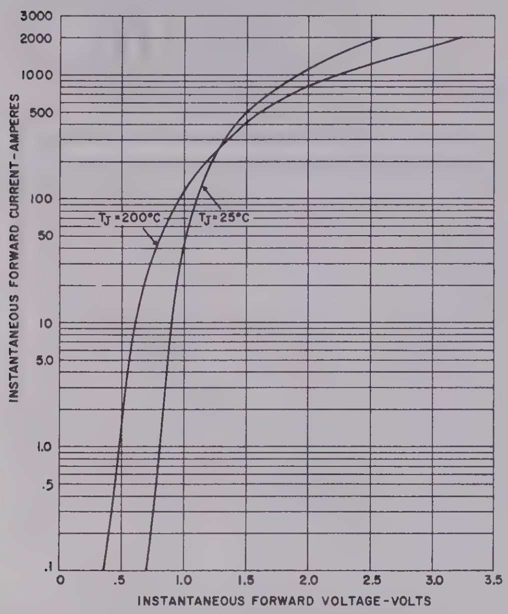
	1N3289 1N3289R	1N3290 1N3290R	1N3291 1N3291R	1N3292 1N3292R	1N3293 1N3293R	A70S A71S	1N3294 1N3294R	A70T A71T	1N3295 1N3295R	1N3296 1N3296R	
Maximum Allowable Transient Peak Reverse Voltage (non-recurrent, 5 millisecond maximum duration)	300	400	525	650	800	925	1050	1175	1300	1500	volts
Maximum Allowable Repetitive Peak Reverse Voltage, V_{RM} (rep)	200	300	400	500	600	700	800	900	1000	1200	volts
Maximum Allowable RMS Reverse Voltage	140	210	280	350	420	490	560	630	700	840	volts
Maximum Allowable DC Blocking Voltage**	200	300	400	500	600	700	800	900	1000	1200	volts
Maximum Allowable Average Forward Current (single phase, 130°C stud temperature)	← 100 amperes →										
Maximum Allowable Peak One-Cycle Surge Current (60 cps single-phase basis, non-recurrent)	← 1600 amperes →										
Minimum I^2t Rating (non-recurrent)	← 4000 amperes^2-seconds (See Curve 8) →										
Maximum Full Load Voltage Drop (full-cycle average, 130°C stud temperature, 100 amperes average single phase)	← 0.6 volts →										
Maximum Full Load Reverse Current (full-cycle average, 130° stud temperature, single phase)	9.5	9.0	9.0	8.0	6.5	6.0	5.5	5.5	4.5	3.5	ma
Maximum Thermal Resistance (junction to stud)	← DC = 0.4°C/w; 1ϕ & 3ϕ = .55°C/w; 6ϕ = .72°C/w →										
Storage and Junction Operating Temperature	← −40°C to +200°C →										
Max. Stud Torque***	← 100 Lb-in (120 Kg-cm) →										
Min. Stud Torque	← 90 Lb-in (105 Kg-cm) →										
Weight	← Approximately 2½ ounces →										

NOTES:

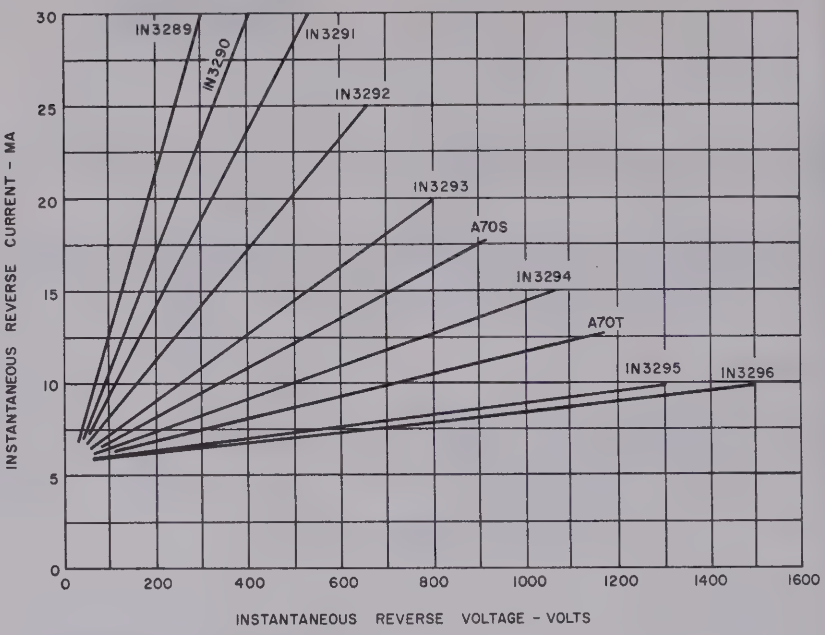
† "R" indicates reverse polarity
* Rating assumes rectifier cell heat sink of less than 3°C/watt.
** Rating assumes rectifier cell heat sink of less than 1.5°C/watt.
*** Use of silicone grease between rectifier base and heat sink is recommended.

Non-recurrent voltage and current ratings, as contrasted to repetitive ratings, are ratings which apply for occasional or unpredicable overloads. For example, the forward surge current ratings are non-recurrent ratings that are used in fault coordination design work.

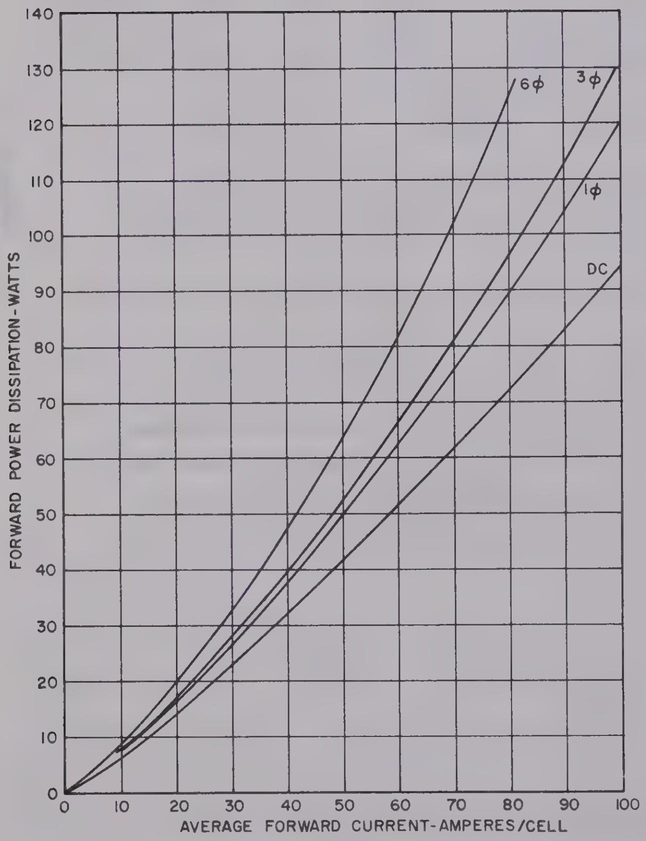
DIODE SPECIFICATIONS



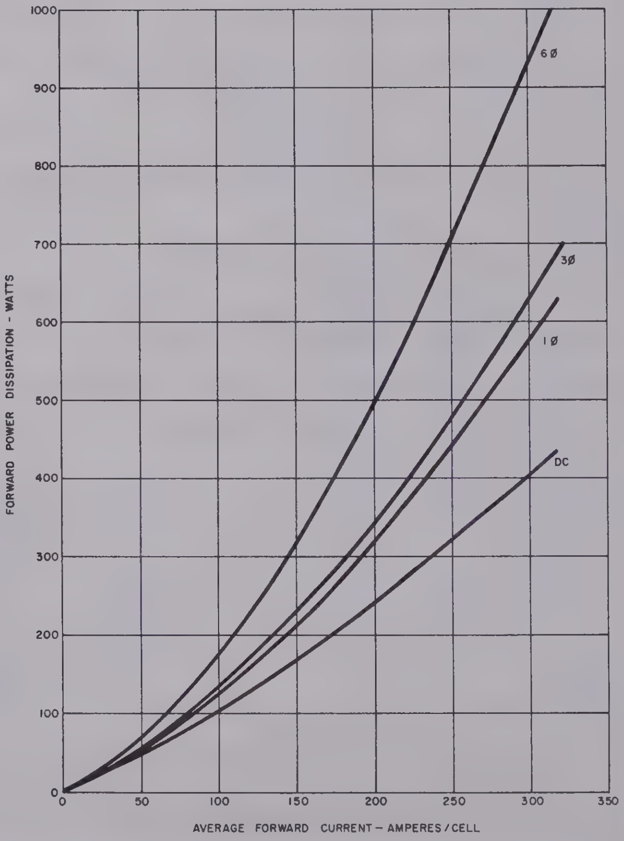
1. MAXIMUM FORWARD CHARACTERISTICS



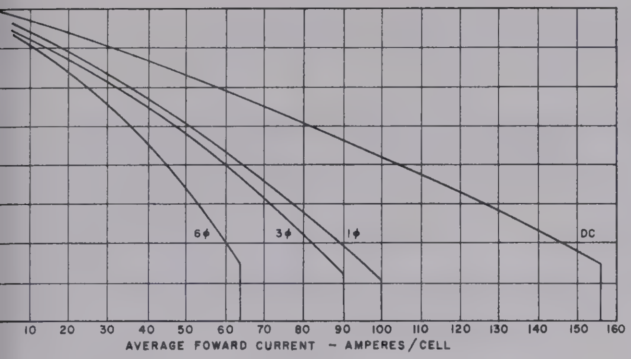
2. MAXIMUM TRANSIENT REVERSE CHARACTERISTICS (T_J = −40°C to +200°C)



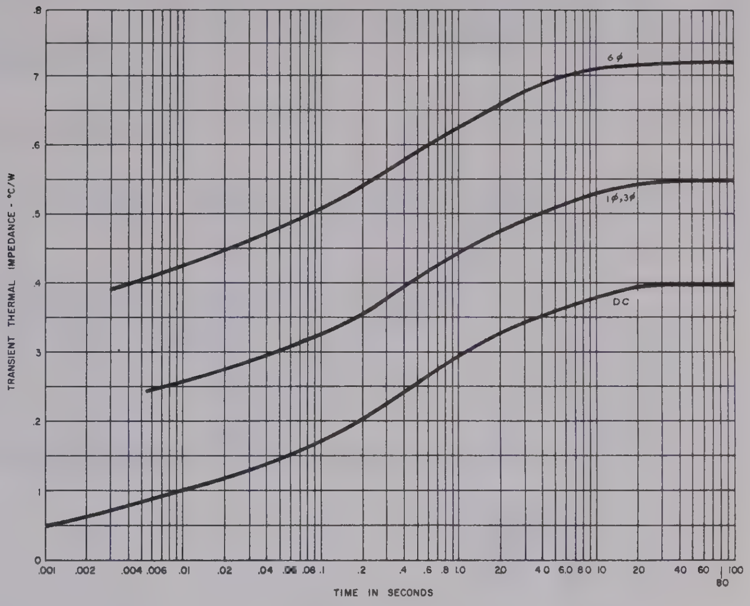
3. AVERAGE FORWARD POWER DISSIPATION VS. AVERAGE FORWARD CURRENT



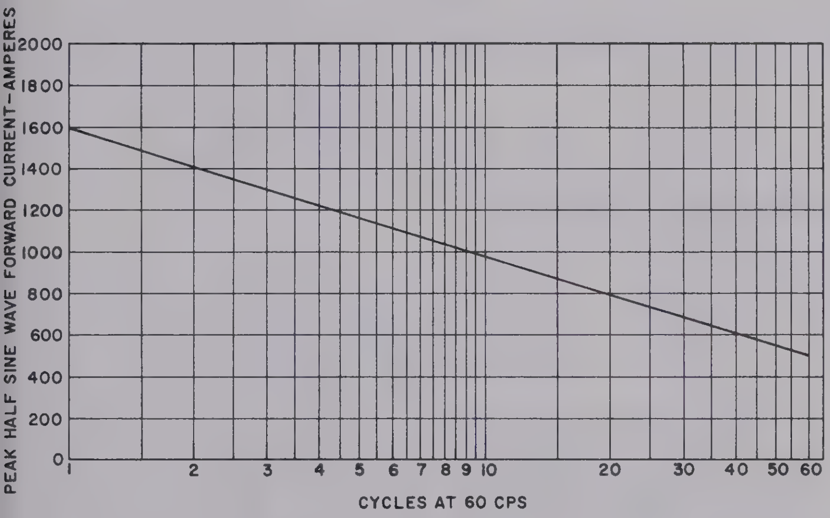
4. AVERAGE FORWARD POWER DISSIPATION VS. AVERAGE FORWARD CURRENT, HIGH LEVEL



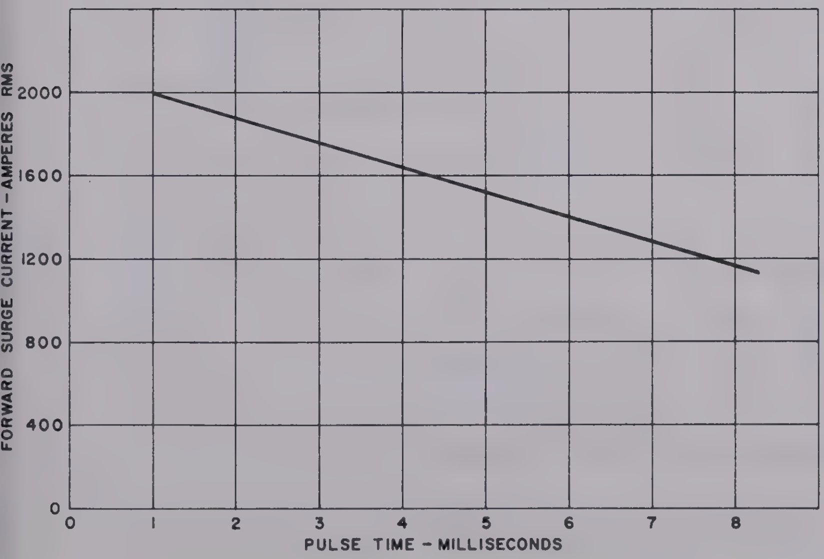
. MAXIMUM STUD TEMPERATURE VS. AVERAGE FORWARD CURRENT



6. JUNCTION TO CASE TRANSIENT THERMAL IMPEDANCE

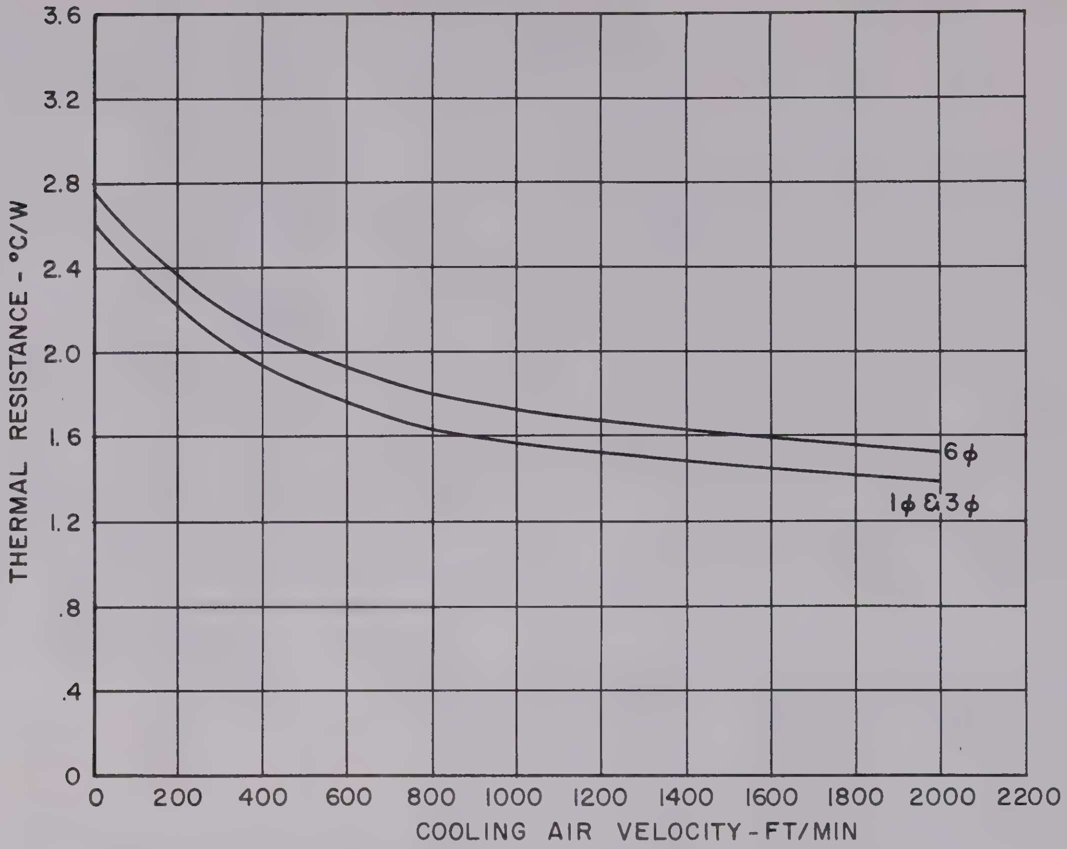


7. MAXIMUM SURGE CURRENT
AT RATED LOAD CONDITIONS
(Non-Recurrent) $T_J = -40°C$ to $+200°C$

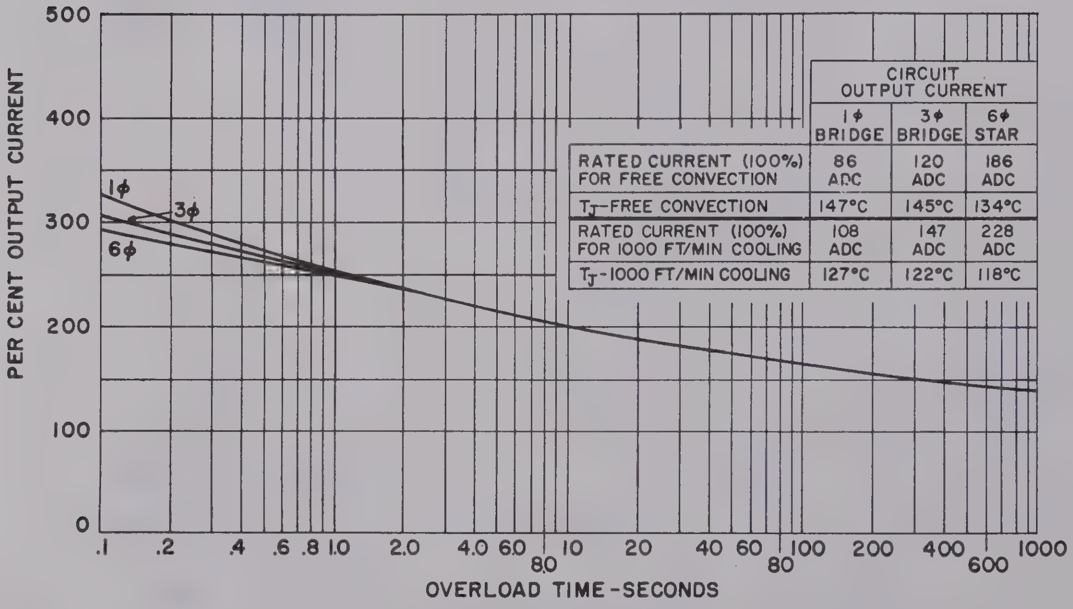


8. MAXIMUM SURGE CURRENT
FOR SUB-CYCLE PULSES
AT RATED LOAD CONDITIONS
(Non-Recurrent)
$T_J = -40°C$ to $+200°C$

RECURRENT OVERLOAD RATINGS
FOR DIODES MOUNTED ON 7 x 7 x 1/4" COPPER FIN (E ≧ 0.9)



17. STEADY-STATE THERMAL RESISTANCE, JUNCTION TO AMBIENT



	CIRCUIT OUTPUT CURRENT		
	1φ BRIDGE	3φ BRIDGE	6φ STAR
RATED CURRENT (100%) FOR FREE CONVECTION	86 ADC	120 ADC	186 ADC
T_J–FREE CONVECTION	147°C	145°C	134°C
RATED CURRENT (100%) FOR 1000 FT/MIN COOLING	108 ADC	147 ADC	228 ADC
T_J-1000 FT/MIN COOLING	127°C	122°C	118°C

18. RECURRENT OVERLOAD CURVE MEETING NEMA STANDARDS FOR "General Purpose Rectifier Equipments Under 100 KW" AT 40°C AMBIENT

See back page to determine Recurrent Overload Ratings for overload conditions other than are shown in Figure 18.

INSTALLATION INSTRUCTIONS

Following these installation instructions will result in a diode-to-heatsink thermal resistance of .10°C/watt.

1. Be sure mounting surface is clean and flat at (.001 inch/inch).
2. Mounting hole diameter should not exceed rectifier stud OD by more than 1/16" and should be deburred.
3. Use Burndy's "Penetrox A" or equivalent on mounting surfaces which come in contact with the heatsink.
4. Use suitable hardware. (Nut and split lockwasher are supplied.)
5. Tighten with a torque wrench, from nut side, to 100 inch-pounds.

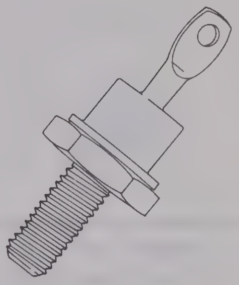
Silicon Rectifier

MEDIUM CURRENT

IN3569-74

The 1N3569-74 series stud mounted device in the popular DO-4 package is designed especially for reliability and long life. This series is especially desirable in industrial applications that require high surge capabilities. In addition to this feature the 1N3569-74 units have:

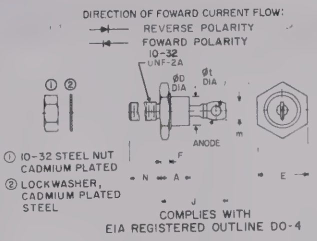
- Hermetically Sealed Housing
- Transient PRV Rating
- Low Forward Drop
- Operating Temperature up to 165°C



OUTLINE DRAWING

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A		.405		10.29	
φD		.424		10.77	
E	.424	.437	10.77	11.10	
F	.075	.175	1.91	4.45	
J		.800		20.32	
m		.250		6.35	1
N	.422	.453	10.72	11.51	
φt	.060		1.52		
W					2

NOTES:
1. Angular orientation of this terminal is undefined.
2. 10-32 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter (.1697", 4.29 MM). Ref: (Screw thread standards for Federal Services 1957) Handbook H28, P1

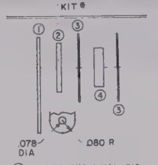


① 10-32 STEEL NUT CADMIUM PLATED

② LOCKWASHER, CADMIUM PLATED STEEL

COMPLIES WITH
EIA REGISTERED OUTLINE DO-4

INSULATING HARDWARE KIT*



① COPPER TERMINAL, 016 THICK, TIN PLATED

② BRASS WASHER, 035 THICK NICKEL PLATED

③ MICA WASHERS, TWO, 625 O.D., 204 I.D., 005 THICK

④ TEFLON WASHER, 270 O.D. 204 I.D., 050 THICK

* AVAILABLE UPON REQUEST

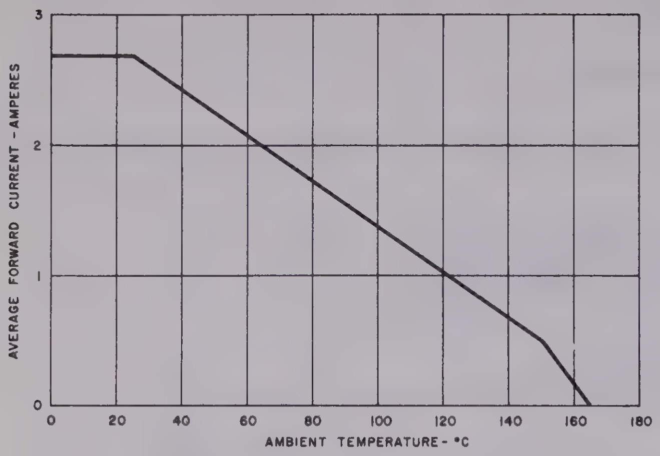
RATINGS AND SPECIFICATIONS
60 cps Resistive or Inductive Load

	1N3569	1N3570	1N3571	1N3572	1N3573	1N3574
**Maximum Allowable Transient Peak Reverse Voltage (non-recurrent, 5 millisecond duration)	150	275	400	525	650	775 V
Maximum Allowable Repetitive Peak Reverse Voltage (PRV)	100	200	300	400	500	600 V
Maximum Allowable RMS Voltage	70	140	210	280	350	420 V
Maximum Allowable DC Blocking Voltage	100	200	300	400	500	600 V
*Maximum Allowable DC Output Current						
at 85°C Stud Temperature	← 3.50 → Amps					
at 150°C Stud Temperature	← 1.25 → Amps					
**Maximum Allowable Peak One Cycle Surge Current (60 cps single phase, non-recurrent)—See Fig. 5	← 35 → Amps					
**Minimum I^2t Rating (non-recurrent)—See Fig. 6	← 3 → Amp² sec					
Maximum Full Load Voltage Drop (full cycle average at rated load) 150°C Ambient	← 0.5 → V					
Maximum Reverse Current (full cycle average at rated voltage) 150°C Ambient	← 0.4 → ma					
Maximum Operating Temperature	← −65°C to +165°C →					
Maximum Storage Temperature	← −65°C to +175°C →					
Thermal Characteristics						
Typical Thermal Impedance: Junction to Stud	← 10°C/W →					

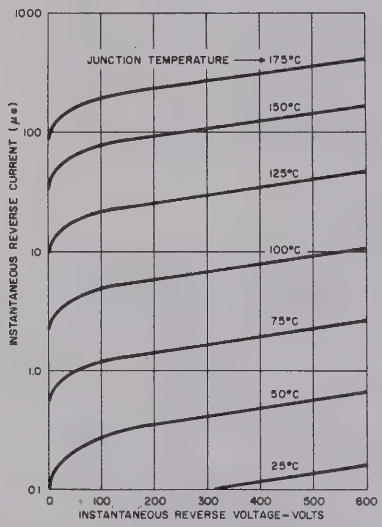
Notes: *For current ratings on fins and at other stud temperatures, see Figures 1 and 2. Stud temperature refers to temperature on outside flat of hex.

**Rectifier must return to normal thermal equilibrium before reapplication of these overloads.

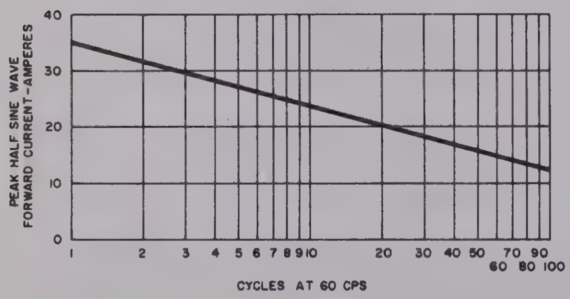
IN3569-74



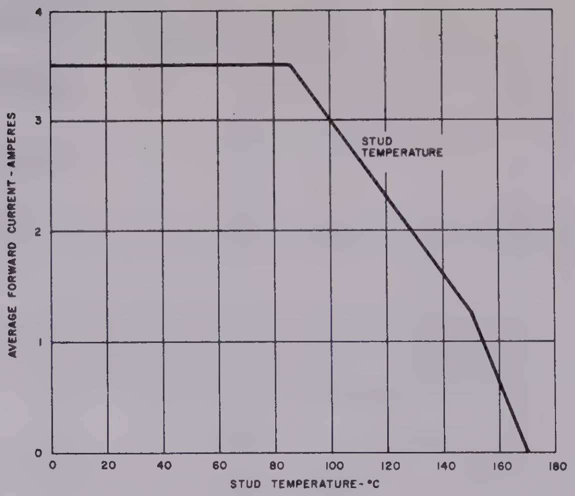
1. MAXIMUM ALLOWABLE DC OUTPUT CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE FOR 1½" SQUARE COOLING FIN-SINGLE PHASE RESISTIVE OR INDUCTIVE LOAD.



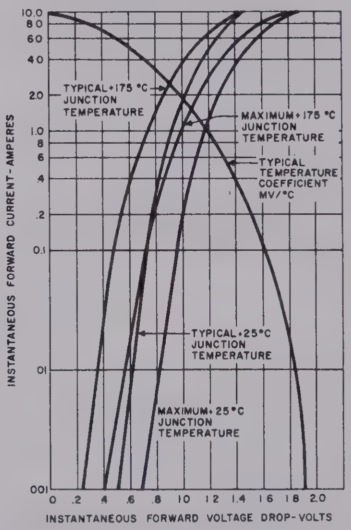
3. TYPICAL REVERSE CHARACTERISTICS



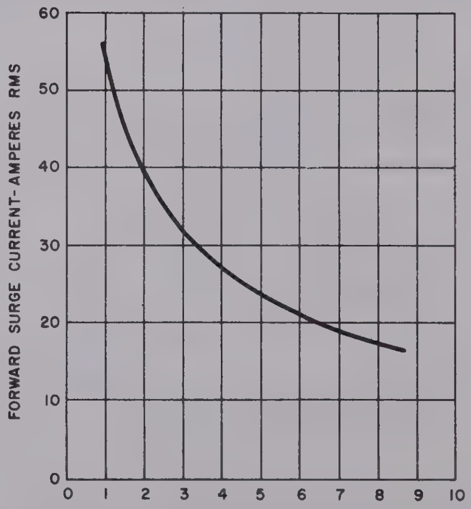
5. MAXIMUM SURGE CURRENT AT RATED LOAD CONDITIONS (NON-RECURRENT).



2. MAXIMUM ALLOWABLE DC OUTPUT CURRENT AS A FUNCTION OF STUD TEMPERATURE SINGLE PHASE RESISTIVE OR INDUCTIVE LOAD.



4. TYPICAL AND MAXIMUM FORWARD CHARACTERISTICS.



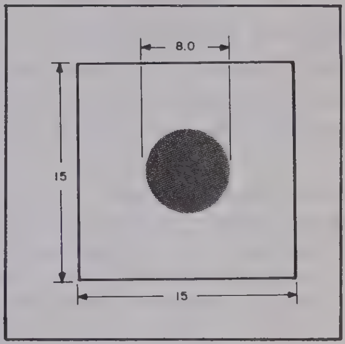
6. MAXIMUM SURGE CURRENT FOR SUB-CYCLE PULSES RATED LOAD CONDITIONS (NON-RECURRENT). CURVE USED IN CALCULATION OF I^2t.

Silicon
Diode Chips

1N3600 (Chip)
1N4150 (Chip)

(M79P-X506)

These General Electric silicon planar oxide-passivated diode chips are designed primarily for high conductance, high-speed switching in logic, core hammer driver circuits and general purpose applications. The chips feature controlled conductance, maximum and minimum forward voltages, specified at five forward currents from 1 mA to 200 mA.



General specifications:
- Gold cathode contact backing, minimum thickness—3000Å
- Aluminum anode contact metalization
- Maximum conditions for mounting chips—425°C for 5 minutes (Max.) in an inert atmosphere
- Shipping containers: Glass vials sealed with a nitrogen back-fill
  Maximum of 10k chips per vial
  Egg crate containers available at extra cost
- Chip drawing dimensions are in mils
- Chip thickness = 5.0 ±2 mils

absolute maximum ratings: ($T_A = 25°C$)

	Symbol		
Voltage			
Reverse	V_R	50	V
Current			
Average Rectified		150	mA
Recurrent Peak Forward		450	mA
Forward Steady State D.C.		200	mA
Peak Forward Surge (1 μsec. pulse)		2	A
Temperature			
Storage	T_{STG}	−65°C to +200°C	
Operating	T_J	−65°C to +200°C	

electrical characteristics: 100% Probe ($T_A = 25°C$)

Tested at outgoing acceptance to a 10% LTPD with a maximum accept number of 3.

	Symbol	Min.	Max.	
Forward Voltage Drop ($I_F = 20$ mA)	V_F	—	1.05	V
Reverse Current ($V_R = 50V$)	I_R	—	1	μA

specifications: ($T_A = 25°C$)

Product yield is at least 93% to each of the following parameters:

	Symbol	Min.	Max.	
Junction Capacitance	C_o			
($V_R = 0$, $e_s = 50$ mV, f = 1MHz)		—	2.5	pF
Maximum Reverse Recovery Time	t_{rr}			
$I_F = 10$ mA, $I_r = 1$ mA)		—	6	nsec.
Forward Voltage	V_F			
($I_F = 1$ mA)		0.54	0.62	V
($I_F = 10$ mA)		0.66	0.74	V
*($I_F = 50$ mA)		0.76	0.86	V
*($I_F = 100$ mA)		0.82	0.92	V
*($I_F = 200$ mA)		0.87	1.0	V

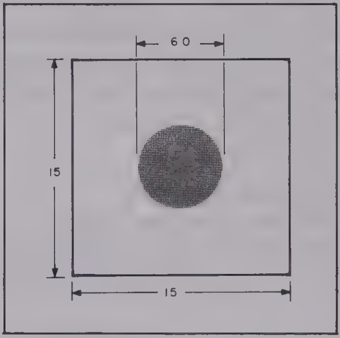
*Voltage measured 25±3μsec. after application of current.

Silicon
Diode Chips

1N3605 (Chip)
1N4152 (Chip)
1N4533 (Chip)

(M46P-X516)

These General Electric silicon planar oxide-passivated diode chips are designed primarily for high-speed switching in computer and general purpose applications. The chips feature high conductance, fast recovery time, low leakage and low capacitance. All chips also feature controlled conductance, maximum and minimum forward voltages, specified at six forward currents from 100 μA to 20 mA.



General specifications:

- Gold cathode contact backing, minimum thickness—3000Å
- Aluminum anode contact metalization
- Maximum conditions for mounting chips—425°C for 5 minutes (Max.) in an inert atmosphere
- Shipping containers: Glass vials sealed with a nitrogen back-fill
  Maximum of 10k chips per vial
  Egg crate containers available at extra cost
- Chip drawing dimensions are in mils
- Chip thickness = 5.0 ±2 mils

absolute maximum ratings: ($T_A = 25°C$)

	Symbol		
Voltage			
Reverse	V_R	30	V
Current			
Average Rectified		150	mA
Recurrent Peak Forward		450	mA
Forward Steady State D.C.		200	mA
Peak Forward Surge (1 μsec. pulse)		2	A
Temperature			
Storage	T_{STG}	−65°C to +200°C	
Operating	T_J	−65°C to +200°C	

electrical characteristics: 100% Probe ($T_A = 25°C$)

Tested at outgoing acceptance to a 10% LTPD with a maximum accept number of 3.

	Symbol	Min.	Max.	
Reverse Breakdown Voltage ($I_R = 5\ \mu A$)	BV_R	40	—	V
Forward Voltage Drop ($I_F = 20$ mA)	V_F	—	1.05	V
Reverse Current ($V_R = 30V$)	I_R	—	50	nA

specifications: ($T_A = 25°C$)

Product yield is at least 93% to each of the following parameters:

	Symbol	Min.	Max.	
Junction Capacitance	C_o			
($V_R = 0$, $e_s = 50$ mv, f = 1 MHz)		—	2	pF
Maximum Reverse Recovery Time	t_{rr}			
($I_F = 10$ mA, $V_r = 6V$, $R_L = 100\ \Omega$)		—	2	nsec.
Forward Voltage	V_F			
($I_F = 100\ \mu A$)		0.49	0.55	V
($I_F = 250\ \mu A$)		0.53	0.59	V
($I_F = 1$ mA)		0.59	0.67	V
($I_F = 2$ mA)		0.62	0.70	V
($I_F = 10$ mA)		0.70	0.81	V
($I_F = 20$ mA)		0.74	0.88	V

Germanium Diodes

1N3712-21

The General Electric 1N3712 through 1N3720 and 1N3713 through 1N3721 are Germanium Tunnel Diodes offering peak currents of 1.0, 2.2, 4.7, 10, and 22 ma. These devices, which make use of the quantum mechanical tunneling phenomenon to obtain a negative conductance characteristic, are designed for low level switching and small signal applications at very high frequencies. All 1N3713-1N3721 version parameters are closely controlled for use in critical applications such as level detection, frequency converters, etc. These devices are housed in General Electric's new hermetically sealed subminiature axial package.

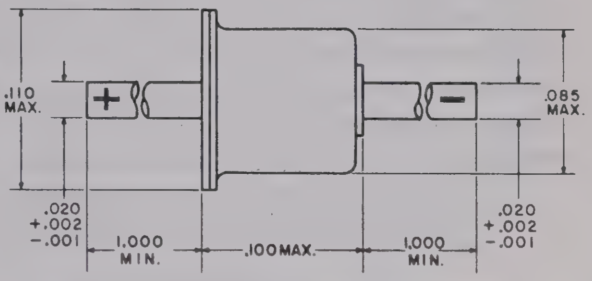
FEATURES:

- V_{FS} Specified for more accurate designing of load lines
- Low capacitance
- Fast speed

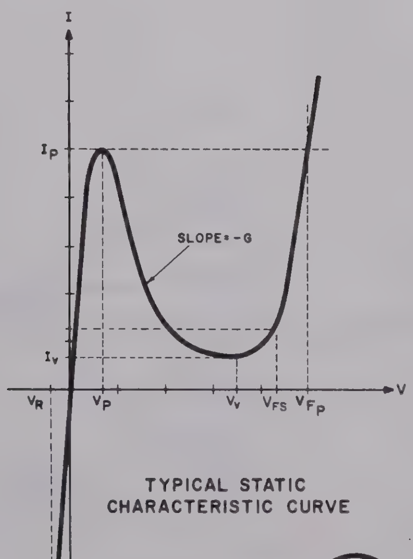
	1N3712 1N3713	1N3714 1N3715	1N3716 1N3717	1N3718 1N3719	1N3720 1N3721	
Forward Current*	5	10	25	50	100	ma
Reverse Current*	10	20	50	50	100	ma
Storage Temperature	← −55 to +100 →					°C
Lead Temperature 1/16" ± 1/32" from case for 10 seconds	← 260 →					°C

*Derate maximum currents 1% per °C ambient temperature above 25°C.

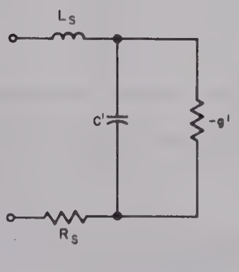
AXIAL DIODE OUTLINE



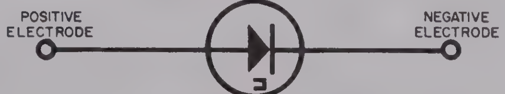
ALL DIMENSIONS IN INCHES.
DIMENSIONS ARE REFERENCE UNLESS TOLERANCED.



TYPICAL STATIC CHARACTERISTIC CURVE



EQUIVALENT CIRCUIT (BIASED IN NEGATIVE CONDUCTANCE REGION)



TUNNEL DIODE SYMBOL

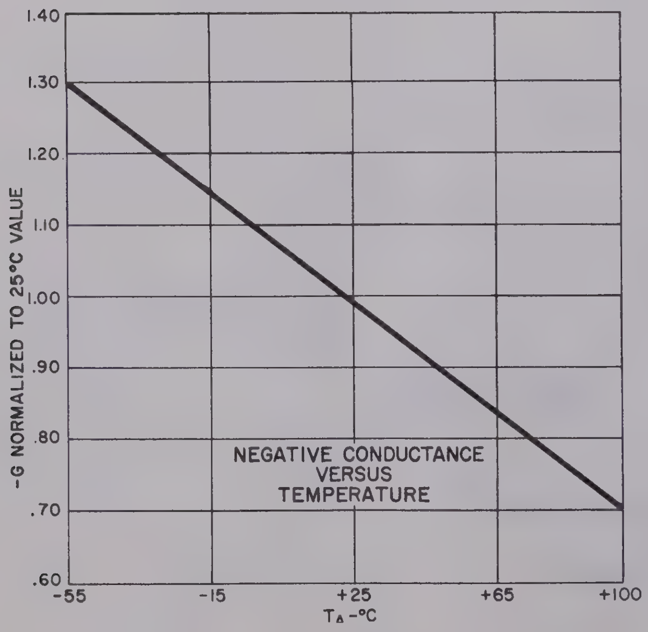
electrical characteristics:

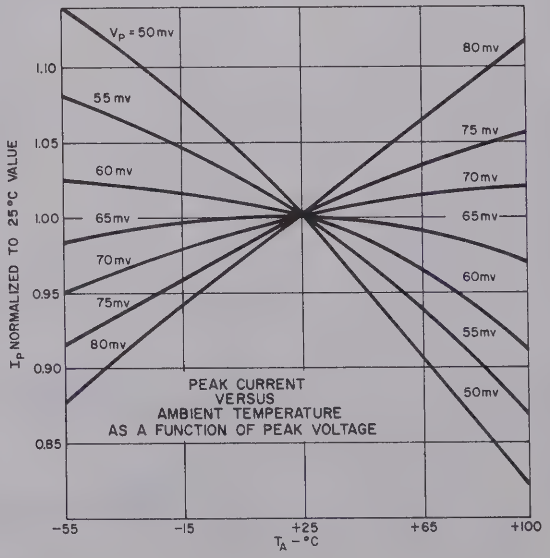
STATIC CHARACTERISTICS		1N3712 Min.	1N3712 Typ.	1N3712 Max.	1N3713 Min.	1N3713 Typ.	1N3713 Max.	1N3714 Min.	1N3714 Typ.	1N3714 Max.	1N3715 Min.	1N3715 Typ.	1N3715 Max.
Peak Point Current	I_P	0.9	1.0	1.1	0.975	1.000	1.025	2.0	2.2	2.4	2.15	2.20	2.25
Valley Point Current	I_V		0.12	0.18	.075	.095	.140		0.29	0.48	.165	.210	.310
Peak Point Voltage	V_P		65		58	65	72		65		58	65	72
Valley Point Voltage	V_V		350		315	355	395		350		315	355	395
Reverse Voltage ($I_R = I_P$ typ.)	V_R			40		20	40			40		20	40
Forward Voltage ($I_F = I_P$ typ.)	V_{FP}		500		475	510	535		500		475	510	535
► ($I_F = .25\ I_P$ typ.)	V_{FS}*				410	450					410	450	
DYNAMIC CHARACTERISTICS													
Total Series Inductance	L_S		0.5			0.5			0.5			0.5	
Total Series Resistance	R_S		1.5	4.0		1.7	4.0		1.0	3.0		1.1	3.0
► **Valley Point Terminal Capacitance**	C		5	10		3.5	5.0		10	25		7.0	10.0
Max. Negative Terminal Conductance	-G		8		7.5	8.5	9.5		18		16	19	22
Resistive Cutoff Frequency	f_{ro}		2.3			3.2			2.2			3.0	
Self-Resonant Frequency	f_{xo}		3.2			3.8			2.2			2.7	
Frequency of Oscillation	F_{osc}**		3.2			3.8			2.2			2.7	
► **Rise Time**	t_r***					1.7						1.6	

*V_{FS} is defined as the value of forward voltage at a forward current of one quarter the typical peak current.

**The frequency of oscillation (under short circuit conditions) for steady state large signal sinusoidal oscillation is given by equation (3) which is the maximum frequency attainable without capacitance compensation.

***Switching speed with constant current drive. $t_r \approx \frac{V_{FP} - V_P}{I_P - I_V} C$



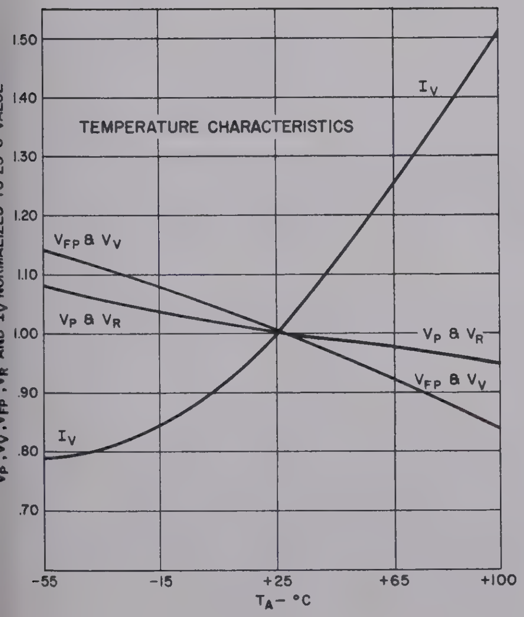


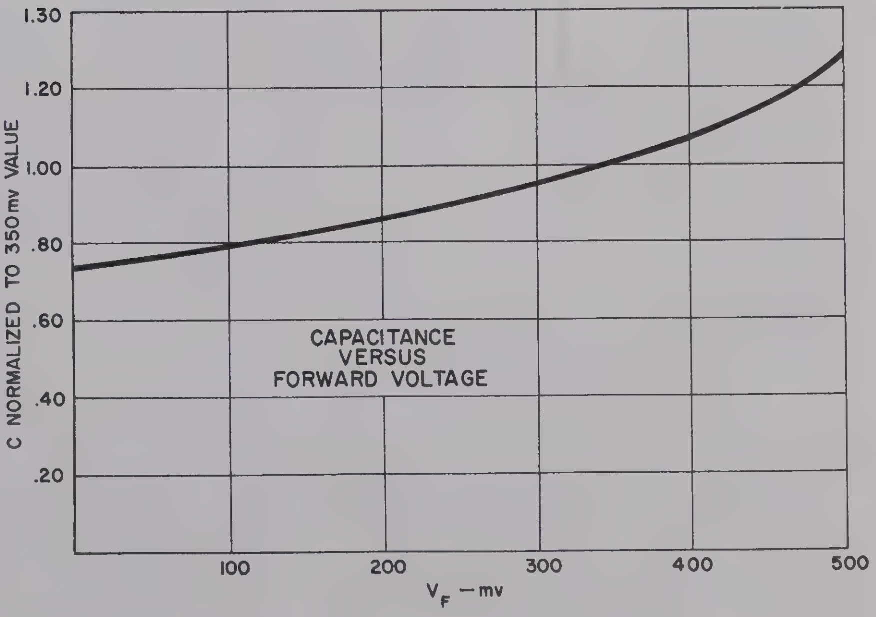
1N3716			1N3717			1N3718			1N3719			1N3720			1N3721			
Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
4.2	4.7	5.2	4.58	4.70	4.82	9.0	10.0	11.0	9.75	10.00	10.25	20	22	24	21.5	22	22.5	ma
	0.60	1.04	.350	.45	.60		1.3	2.2	.75	.95	1.40		2.9	4.8	1.65	2.10	3.10	ma
	65		58	65	72		65		58	65	72		65		58	65	72	mv
	350		315	355	395		350		315	355	395		350		315	355	395	mv
		40		20	40			40		20	40			40		20	40	mv
	500		475	510	535		500		475	510	535		500		475	510	575	mv
			410	450					410	450					410	450		
	0.5			0.5			0.5			0.5			0.5			0.5		nh
	.50	2.0		.52	2.0		.30	1.5		.36	1.5		.20	1.0		.22	1.0	ohms
	25	50		13	25		50	90		27	50		90	150		55	100	pf
	40		36	41	46		80		75	85	95		180		160	190	220	10^{-3} mho
	1.8			3.4			1.6			2.8			1.6			2.6		KMC
	1.4			1.9			.97			1.3			.67			.78		KMC
	1.4			2.0			1.0			1.4			.74			.95		KMC
				1.4						1.3						1.2		nsec

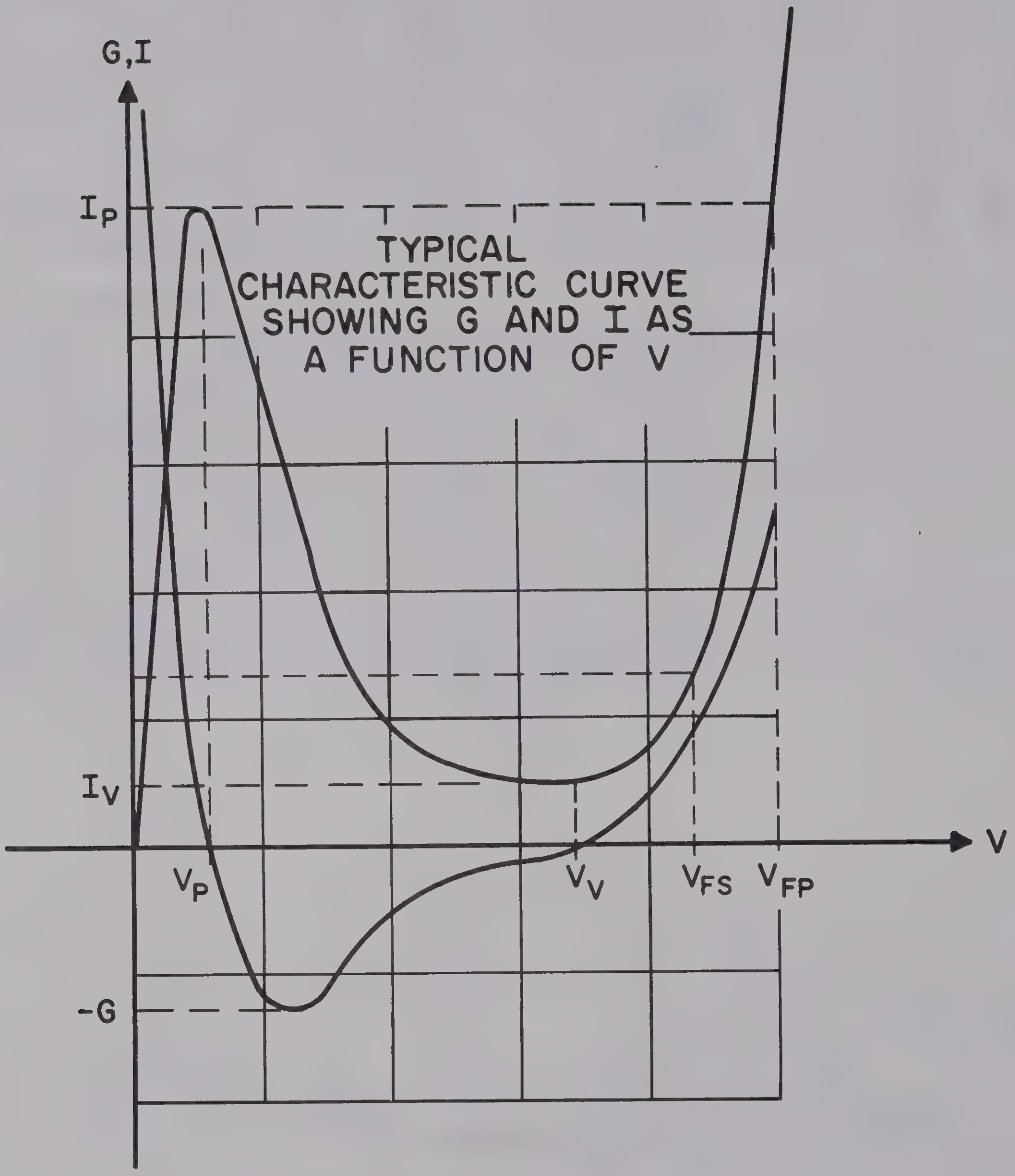
$$f_{ro} = \frac{|g'|}{2\pi C'} \sqrt{\frac{1}{R_S |g'|} - 1} \quad (1)$$

$$f_{xo} = \frac{1}{2\pi} \sqrt{\frac{1}{L_S C'} - \left(\frac{|g'|}{C'}\right)^2} \quad (2)$$

$$f_{osc} = \frac{1}{2\pi} \sqrt{\frac{1}{L_S C} - \left(\frac{R_T}{L}\right)^2} \quad (3)$$





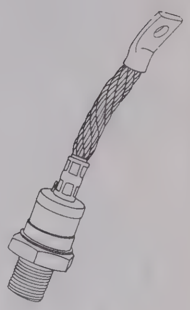

G,I
I$_P$
I$_V$
-G
V
V$_P$
V$_V$
V$_{FS}$
V$_{FP}$
TYPICAL CHARACTERISTIC CURVE SHOWING G AND I AS A FUNCTION OF V

Silicon
RECTIFIERS

A90 IN3735-42

The A90 (1N3735) Series is General Electric's highly reliable, double-diffused, all hard soldered 250 ampere silicon rectifier diode.

This series of rectifier diodes is particularly suited to a wide range of industrial applications, especially those requiring high performance rectifiers.



Typical applications are:

- Transportation Equipment
- DC Motor Control
- DC Power Supplies
- Battery Vehicles

Maximum Allowable Ratings

TYPES*	REPETITIVE PEAK REVERSE VOLTAGE (PRV)(1)	TRANSIENT PEAK REVERSE VOLTAGE (non-recurrent 5 msec max)(2)	D.C. BLOCKING VOLTAGE(3)	FULL LOAD REVERSE CURRENT (full-cycle average, 130°C case temperature, single phase)
A90A, 1N3735	100 Volts	200 Volts	100 Volts	16.0 mA
A90B, 1N3736	200	300	200	16.0
A90C, 1N3737	300	400	300	16.0
A90D, 1N3738	400	525	400	16.0
A90E, 1N3739	500	650	500	13.0
A90M, 1N3740	600	800	600	12.0
A90S	700	925	700	11.0
A90N, IN3741	800	1050	800	9.0
A90T	900	1175	900	8.0
A9QP, 1N3742	1000	1300	1000	7.0
A90PA	1100	1400	1100	7.0
A90PB	1200	1500	1200	7.0

*Models listed are stud cathode (forward polarity) types. Specify A91__ or 1N37___R for stud anode (reverse polarity) types. Ratings and specifications are for frequencies from 50 to 400 Hz., except where noted otherwise.

Average Forward Current, I_O (T_C = +130°C, single-phase, half sine wave)		250 Amperes
Peak One-Cycle Surge Current (non-repetitive), I_{FM} (surge)		4500 Amperes
Minimum I^2t Rating (see Curve 5), $t \geqq$ 1msec. (non-repetitive)		31,360 Ampere^2 seconds
Forward Peak Voltage Drop, V_{FM} (T_C = +130°C, I_O = 250 amps avg.)		1.3 Volts
Thermal Resistance, Θ_{J-C}	DC	0.18°C/Watt
	1ϕ & 3ϕ (50 to 400 Hz)	0.24°C/Watt
	6ϕ (50 to 400 Hz)	0.30°C/Watt
Storage and Operating Junction Temperature, T_J		−40°C to +200°C
Stud Torque(4)		275 Lb-in (Min), 325 Lb-in (Max) 320 Kg-cm (Min), 380 Kg-cm (Max)

Notes:

(1) Assumes a heatsink thermal resistance of less than 2.0°C/watt.

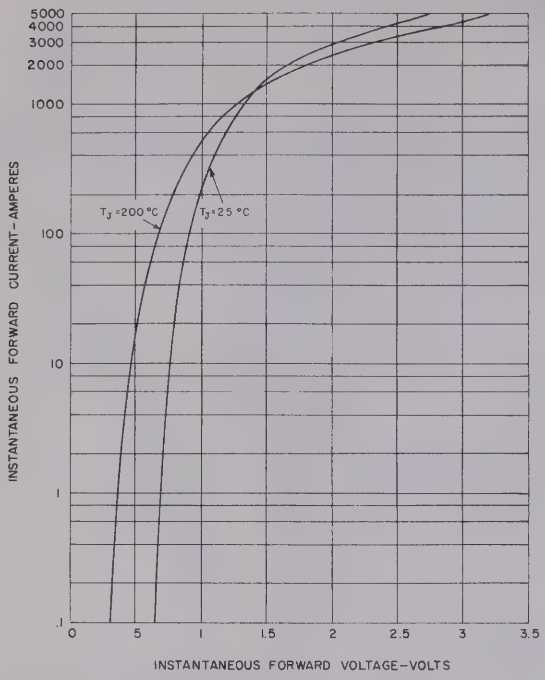
(2) Non-recurrent voltage and current ratings, as contrasted to repetitive ratings, apply for occasional or unpredictable overloads. For example, the forward surge current ratings are non-recurrent ratings that are used in fault coordination work.

(3) Assumes a heatsink thermal resistance of less than 1.0°C/watt.

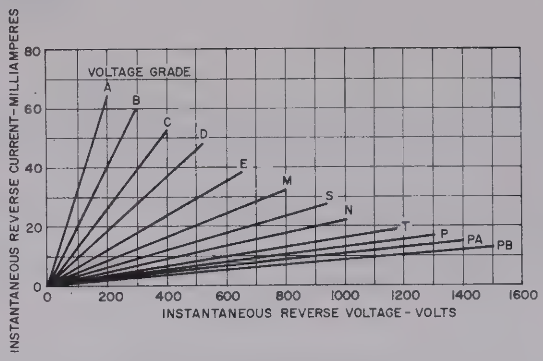
(4) Use of Burndy's Penetrox "A" between the rectifier diode base and the heatsink is recommended.

A90 IN3735-42

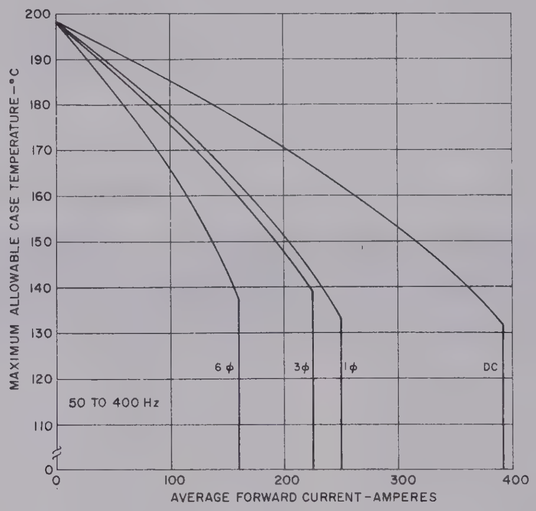
DEVICE SPECIFICATIONS



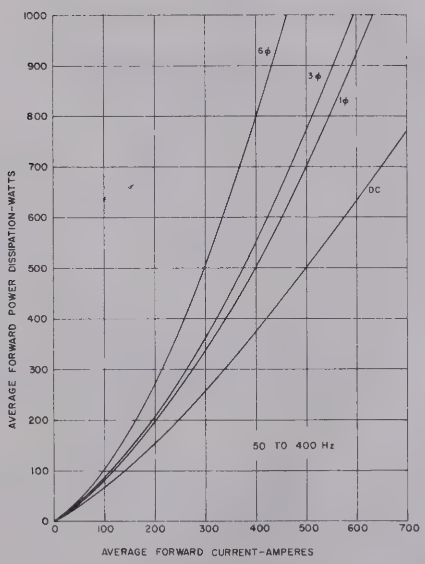
1. MAXIMUM FORWARD CHARACTERISTICS



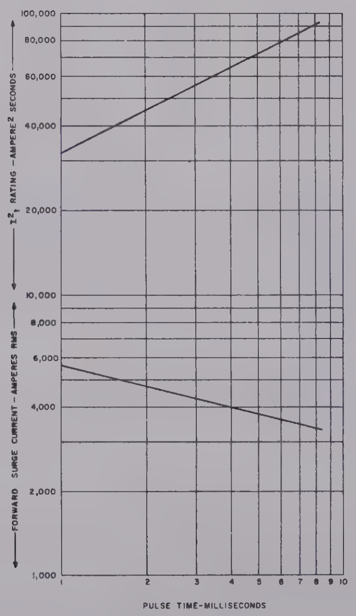
2. MAXIMUM REVERSE CHARACTERISTICS



3. MAXIMUM CASE TEMPERATURE VS. AVERAGE FORWARD CURRENT



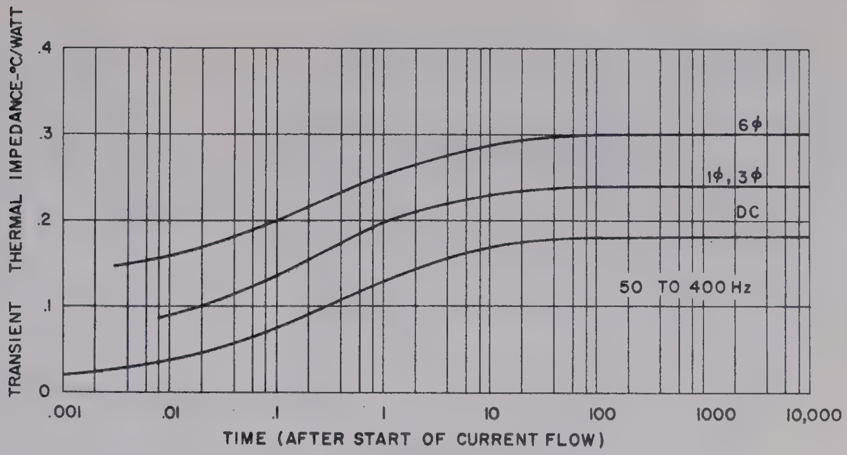
4. AVERAGE FORWARD POWER DISSIPATION VS. AVERAGE FORWARD CURRENT



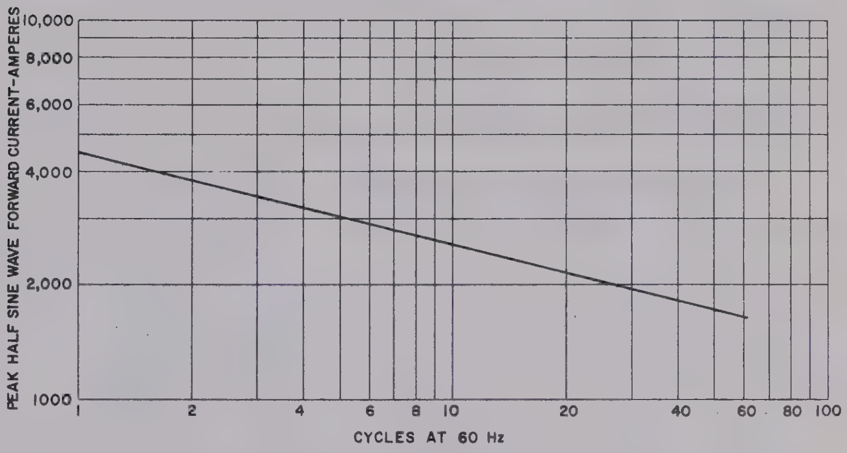
5. SUBCYCLE SURGE FORWARD CURRENT AND I^2t RATING VS. PULSE TIME FOLLOWING RATED LOAD CONDITIONS

DEVICE SPECIFICATIONS

6. TRANSIENT THERMAL IMPEDANCE—JUNCTION-TO-CASE

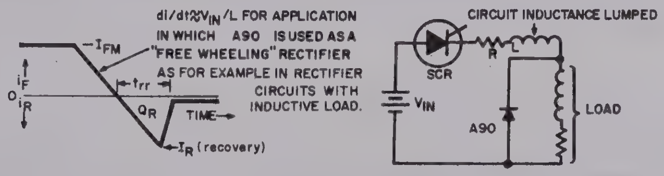


7. MAXIMUM SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS



RECOVERY SPECIFICATIONS AND INFORMATION

In most power circuits where the rectifier reverse loop, L/R, is large, the A90 recovery characteristics are essentially as shown below:



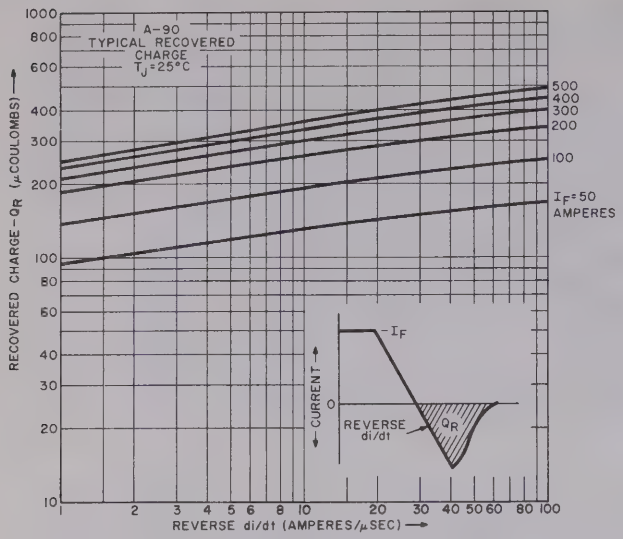
$di/dt \approx V_{IN}/L$ FOR APPLICATION IN WHICH A90 IS USED AS A "FREE WHEELING" RECTIFIER AS FOR EXAMPLE IN RECTIFIER CIRCUITS WITH INDUCTIVE LOAD.

$di/dt \approx 2\pi f I_{FM}$ WHEN A90 IS USED IN RECTIFIER CIRCUITS WITH SINUSOIDAL INPUT VOLTAGES AND RESISTIVE LOADS.

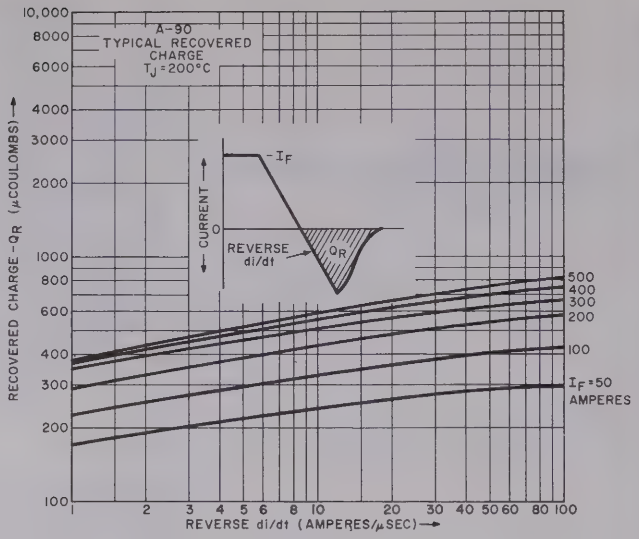
From the curves (Figures 8 and 9) of typical recovered charge, Q_R, the recovery time, t_{rr}, and peak recovery current (as defined above), I_R (recovery), may be very closely approximated by using the following formulas if I_{FM}, di/dt, and the A90 operating junction temperature are known.

$$I_R\text{ (recovery)} = \sqrt{2\,Q_R\,di/dt} \qquad t_{rr} = \sqrt{\frac{2\,Q_R}{di/dt}}$$

Note: At high values of di/dt, reverse voltage transients may be generated that will destroy the A90; especially with high values of I_{FM} and T_J. In these cases, R-C suppression should be connected across the A90. Refer to Application Note 200.42 for further information on the R-C Suppression circuit.



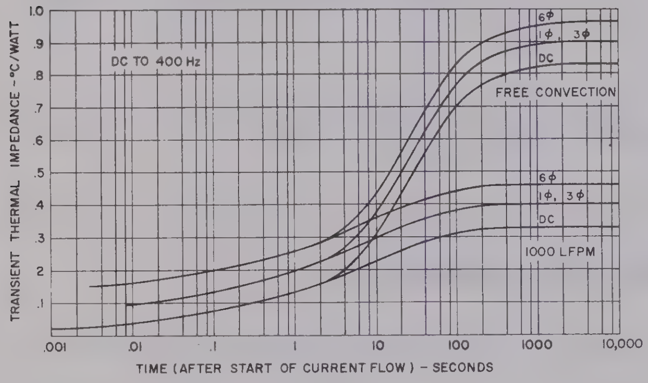
8. TYPICAL RECOVERED CHARGE (T_J = 25°C)



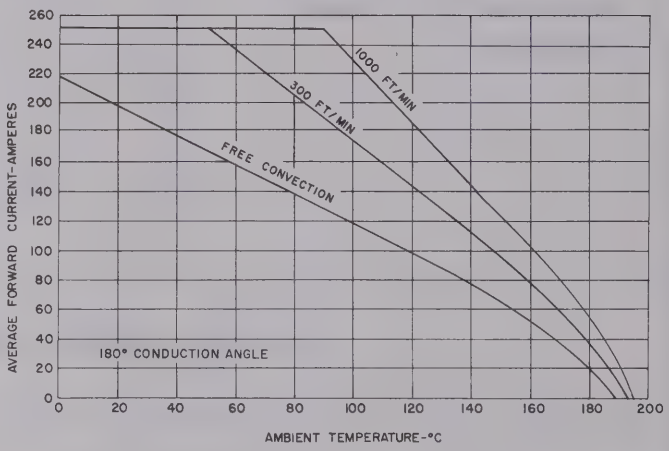
9. TYPICAL RECOVERED CHARGE (T_J = 200°C)

MAXIMUM CIRCUIT RATINGS

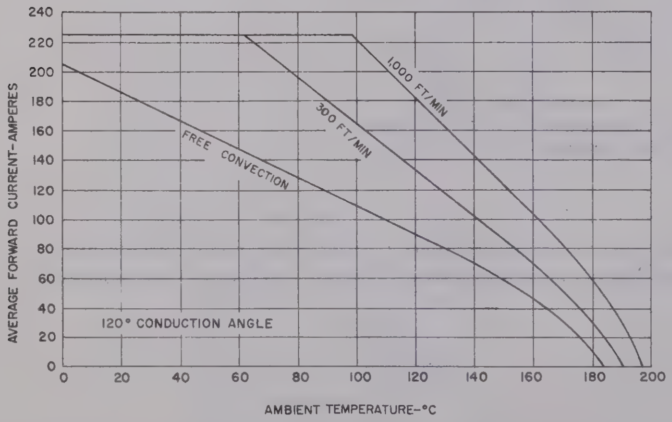
Device Mounted On A 5"x5"x6" Aluminum Extrusion (GE #15)



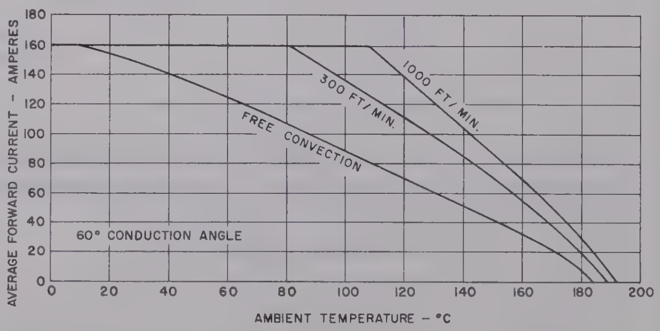
10. TRANSIENT THERMAL IMPEDANCE—JUNCTION-TO-AMBIENT



11. SINGLE-PHASE, HALF-WAVE FORWARD CURRENT VS. AMBIENT TEMPERATURE



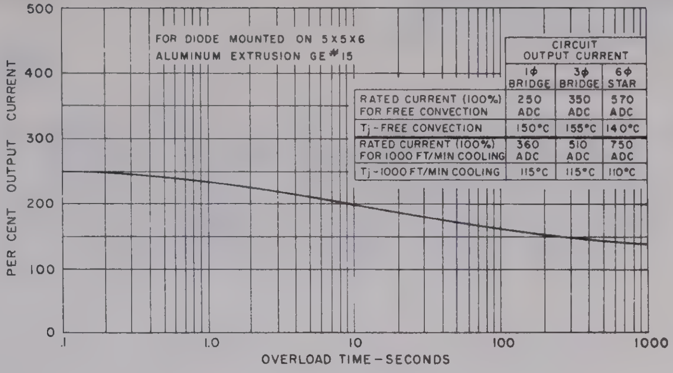
12. THREE-PHASE FORWARD CURRENT VS. AMBIENT TEMPERATURE



13. SIX-PHASE FORWARD CURRENT VS. AMBIENT TEMPERATURE

RECURRENT OVERLOAD RATINGS

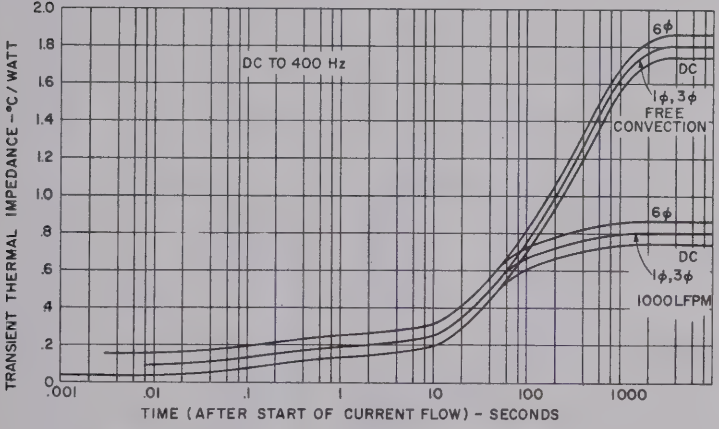
14. RECURRENT OVERLOAD CURVE MEETING NEMA STANDARDS FOR "GENERAL PURPOSE RECTIFIER EQUIPMENTS UNDER 100 KW", AT 40°C AMBIENT (FOR OVERLOAD CONDITIONS OTHER THAN AS SHOWN REFER TO APPLICATION NOTE 200.9)



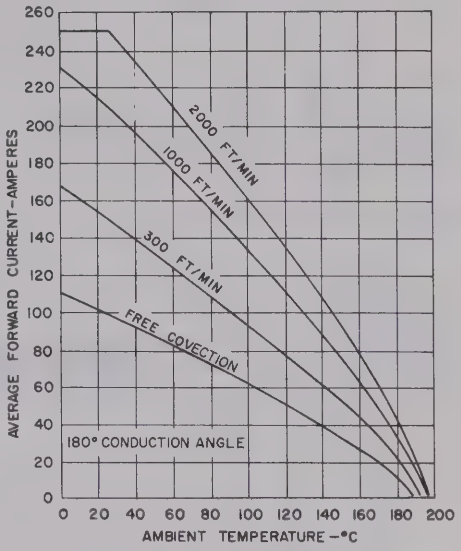
	CIRCUIT OUTPUT CURRENT		
	1ϕ BRIDGE	3ϕ BRIDGE	6ϕ STAR
RATED CURRENT (100%) FOR FREE CONVECTION	250 ADC	350 ADC	570 ADC
T_j - FREE CONVECTION	150°C	155°C	140°C
RATED CURRENT (100%) FOR 1000 FT/MIN COOLING	360 ADC	510 ADC	750 ADC
T_j - 1000 FT/MIN COOLING	115°C	115°C	110°C

MAXIMUM CIRCUIT RATINGS

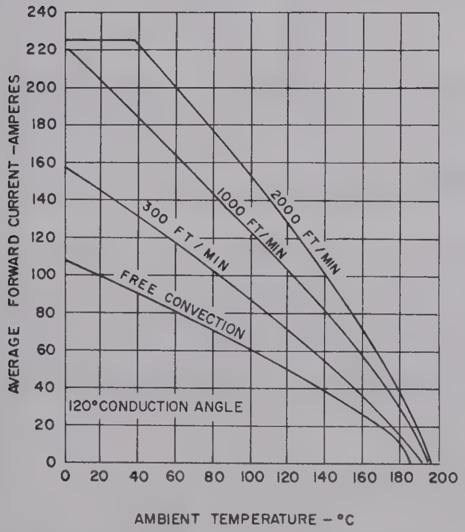
Device Mounted On A 7"x7"x⅜" Aluminum Fin (GE #13) or A 7"x7"x¼" Copper Fin
Minimum Fin Spacing 1 Inch — Fins Mounted Vertically or Parallel to Forced Air Flow



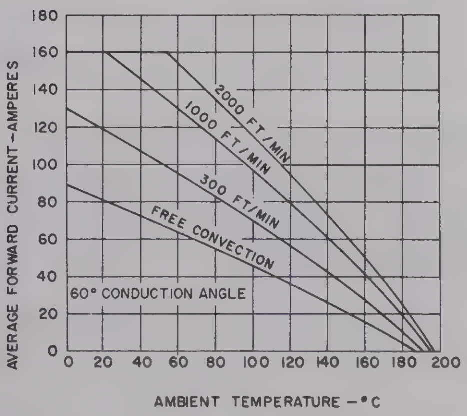
15. TRANSIENT THERMAL IMPEDANCE—JUNCTION-TO-AMBIENT



16. SINGLE-PHASE, HALF-WAVE FORWARD CURRENT VS. AMBIENT TEMPERATURE



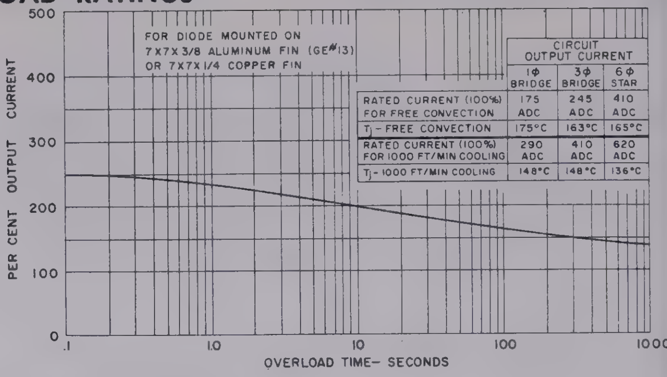
17. THREE-PHASE FORWARD CURRENT VS. AMBIENT TEMPERATURE



18. SIX-PHASE FORWARD CURRENT VS. AMBIENT TEMPERATURE

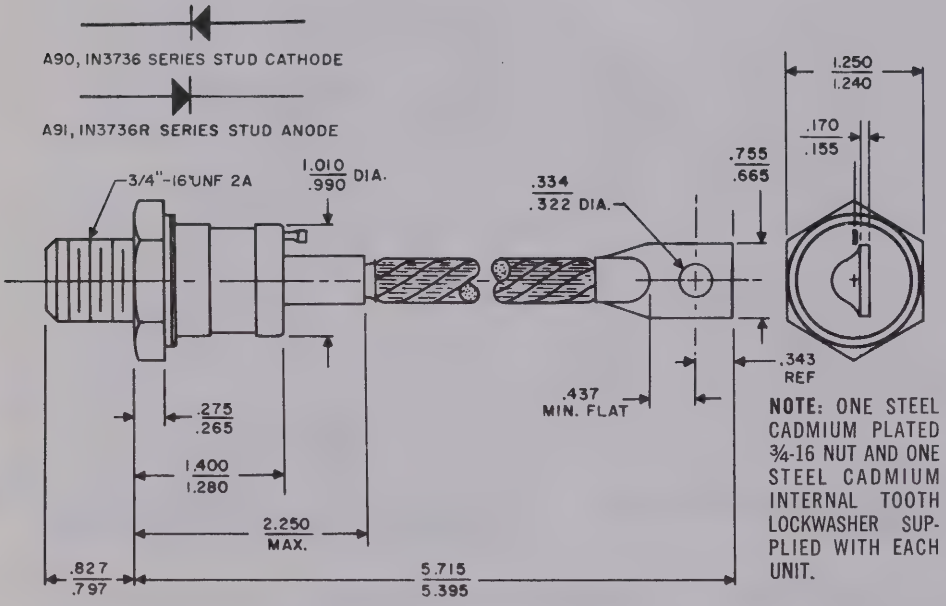
RECURRENT OVERLOAD RATINGS

19. RECURRENT OVERLOAD CURVE MEETING NEMA STANDARDS FOR "GENERAL PURPOSE RECTIFIER EQUIPMENTS UNDER 100 KW," at 40°C AMBIENT (FOR OVERLOAD CONDITIONS OTHER THAN AS SHOWN REFER TO APPLICATION NOTE 200.9)



	CIRCUIT OUTPUT CURRENT		
	1φ BRIDGE	3φ BRIDGE	6φ STAR
RATED CURRENT (100%) FOR FREE CONVECTION	175 ADC	245 ADC	410 ADC
T_j – FREE CONVECTION	175°C	163°C	165°C
RATED CURRENT (100%) FOR 1000 FT/MIN COOLING	290 ADC	410 ADC	620 ADC
T_j - 1000 FT/MIN COOLING	148°C	148°C	136°C

OUTLINE DRAWING


A90, IN3736 SERIES STUD CATHODE
A91, IN3736R SERIES STUD ANODE
3/4"-16 UNF 2A
1.010
.990
DIA.
.334
.322 DIA.
.755
.665
.170
.155
1.250
1.240
.343
REF
.437
MIN. FLAT
.275
.265
1.400
1.280
2.250
MAX.
.827
.797
5.715
5.395

NOTE: ONE STEEL CADMIUM PLATED ¾-16 NUT AND ONE STEEL CADMIUM INTERNAL TOOTH LOCKWASHER SUPPLIED WITH EACH UNIT.

Device Configuration complies with EIA Registered Outline DO-9

CONVERSION TABLE

Inches	Millimeters
.155	3.936
.170	4.318
.265	6.730
.275	6.985
.322	8.178
.334	8.483
.343	8.712
.437	11.099
.665	16.890
.755	19.177
.797	20.243
.827	21.006
.990	25.145
1.010	25.654
1.240	31.495
1.250	31.750
1.280	32.511
1.400	35.560
2.250	57.149
5.395	137.031
5.715	145.160

INSTALLATION INSTRUCTIONS

Following these installation instructions will result in a rectifier diode-to-heatsink contact thermal resistance of 0.08°C/watt.

(1) Be sure mounting surface is clean, and flat within .001 inch/inch.

(2) Mounting hole diameter should not exceed the outside diameter of the rectifier diode stud by more than 1/16 inch, and should be de-burred.

(3) Use Burndy's Penetrox "A", or equivalent, on mounting surfaces that come in contact with the heatsink.

(4) Use only hardware furnished with each rectifier diode.

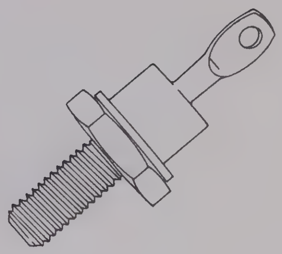
(5) Tighten with a torque wrench, from nut side, to 300 lb-in.

Silicon
Rectifier
FAST RECOVERY

IN3879-83,R

Features:

- Fast Recovery Time . . . 200 Nanoseconds Maximum
- Diffused Construction
- For Use in:
  - — Inverters
  - — Choppers
  - — Low RF Interference Applications
  - — Free-Wheeling Rectifier Applications
  - — Sonar Power Supplies
  - — Ultrasonic Systems
  - — DC-DC Power Supplies



maximum allowable ratings (Resistive or Inductive Load)

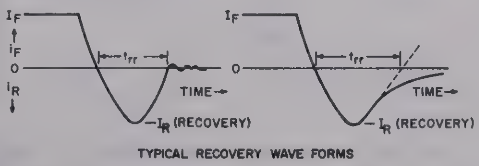
	1N3879,R	1N3880,R	1N3881,R	1N3882,R	1N3883,R	
*Maximum Repetitive Peak Reverse Voltage, $T_J = -65°C$ to $+150°C$, V_{RM} (rep) (Note 1)	50	100	200	300	400	Volts
Maximum RMS Voltage, $T_J = -65°C$ to $+150°C$, V_r (Note 1)	35	70	140	210	280	Volts
*Maximum DC Blocking Voltage, $T_J = -65°C$ to $+100°C$, V_R (Note 1)	50	100	200	300	400	Volts
*Maximum Average Forward Current, Single Phase, $T_C = +100°C$, I_O	6 Amperes					
*Maximum Peak One Cycle Surge Current, 60 Cycle, Non-Recurrent, $T_J = -65°C$ to $+150°C$, I_{FM}(surge)	75 Amperes					
*Maximum Peak Ten Cycle Surge Current, 60 Cycle, Non-Recurrent, $T_J = -65°C$ to $+150°C$, I_{FM}(surge)	35 Amperes					
*Maximum Forward Voltage Drop, $I_F = 6$ A DC, $T_C = +25°C$, V_F	1.4 Volts					
*Maximum Reverse Current at Full Load, Single Phase Full-Cycle Average, $I_O = 6$ Amp at $T_C = +100°C$, $I_{R(AV)}$	3.0 mA					
*Maximum DC Reverse Current at Rated DC Blocking Voltage, V_R, and $T_C = +100°C$, I_R	1.0 mA					
*Maximum DC Reverse Current at Rated DC Blocking Voltage, V_R, and $T_C = +25°C$, I_R	15 μA					
*Junction Operating Temperature Range, T_J	−65°C to +150°C					
*Storage Temperature Range, T_{stg}	−65°C to +175°C					
*Stud Torque	15 in-lbs. Maximum					
*Maximum Reverse Recovery Characteristics: (See figure below) Recovery Time, t_{rr}	200 Nanoseconds Maximum					
Peak Recovery Current, I_R (recovery) (Note 2)	2.0 Amperes Maximum					

*The asterisk denotes JEDEC (EIA) registered information.

test conditions

These rectifiers are factory tested to reverse recovery limits which correlate with EIA registered values. This testing is in accordance with NEMA-EIA recommendations for silicon rectifier diodes and stacks.

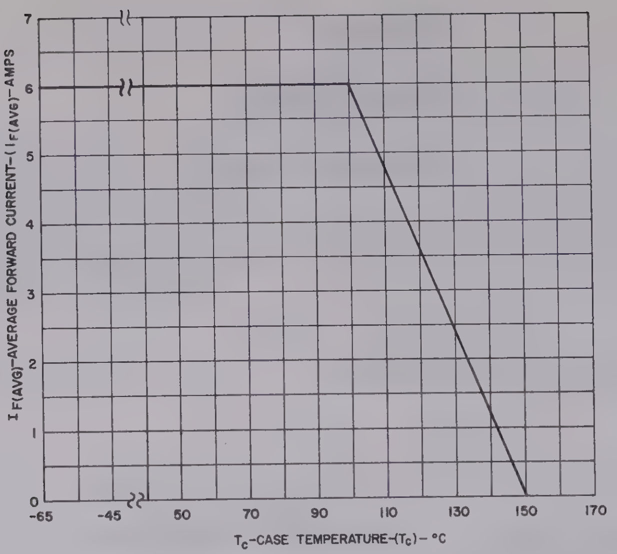
Recovery characteristic test conditions: $I_{FM} = 5.0$ amps; di/dt = 50 amps/μsec switching rate, and a reverse bias of 50% V_R for 200, 300 and 400 volt grades or 100% V_R for 50 and 100 volt grades; $T_C = 25°C$; $t_{rr} = 150$ nanoseconds; and I_R (recovery) = 5.0 amperes max.



TYPICAL RECOVERY WAVE FORMS

NOTES:

1. Rating assumes rectifier heatsink ≦6°C/W at max. T_J.
2. Some manufacturers call this Overshoot Current and use the symbol I_{OS}.

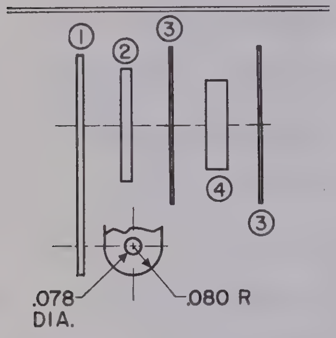


1. Forward Current Rating vs. Case Temperature

NOTE: Case temperature is measured at the center of any flat on the hex base.

OUTLINE DRAWING

INSULATING HARDWARE KIT*


①
②
③
④
③
.078 DIA.
.080 R

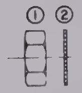
① COPPER TERMINAL, .016 THICK, TIN PLATED

② BRASS WASHER, .035 THICK NICKEL PLATED

③ MICA WASHERS, TWO, .625 O.D., .204 I.D., .005 THICK

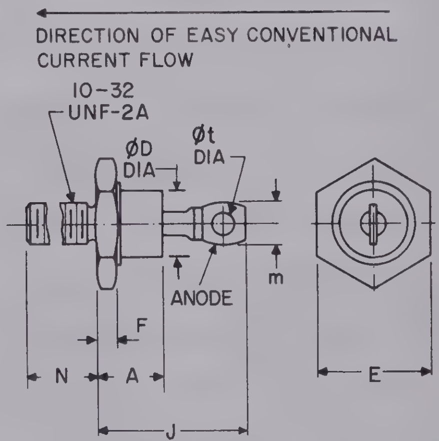
④ TEFLON WASHER, .270 O.D. .204 I.D., .050 THICK

* AVAILABLE UPON REQUEST



① 10-32 STEEL NUT CADMIUM PLATED

② LOCKWASHER, CADMIUM PLATED STEEL


DIRECTION OF EASY CONVENTIONAL CURRENT FLOW
10-32 UNF-2A
ØD DIA
Øt DIA
ANODE
m
F
N
A
J
E

COMPLIES WITH
EIA REGISTERED OUTLINE DO-4

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A		.405		10.29	
ϕD		.424		10.77	
E	.424	.437	10.77	11.10	
F	.075	.175	1.91	4.45	
J		.800		20.32	
m		.250		6.35	1
N	.422	.453	10.72	11.51	
ϕt	.060		1.52		
W					2

NOTES:
1. Angular orientation of this terminal is undefined.
2. 10-32 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter (.1697", 4.29 MM) Ref. (Screw thread standards for Federal Services 1957) Handbook H28 1957 P1.

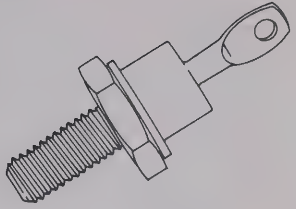
Silicon
Rectifier

FAST RECOVERY

IN3889-93,R

Features:

- Fast Recovery Time . . . 200 Nanoseconds Maximum
- Diffused Construction
- For Use in:
  - — Inverters
  - — Choppers
  - — Low RF Interference Applications
  - — Free-Wheeling Rectifier Applications
  - — Sonar Power Supplies
  - — Ultrasonic Systems
  - — DC-DC Power Supplies



maximum allowable ratings (Resistive or Inductive Load)

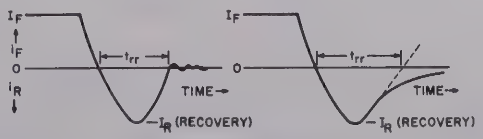
	1N3889,R	1N3890,R	1N3891,R	1N3892,R	1N3893,R	
*Maximum Repetitive Peak Reverse Voltage, $T_J = -65°C$ to $+150°C$, V_{RM} (rep) (Note 1)	50	100	200	300	400	Volts
Maximum RMS Voltage, $T_J = -65°C$ to $+150°C$, V_r (Note 1)	35	70	140	210	280	Volts
*Maximum DC Blocking Voltage, $T_J = -65°C$ to $+100°C$, V_R (Note 1)	50	100	200	300	400	Volts
*Maximum Average Forward Current, Single Phase, $T_C = +100°C$, I_O	←12 Amperes→					
*Maximum Peak One Cycle Surge Current, 60 Cycle, Non-Recurrent, $T_J = -65°C$ to $+150°C$, I_{FM} (surge)	←150 Amperes→					
*Maximum Peak Ten Cycle Surge Current, 60 cycle, Non-Recurrent, $T_J = -65°C$ to $+150°C$, I_{FM} (surge)	←70 Amperes→					
*Maximum Forward Voltage Drop, $I_F = 12$ ADC, $T_C = +25°C$, V_F	←1.4 Volts→					
*Maximum Reverse Current at Full Load, Single Phase Full-Cyle Average, $I_O = 12$ Amp. at $T_C = +100°C$, $I_{R(AV)}$	←5.0 mA→					
*Maximum DC Reverse Current at Rated DC Blocking Voltage, V_R, and $T_C = +100°C$, I_R	←3.0 mA→					
*Maximum DC Reverse Current at Rated DC Blocking Voltage, V_R, and $T_C = +25°C$, I_R	←25 μA→					
*Junction Operating Temperature Range, T_J	←-65°C to +150°C→					
*Storage Temperature Range, T_{stg}	←-65°C to +175°C→					
*Stud Torque	←15 in-lbs. Maximum→					
*Maximum Reverse Recovery Characteristics: (See figure below) Recovery Time, t_{rr}	←200 Nanoseconds Maximum→					
Peak Recovery Current, I_R (recovery) (Note 2)	←2.0 Amperes Maximum→					

*The asterisk denotes JEDEC (EIA) registered information.

test conditions

These rectifiers are factory tested to reverse recovery limits which correlate with EIA registered values. This testing is in accordance with NEMA-EIA recommendations for silicon rectifier diodes and stacks.

Recovery characteristic test conditions: $I_{FM} = 5.0$ amps; di/dt = 50 amps/μsec switching rate, and a reverse bias of 50% V_R for 200, 300 and 400 volt grades or 100% V_R for 50 and 100 volt grades; $T_C = 25°C$; $t_{rr} = 150$ nanoseconds; and I_R (recovery) = 5.0 amperes max.

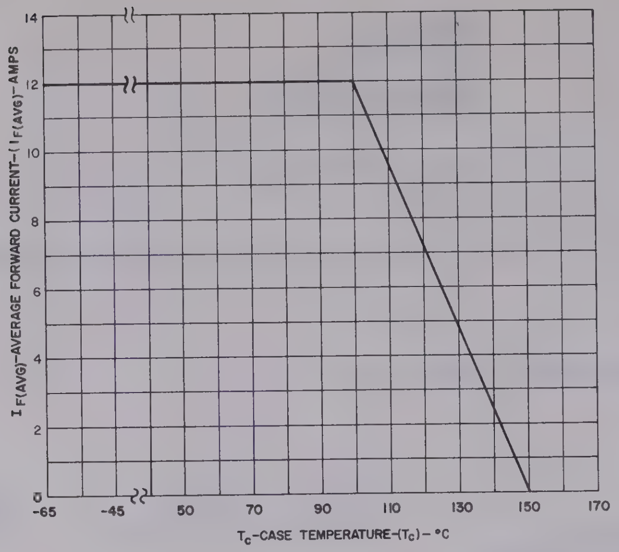


TYPICAL RECOVERY WAVE FORMS

TYPICAL RECOVERY WAVE FORMS

NOTES:

1. Rating assumes rectifier heatsink ≦6°C/W at max. T_J.
2. Some manufacturers call this Overshoot Current and use the symbol I_{OS}.

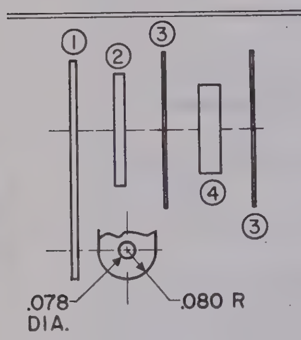


1. Forward Current Rating vs. Case Temperature

NOTE: Case temperature is measured at the center of any flat on the hex base.

OUTLINE DRAWING

INSULATING HARDWARE KIT *


①
②
③
④
③
.078 DIA.
.080 R

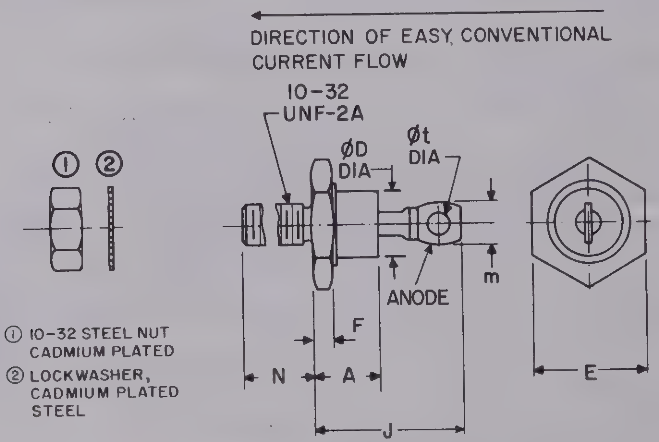
① COPPER TERMINAL, .016 THICK, TIN PLATED

② BRASS WASHER, .035 THICK NICKEL PLATED

③ MICA WASHERS, TWO, .625 O.D., .204 I.D., .005 THICK

④ TEFLON WASHER, .270 O.D. .204 I.D., .050 THICK

* AVAILABLE UPON REQUEST


DIRECTION OF EASY CONVENTIONAL CURRENT FLOW
10-32 UNF-2A
ØD DIA
Øt DIA
①
②
ANODE
m
F
N
A
J
E

① 10-32 STEEL NUT CADMIUM PLATED

② LOCKWASHER, CADMIUM PLATED STEEL

COMPLIES WITH
EIA REGISTERED OUTLINE DO-4

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A		.405		10.29	
ϕD		.424		10.77	
E	.424	.437	10.77	11.10	
F	.075	.175	1.91	4.45	
J		.800		20.32	
m		.250		6.35	1
N	.422	.453	10.72	11.51	
ϕt	.060		1.52		
W					2

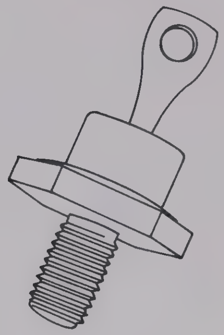
NOTES:
1. Angular orientation of this terminal is undefined.
2. 10-32 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter (.1697", 4.29 MM) Ref. (Screw thread standards for Federal Services 1957) Handbook H28 1957 P1.

Silicon
Diodes

1N3899-903,R

Features:

- Fast Recovery Time—200 Nanoseconds Maximum
- Recovery Characteristics match the High Frequency capability of the new General Electric High Speed SCR's such as the C140 and 141, the C155 and C185
- For Use in:
  - — Inverters
  - — Choppers
  - — Low RF Interference Applications
  - — Free-Wheeling Rectifier Applications
  - — Sonar Power Supplies
  - — Ultrasonic Systems
  - — DC-DC Power Supplies



maximum allowable ratings (Resistive or Inductive Load)

	1N3899,R	1N3900,R	1N3901,R	1N3902,R	1N3903,R	
*Maximum Repetitive Peak Reverse Voltage, $T_J = -65°C$ to $+150°C$, V_{RM} (rep) (Note 1)	50	100	200	300	400	Volts
Maximum RMS Voltage, $T_J = -65°C$ to $+150°C$, V_r	35	70	140	210	280	Volts
*Maximum DC Blocking Voltage, $T_J = -65°C$ to $+100°C$, V_R (Note 1)	50	100	200	300	400	Volts
*Maximum Average Forward Current, Single Phase, $T_C = +100°C$, I_O	← 20 Amperes →					
*Maximum Peak One Cycle Surge Current, 60 cycle, Non-Recurrent, $T_J = -65°C$ to $+150°C$, I_{FM} (surge)	← 225 Amperes →					
*Maximum Peak Ten Cycle Surge Current, 60 cycle, Non-Recurrent, $T_J = -65°C$ to $+150°C$, I_{FM} (surge)	← 120 Amperes →					
*Maximum Forward Voltage Drop, $I_F = 20$ ADC, $T_C = +25°C$, V_F	← 1.4 Volts →					
*Maximum Reverse Current at Full Load, Single Phase Full-Cycle Average, $I_O = 20$ Amp. at $T_C = +100°C$, $I_{R(AV)}$	← 10.0 mA →					
Maximum Effective Thermal Resistance (Junction to Case), $\theta_{J\text{-}C}$	← 1.5° C/W →					
*Maximum DC Reverse Current at Rated DC Blocking Voltage, V_R, and $T_C = +100°C$, I_R	← 6.0 mA →					
*Maximum DC Reverse Current at Rated DC Blocking Voltage, V_R and $T_C = +25°C$, I_R	← 50 μA →					
*Junction Operating Temperature Range, T_J	← −65°C to +150°C →					
*Storage Temperature Range, T_{stg}	← −65°C to +175°C →					
*Stud Torque	← 30 in-lbs. Maximum →					
*Maximum Reverse Recovery Characteristics:						
Recovery Time (Note 2), t_{rr}	← 200 Nanoseconds Maximum →					
Peak Recovery Current (Note 2), I_R (recovery) (or Overshoot Current, I_{OS})	← 3.0 Amperes Maximum →					

*The asterisk denotes JEDEC (EIA) registered information.

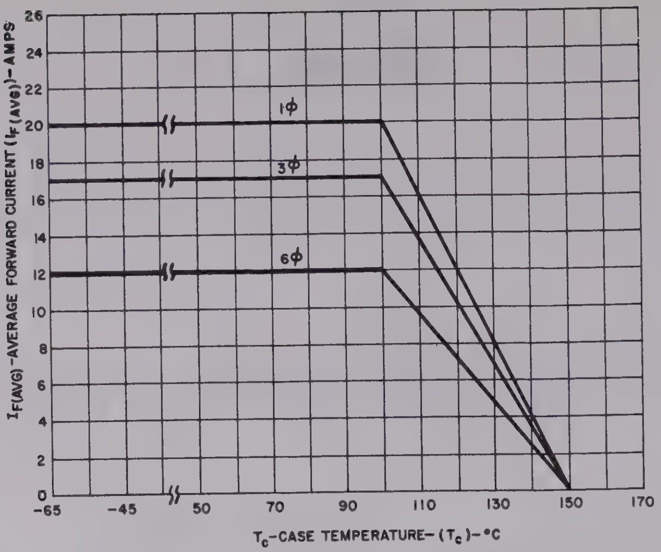
NOTES:

. The ratings assume the rectifier heatsink thermal resistance to be 6°C/W or less at maximum junction temperature.

. These rectifiers are factory tested to reverse recovery limits which correlate with EIA registered values. This testing is in accordance with NEMA-EIA recommendations for silicon rectifier diodes and stacks.

Recovery characteristic test conditions: $I_{FM} = 5.0$ amps; di/dt = 50 amps/μsec switching rate, and a reverse bias of 50% V_R for 200, 300 and 400 volt grades or 100% V_R for 50 and 100 volt grades; $T_C = 25°C$; $t_{rr} = 150$ nanoseconds; and I_R (recovery) = 6.0 amperes max.

1N3899-903,R

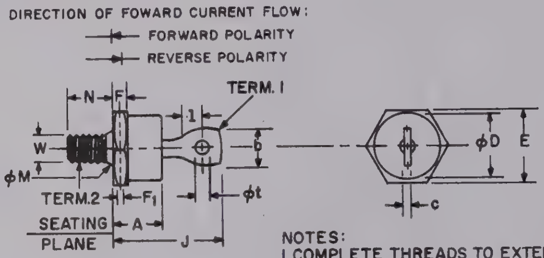


1. Forward Current Rating vs. Case Temperature

Note: Case temperature, T$_C$, is measured at center of any flat on hex base.

OUTLINE DRAWING

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A		.450		11.43	
b		.375		9.53	2
c		.080		2.03	
φD		.667		16.94	
E	.667	.687	16.94	17.45	
F	.115	.200	2.92	5.08	
F$_1$	.060		1.52		
J		1.000		25.40	
1	.156		3.96		4
φM	.220	.249	5.59	6.32	1
N	.422	.453	10.72	11.51	
φt	.140	.175	3.56	4.45	
W					1,3



DIRECTION OF FOWARD CURRENT FLOW:
FORWARD POLARITY
REVERSE POLARITY
N
F
TERM. 1
1
W
b
φM
TERM.2
F$_1$
φt
SEATING PLANE
A
J
φD
E
c

NOTES:
1. COMPLETE THREADS TO EXTEND TO WITHIN 2-1/2 THREADS OF SEATING PLANE.
2. ANGULAR ORIENTATION OF TERMINAL IS UNDEFINED.
3. 1/4-28 UNF-2A. MAXIMUM PITCH DIAMETER OF PLATED THREADS SHALL BE BASIC PITCH DIAMETER (.2268", 5.74 MM) REF. (SCREW THREAD STANDARDS FOR FEDERAL SERVICES 1957) HANDBOOK H28 1957 P1.
4. MINIMUM FLAT.

EIA-NEMA STANDARD OUTLINE, NEMA SK-51 - EIA RS-241.
INSULATING HARDWARE IS AVAILABLE UPON REQUEST.

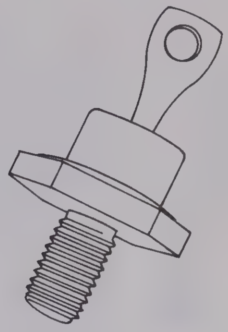
COMPLIES WITH EIA REGISTERED OUTLINE DO-5

Fast Recovery Rectifiers

1N3909-13,R

Features:

- Fast Recovery Time—200 Nanoseconds Maximum
- Recovery Characteristics match the High Frequency capability of the new General Electric High Speed SCR's such as the C140 and 141, the C155 and C185
- For Use in:
  - — Inverters
  - — Choppers
  - — Low RF Interference Applications
  - — Free-Wheeling Rectifier Applications
  - — Sonar Power Supplies
  - — Ultrasonic Systems
  - — DC-DC Power Supplies



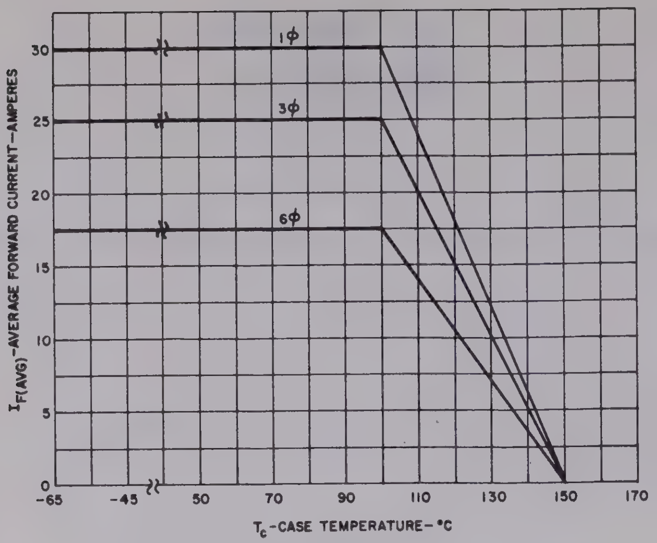
maximum allowable ratings (Resistive or Inductive Load)

	1N3909,R	1N3910,R	1N3911,R	1N3912,R	1N3913,R	
*Maximum Repetitive Peak Reverse Voltage, $T_J = -65°C$ to $+150°C$, V_{RM}(rep) (Note 1)	50	100	200	300	400	Volts
Maximum RMS Voltage, $T_J = -65°C$ to $+150°C$, V_r	35	70	140	210	280	Volts
*Maximum DC Blocking Voltage, $T_J = -65°C$ to $+100°C$, V_R (Note 1)	50	100	200	300	400	Volts
*Maximum Average Forward Current, Single Phase, $T_C = +100°C$, I_O	← 30 Amperes →					
*Maximum Peak One Cycle Surge Current, 60 cycle, Non-Recurrent, $T_J = -65°C$ to $+150°C$, I_{FM} (surge)	← 300 Amperes →					
*Maximum Peak Ten Cycle Surge Current, 60 cycle, Non-Recurrent, $T_J = -65°C$ to $+150°C$, I_{FM} (surge)	← 160 Amperes →					
*Maximum Forward Voltage Drop, $I_F = 30$ ADC, $T_C = +25°C$, V_F	← 1.4 Volts →					
*Maximum Reverse Current at Full Load, Single Phase Full-Cycle Average, $I_O = 30$ Amp. at $T_C = +100°C$, $I_{R(AV)}$	← 15.0 mA →					
Maximum Effective Thermal Resistance (Junction to Case), $\theta_{J\text{-}C}$	← 1.0° C/W →					
*Maximum DC Reverse Current at Rated DC Blocking Voltage, V_R, and $T_C = +100°C$, I_R	← 10.0 mA →					
*Maximum DC Reverse Current at Rated DC Blocking Voltage, V_R, and $T_C = +25°C$, I_R	← 80 μA →					
*Junction Operating Temperature Range, T_J	← −65°C to +150°C →					
*Storage Temperature Range, T_{stg}	← −65°C to +175°C →					
*Stud Torque	← 30 in-lbs. Maximum →					
*Maximum Reverse Recovery Characteristics: Recovery Time (Note 2), t_{rr}	← 200 Nanoseconds Maximum →					
Peak Recovery Current (Note 2), I_R (recovery) (or Overshoot Current, I_{OS})	← 3.0 Amperes Maximum →					

*The asterisk denotes JEDEC (EIA) registered information.

NOTES:

1. The ratings assume the rectifier heatsink thermal resistance to be 6°C/W or less at maximum junction temperature.
2. These rectifiers are factory tested to reverse recovery limits which correlate with EIA registered values. This testing is in accordance with NEMA-EIA recommendations for silicon rectifier diodes and stacks.
   Recovery characteristic test conditions: $I_{FM} = 5.0$ amps; di/dt = 50 amps/μsec switching rate, and a reverse bias of 50% V_R for 200, 300 and 400 volt grades or 100% V_R for 50 and 100 volt grades; $T_C = 25°C$; $t_{rr} = 150$ nanoseconds; and I_R (recovery) = 6.0 amperes max.

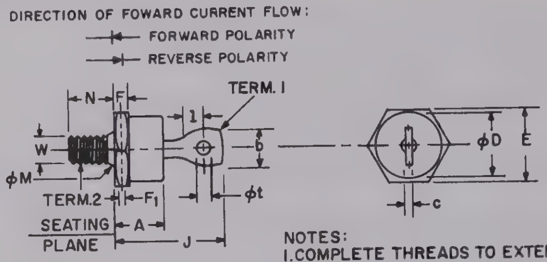


1. Forward Current Rating vs. Case Temperature

Note: Case temperature, T_C, is measured at center of any flat on hex base.

OUTLINE DRAWING

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A		.450		11.43	
b		.375		9.53	2
c		.080		2.03	
ϕD		.667		16.94	
E	.667	.687	16.94	17.45	
F	.115	.200	2.92	5.08	
F_1	.060		1.52		
J		1.000		25.40	
1	.156		3.96		4
ϕM	.220	.249	5.59	6.32	1
N	.422	.453	10.72	11.51	
ϕt	.140	.175	3.56	4.45	
W					1,3


DIRECTION OF FOWARD CURRENT FLOW:
FORWARD POLARITY
REVERSE POLARITY
TERM. 1
N
F
1
W
ϕM
b
TERM.2
F_1
ϕt
SEATING PLANE
A
J
ϕD
E
c

NOTES:
1. COMPLETE THREADS TO EXTEND TO WITHIN 2-1/2 THREADS OF SEATING PLANE.
2. ANGULAR ORIENTATION OF TERMINAL IS UNDEFINED.
3. 1/4-28 UNF-2A. MAXIMUM PITCH DIAMETER OF PLATED THREADS SHALL BE BASIC PITCH DIAMETER (.2268", 5.74 MM) REF. (SCREW THREAD STANDARDS FOR FEDERAL SERVICES 1957) HANDBOOK H28 1957 P1.
4. MINIMUM FLAT.

EIA-NEMA STANDARD OUTLINE, NEMA SK-51-EIA RS-241.
INSULATING HARDWARE IS AVAILABLE UPON REQUEST.

COMPLIES WITH EIA REGISTERED OUTLINE DO-5

Silicon
RECTIFIERS

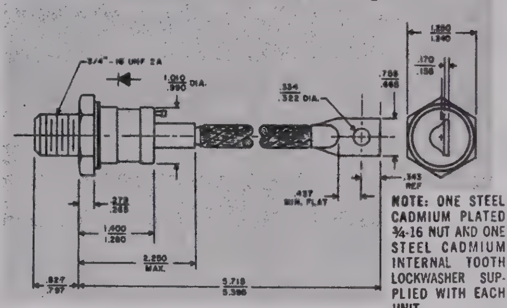
1N4044-56,R

This series of General Electric 275 ampere silicon rectifier diodes are of double-diffused, all hard solder construction.

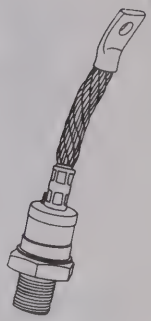
The proven benefits of G. E.'s high current rectifier diodes are:

- Choice of stud anode or stud cathode types
- Thermal fatigue resistant
- Low reverse current
- Great uniformity of product
- Higher surge current capabilities

OUTLINE DRAWING



NOTE: ONE STEEL CADMIUM PLATED ¾-16 NUT AND ONE STEEL CADMIUM INTERNAL TOOTH LOCKWASHER SUPPLIED WITH EACH UNIT.



RATINGS AND SPECIFICATIONS:(1)

	1N4044	1N4045	1N4046	1N4047	1N4048	1N4049	1N4050	1N4051	1N4052	1N4053	1N4054	1N4055	1N4056
*Maximum Allowable Transient Peak Reverse Voltage, V_{RM}(non-rep) (non-repetitive, 8.33 millisecond half sine wave pulse) (2)	100	200	250	300	350	400	525	650	800	925	1050	1175	1300
*Maximum Allowable Working and Repetitive Peak Reverse Voltage, V_{RM}(wkg) & V_{RM}(rep) (3), and DC Blocking Voltage, V_R (4)	50	100	150	200	250	300	400	500	600	700	800	900	1000
*Maximum Allowable Average Forward Current, I_O (single phase, 120°C case temperature)	← 275 amperes →												
*Maximum Allowable Peak One-Cycle Surge Current, I_{FM}(surge) (60 cps single-phase basis, non-repetitive)	← 5000 amperes →												
Minimum I^2t Rating (non-repetitive)	← 50,000 amperes² seconds (see Chart 6) →												
*Maximum Peak Forward Voltage Drop, V_{FM} (I_O=275 amps DC, T_C=120°C)	← 1.35 volts →												
*Maximum Full Load Reverse Current, $I_{R(AV)}$ (full-cycle average, 120°C case temperature, single phase)	← 15 milliamperes →												
Maximum Thermal Resistance, Θ_{J-C} (junction to case)	← 0.18°C/watt →												
*Storage and Junction Operating Temperature, T_C	← −65°C to +190°C →												
Stud Torque(5)—Maximum	← 325 inch-pounds (375 kg-cm) →												
—Minimum	← 275 inch-pounds (320 kg-cm) →												

NOTES: (1)Models listed are stud cathode (forward polarity) types. Order 1N40__R for stud anode (reverse polarity) types. Ratings and specifications are for frequencies from 50 up to 400 cycles/second, except where noted differently.

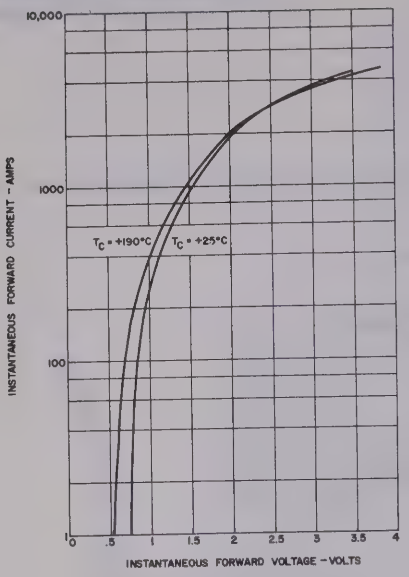
(2)Non-repetitive voltage and current ratings, as contrasted to repetitive ratings, are ratings which apply for occasional or unpredictable overloads. For example, the forward surge current ratings are non-repetitive ratings that are used in fault co-ordination work.

(3)Rating assumes a rectifier diode heat sink dissipation of 2.0°C/watt, or less.

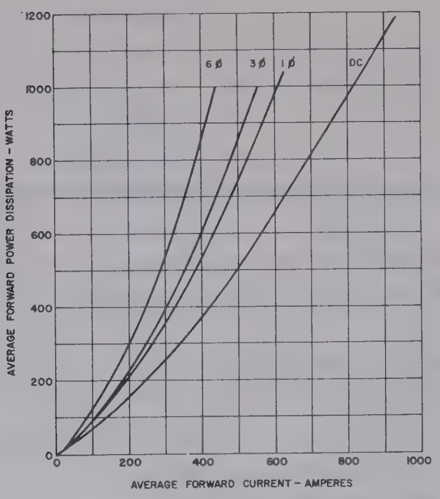
(4)Rating assumes a rectifier diode heat sink dissipation of 1.0°C/watt, or less.

(5)Use of a silicone grease (G-E #G623) between the rectifier base and heat sink is recommended.

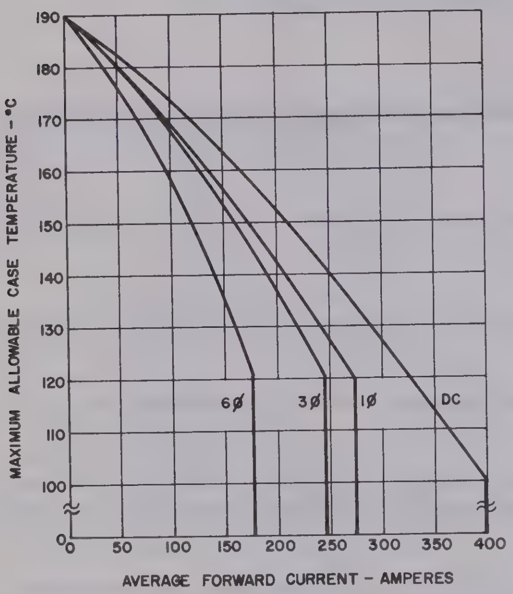
***Indicates JEDEC Registration Parameters.**



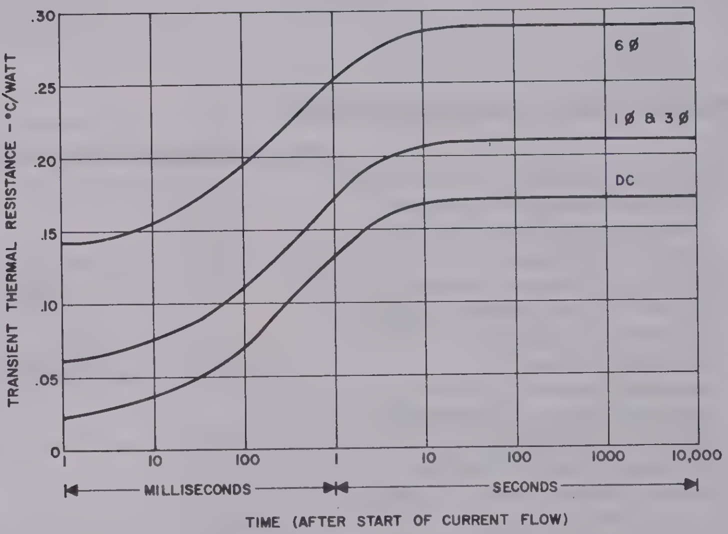
1. MAXIMUM FORWARD CHARACTERISTICS



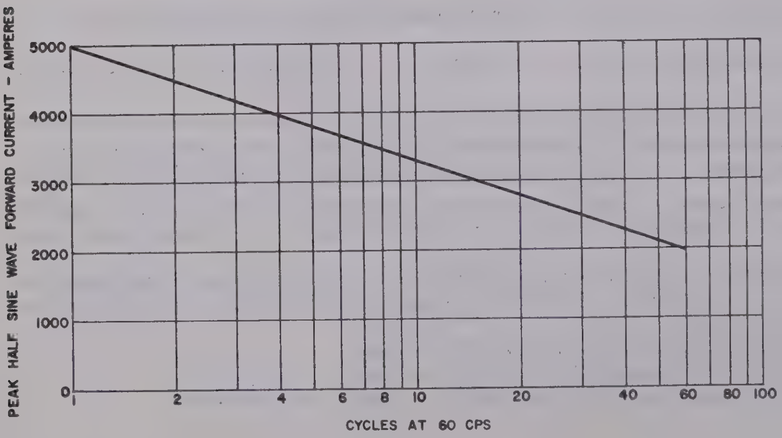
2. AVERAGE FORWARD POWER DISSIPATION VS. AVERAGE FORWARD CURRENT (T_C = +190°C)



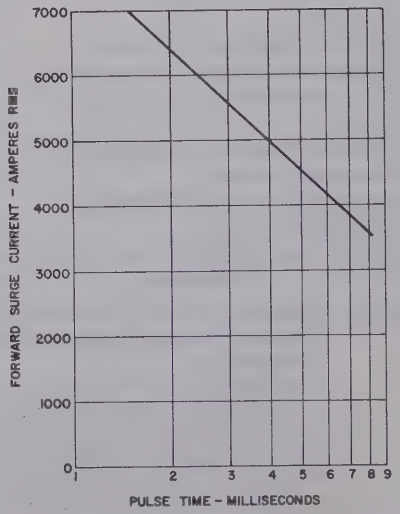
3. MAXIMUM CASE TEMPERATURE VS. AVERAGE FORWARD CURRENT



4. TRANSIENT THERMAL RESISTANCE — JUNCTION TO CASE



5. MAXIMUM SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS (T_C = −65°C TO +190°C)

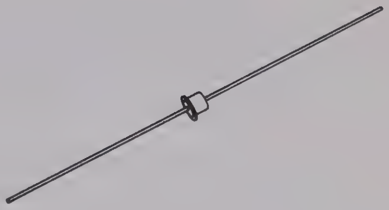


6. SUBCYCLE SURGE FORWARD CURRENT FOLLOWING RATED LOAD CONDITIONS (T_C = −65°C TO +190°C)

Germanium Diode

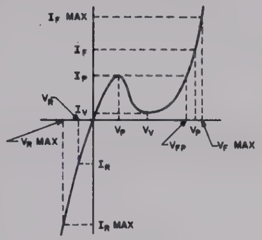
1N4090

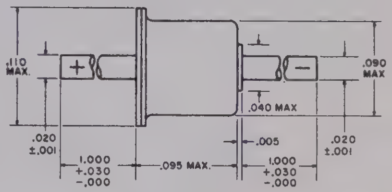
The General Electric Germanium Tunnel Mixer Diode - Type 1N4090 is an alloy-junction Tunnel device designed for use as UHF and microwave mixer. Exhibiting a nonlinear VI characteristic, going through zero at the origin, makes this unit also very attractive for use as low level detector. The 1N4090 features very low capacitance, series resistance, video and I.F. impedances as well as extremely low turn-on and turn-off characteristics. The 1/f noise contribution is much lower than in point-contact mixers.



absolute maximum ratings: (25°C) (unless otherwise specified)

Forward Current (-55° to +100°C)	5 ma
Reverse Current (-55° to +100°C)	5 ma
Lead Temperature 1/16" ± 1/31" from case for 10 seconds	260°C
Storage Temperature Range	- 55°C to +100°C





ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.

electrical characteristics: (25°C) (unless otherwise specified)

		Min.	Typ.	Max.	
Total Terminal Capacitance	C	-	1.0	1.5	pfd
Total Series Resistance	R_s	-	4.5	10.0	
Total Series Inductance	L_s	-	0.2	-	nh
Peak-Point Current	I_p	130	160	180	ua
Peak-Point Voltage	V_p	50	62	75	mv
Forward Voltage at I_F =180 ua	V_{FP}	430	-	-	mv
Forward Voltage at I_F =1 ma	V_F	500	-	-	mv
Reverse Voltage at I_R =2 ma	V_R	80	100	120	mv
Reverse Voltage at I_{Rmax} =5 ma	V_{Rmax}	110	-	250	mv
Forward Voltage at I_{Fmax} =5 ma	V_{Fmax}	520	-	-	mv
Valley Voltage	V_v	275	-	-	mv
Peak to Valley Ratio	I_p/I_v	4:1	-	-	ratio
Recovery Time*	t_r	-	0.1	-	nsec

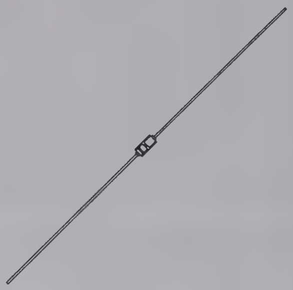
*The recovery time is measured to a reverse current of 1 ma when switching from 0.1 volt forward to 0.4 volt reverse from a 50 source. Since this diode does not exhibit charge storage, the recovery time is determined by the charging time of the total device capacity.

Silicon
Signal Diodes

1N4150
1N4450
1N4606

This family of General Electric Double Heatsink diodes are high conductance, high speed low capacitance switching units for core and hammer driver circuits and general purpose applications. These diodes incorporate an oxide passivated planar structure built in a high resistivity, epitaxial layer grown on a low resistivity substrate.

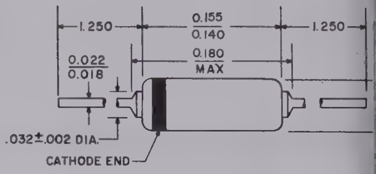
The 1N4150 and 1N4606 feature controlled conductance, with minimum and maximum forward voltages at five levels of forward current. The 1N4450 offers controlled conductance at four levels of I_F from 100μA to 50mA with a maximum voltage of 1.0 volts at 200mA. This closely controlled conductance is necessary for the design of clamping and logic circuits where tight tolerances on voltage levels are required.



absolute maximum ratings: (25°C)

	1N4450	1N4150	1N4606	
Voltage				
Reverse	30	50	70	Volts
Current				
Average Rectified	←	200	→	mA
Recurrent Peak Forward	←	600	→	mA
Forward Steady-State DC	←	250	→	mA
Peak Forward Surge (1 μsec. pulse)	←	4	→	Amps
Power				
Dissipation*	←	500	→	mW
Temperature				
Operating	←	−65 to +200	→	°C
Storage	←	−65 to +200	→	°C

*Derate 2.85 mW/°C for ambient temperatures above 25°C based on a maximum junction temperature of 200°C.



NOTE: ALL DIMENSIONS IN INCHES

electrical characteristics: (25°C) (unless otherwise specified)

		1N4450		1N4150		1N4606		
		Min.	Max.	Min.	Max.	Min.	Max.	
Forward Voltage								
($I_F = 100\mu A$)	V_F	420	540					mV
($I_F = 1mA$)	V_F	520	640	540	620	540	660	mV
($I_F = 10mA$)	V_F	640	720	660	740	650	770	mV
($I_F = 50mA$)†	V_F	800	920	760	860	740	860	mV
($I_F = 100mA$)†	V_F			820	920	790	920	mV
($I_F = 200mA$)†	V_F		1000	870	1000	860	1000	mV
($I_F = 250mA$)†	V_F						1100	mV
Breakdown Voltage								
($I_R = 5\mu A$)	B_V	40						Volts
($I_R = 100\mu A$)	B_V					85		Volts
Reverse Current								
($V_R = 30V$)	I_R		50					nA
($V_R = 30V, T_A = +150°C$)	I_R		50					μA
($V_R = 50V$)	I_R				100		100	nA
($V_R = 50V, T_A = +100°C$)	I_R						25	μA
($V_R = 50V, T_A = +150°C$)	I_R				100			μA
($V_R = 70V$)	I_R						250	nA

electrical characteristics: (25°C) (unless otherwise specified)

		1N4450		1N4150		1N4606		
		Min.	Max.	Min.	Max.	Min.	Max.	
Capacitance ($V_R = 0V$)‡	C_o		4		2.5		2.5	pF
Reverse Recovery Time								
($I_F = I_R = 10$ to 200mA, $I_{rr} = 0.1 I_F$, Fig. 3)	t_{rr}				4			ns
($I_F = I_R = 200$ to 400mA, $I_{rr} = 0.1 I_F$, Fig. 3)	t_{rr}				6			ns
($I_F = 10mA$, $I_R = 1mA$, $I_{rr} = 0.1mA$, Fig. 1)	t_{rr}				6			ns
($I_F = I_R = 10$ mA, $I_{rr} = 1mA$, Figs. 1, 2 & 6)	t_{rr}						6	ns
($I_F = I_R = 10$ to 200mA, $I_{rr} = 0.1 I_F$, Fig. 4)	t_{rr}						4	ns
($I_F = I_R = 200$ to 400mA, $I_{rr} = 0.1 I_F$, Fig. 4)	t_{rr}						6	ns
Forward Recovery Time								
($I_F = 200mA$, $t_r = 0.4$ nsec., $t_p = 100$ nsec., $V_{fr} = 1.0V$, Fig. 5)	t_{fr}				10			ns
Stored Charge (Note 1) ($I_F = 10mA$)§	Q_S		42		42		42	pC

†Pulsed measurement. Pulse width ≤ 300 µsec. Duty Cycle ≤ 2%.

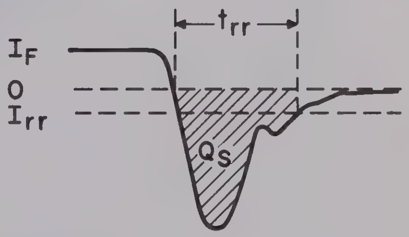
‡Capacitance as measured on Boonton Model 75A capacitance bridge at a signal level of 50 mV and a frequency of 1MHz.

§Stored charge is measured on B-Line Electronics Model QS-3 stored charge meter. Pulse amplitude = 5 volts, pulse width = 50 nsec., rise time = 0.4 nsec., source impedence = 10 ohms.

NOTE: 1: STORED CHARGE

When a forward biased diode is subjected to a reverse voltage step a reverse current will flow for a short time as a result of the stored charge consisting of minority carriers in the vicinity of the junction. The typical waveform of reverse current vs time for a diode subjected to a large reverse voltage is shown in Figure 1. The time required for the diode to recover its reverse blocking condition will depend on the quantity of charge stored and the rate at which the charge is removed by recombination inside the diode and by current flowing in the external circuit. Conventionally, the speed of a diode is characterized by the reverse recovery time, t_{rr}, measured to some arbitrary current level as in Figure 1. However, for higher speed diodes reverse recovery time is not a satisfactory parameter for characterizing the speed of the diode since it is dependent on arbitrary circuit conditions and is very dependent on the construction of the test circuit. Stored charge, on the other hand, is measured by integrating the reverse current of the diode (as shown by the shaded area in Figure 1), and is consequently much less dependent on the construction of the test circuit and on arbitrary circuit conditions. Stored charge is a more ideal parameter for characterizing the speed of a diode since it represents an intrinsic characteristic of the diode and can be measured with good reproducibility on low cost instruments which have direct meter readout.

Stored charge can be correlated with reverse recovery time measurements on a specific t_{rr} test jig. Typical correlation curves are shown on the graph below.



TYPICAL REVERSE RECOVERY WAVEFORM FOR A HIGH SPEED DIODE

Figure 1

References:

(1) JEDEC Proposed Method for Direct Measurement of Diode Stored Charge, JS-2-65-11
(2) "Measurement of Stored Charge in High Speed Diodes," T. P. Sylvan Application Note #90.30 (available on request)

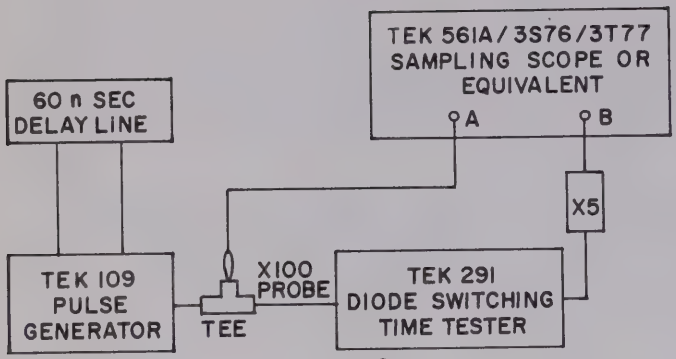
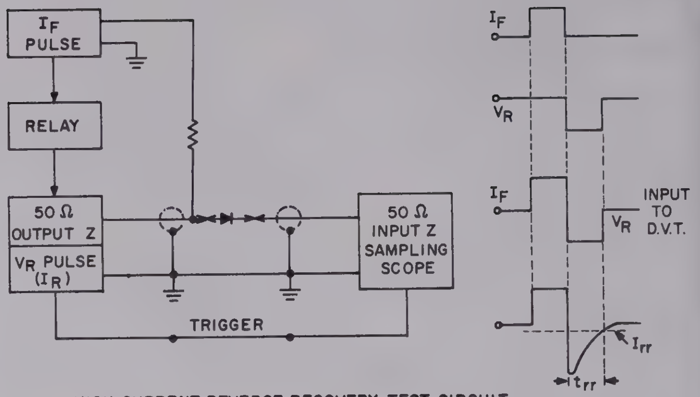
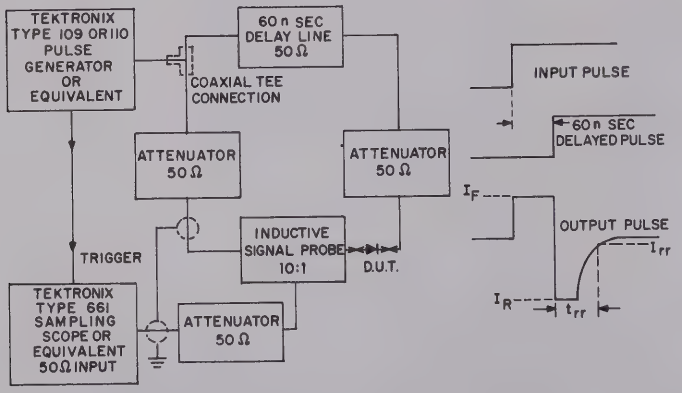

TEK 561A/3S76/3T77 SAMPLING SCOPE OR EQUIVALENT
A
B
60 n SEC DELAY LINE
X5
X100 PROBE
TEK 109 PULSE GENERATOR
TEE
TEK 291 DIODE SWITCHING TIME TESTER

Figure 2


I_F PULSE
RELAY
50 Ω OUTPUT Z
V_R PULSE (I_R)
50 Ω INPUT Z SAMPLING SCOPE
TRIGGER
I_F
V_R
I_F
V_R
INPUT TO D.V.T.
I_{rr}
t_{rr}

HIGH CURRENT REVERSE RECOVERY TEST CIRCUIT

Figure 3


TEKTRONIX TYPE 109 OR 110 PULSE GENERATOR OR EQUIVALENT
60 n SEC DELAY LINE 50 Ω
COAXIAL TEE CONNECTION
ATTENUATOR 50 Ω
ATTENUATOR 50 Ω
TRIGGER
INDUCTIVE SIGNAL PROBE 10:1
D.U.T.
TEKTRONIX TYPE 661 SAMPLING SCOPE OR EQUIVALENT 50Ω INPUT
ATTENUATOR 50 Ω
INPUT PULSE
60 n SEC DELAYED PULSE
I_F
OUTPUT PULSE
I_{rr}
I_R
t_{rr}

HIGH CURRENT REVERSE RECOVERY TEST CIRCUIT

Figure 4

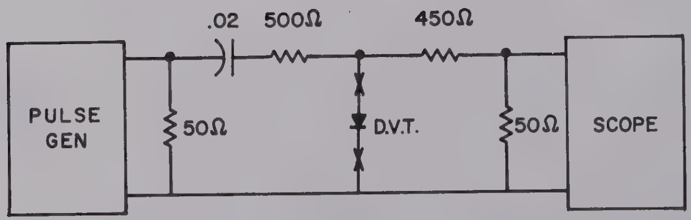

.02
500Ω
450Ω
PULSE GEN
50Ω
D.V.T.
50Ω
SCOPE

Figure 5

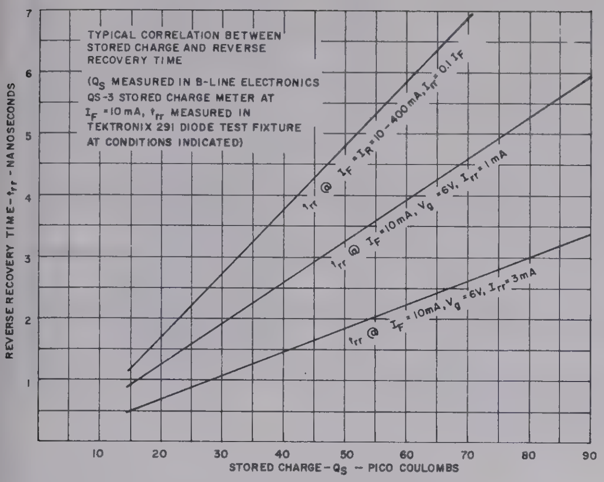


Figure 6

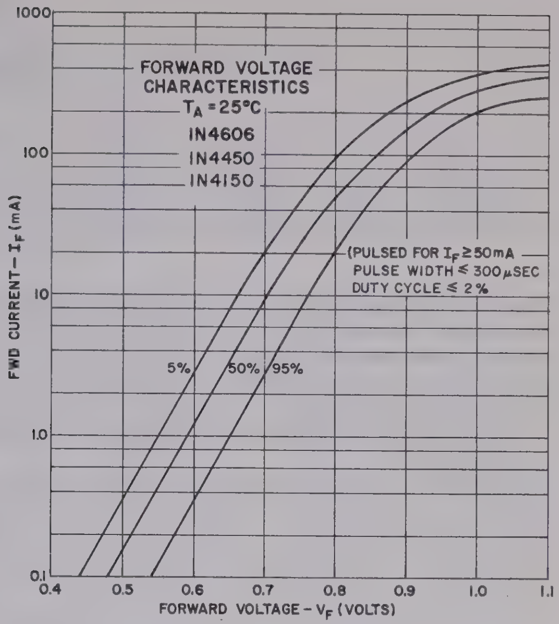


Figure 7

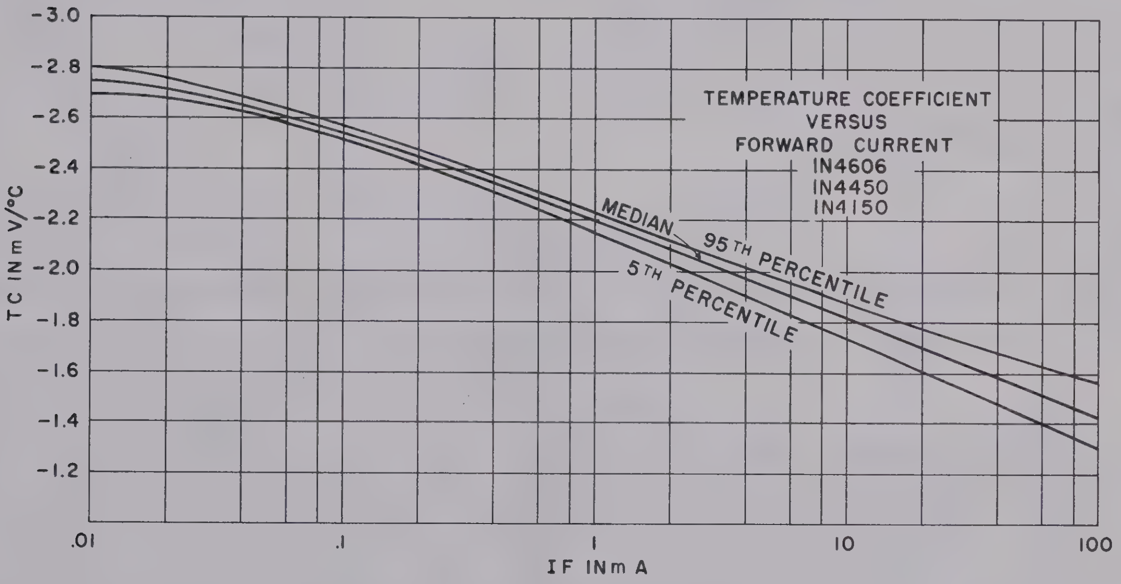


Figure 8

HEATSINK SPACING FROM END OF DIODE BODY	STEADY STATE THERMAL RESISTANCE °C/mW	POWER DISSIPATION AT 25°C mW †
	DHD	DHD
.062"	.250	700
.250"	.319	550
.500"	.380	460

Figure 9

Silicon Diodes

MULTI-PELLET

1N4156,7
1N4453
1N4829,30
1N5179
MPD200
MPD300
MPD400

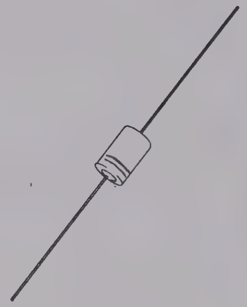
These General Electric high speed multi-pellet diodes are for use in computer circuits and general purpose applications. They consist of one, two, three, or four planar passivated epitaxial diode pellets in series, mounted in a subminiature double heatsink package. This structure makes possible stabistors having controlled conductance and low leakage.

This controlled conductance is necessary for the design of clippers, dc coupling circuits, clamping circuits, meter protectors, bias regulators, and other types of circuits that require tight tolerances on voltage levels.

The MPD200, 300, and 400 series may be used as signal limiters or level shifting diodes in transistor logic circuits, and also as dc coupling devices in dc amplifiers and digital circuits like multivibrators. Other lower cost stabistors are the STB567, 8, 9 devices. See publication 75.46.

absolute maximum ratings: (25°C)

	1N4156,7 1N4453 1N4829,30 1N5179	MPD200	MPD300	MPD400	
Voltage					
Reverse	20	30	60	90	Volts
Power					
Dissipation (Derate 2.67 mW/°C for ambient temperature above 25°C)	400	400	400	400	mW
Temperature					
Operating		–65 to +175°C			
Storage		–65 to +200°C			



electrical characteristics: (25°C) (unless otherwise specified)

Type	Minimum Breakdown Voltage, B_V @ 5μA, Volts	Forward Voltage	Maximum Reverse Current @ 25°C nA	Maximum Reverse Current @ 150°C μA	Maximum Reverse Current @ Volts	Maximum Capacitance* @ 0 Volts f = 1MHz, pF	Q_S† @ 1mA Min. pC	Q_S† @ 1mA Max. pC
1N4156	30	Table 1	50	50	20	25	50	500
1N4157	30	Table 2	50	50	20	20	50	500
1N4453	30	Table 3	50	50	20	30	50	500
1N5179	30	Table 4	50	50	20	20	50	500
1N4829	30 @ 100 μA	Table 5	100	25 @ 100°C	20	25	—	—
1N4830	30 @ 100 μA	Table 6	100	25 @ 100°C	20	20	—	—
MPD200	30	Table 7	30	—	30	15 (typ.)	75	400
MPD300	60	Table 8	30	—	30	10 (typ.)	75	400
MPD400	90	Table 9	30	—	30	7 (typ.)	60	300

I_f	Forward Voltage, V_f, Volts								
	Table 1	Table 2	Table 3	Table 4	Table 5	Table 6	Table 7	Table 8	Table 9
mA	Min. Max	Min. Max	Min. Max	Min. Max	Min. Max	Min. Max	Min. Max	Min. Max	Min. Max
0.010	0.74-1.09	1.19-1.54	.430-.550	1.40-2.10			0.90-1.00	1.40-1.54	1.82-2.01
0.100	0.97-1.22	1.52-1.77	.510-.630	1.80-2.50	0.84-1.25	1.35-1.80	1.05-1.16	1.62-1.78	2.14-2.36
1.0	1.21-1.41	1.85-2.05	.600-.710	2.20-2.80	0.99-1.44	1.63-2.08	1.22-1.34	1.84-2.03	2.47-2.71
10	1.38-1.58	2.12-2.32	.690-.800	2.60-3.20	1.16-1.61	1.90-2.35	1.39-1.54	2.10-2.33	2.80-3.07
100‡	1.54-1.84	2.36-2.66	.800-.920	3.00-3.70	1.35-1.87	2.15-2.69	1.60-1.76	2.40-2.65	3.16-3.49

*Capacitance as measured on Boonton Electronics model 75A Capacitance Bridge at a signal level of 50 mA rms and a frequency of 1MHz.

†Stored charge as measured on B-Line Electronics model QS-3 Stored Charge Meter. (Pulse amplitude = 5 volts, pulse width = 50 nsec, rise time ≤ 0.4 nsec, source impedance = 10 ohms.) See Notes 2, 3 and Figure 1.

‡Pulsed measurement. Pulse width ≤ 300 nsec, Duty Cycle ≤ 2%.

NOTES:

(1) For typical temperature coefficients see Fig. 2.

(2) Stored Charge is measured in the circuit given in MIL-STD-750, 19 January 1962, Method 4061. In this circuit (See Fig. 4) D_1 should be an ultra fast recovery diode having a stored charge less than 5% of that for the diode under test, with breakdown voltage greater than V_r, the turn-off pulse voltage. D_2 should be a high speed planar epitaxial diode (1N4150) with rapid turn-on time. The pulse used for measuring stored charge should have V_r equal to 10 volts, a rise time <0.5 nanosecond, a repetition rate of 100 kHz and a width greater than 10 nanoseconds. The stored charge is first measured with no current (I_1 in method 4061) and then with I_F = 1 mA (I_2 in method 4061). The stored charge specified is the difference between these two readings.

(3) The Tektronix diode recovery time plug-in unit, type S, can be used for approximate stored charge measurements. The stored charge reading in the type S under the conditions $I_F = 1$ mA, $I_R = 2$ mA, measuring to $V_F = 0$ volts, will be up to a factor of 2 lower than the stored charge measured according to method 4061, because of the lower rate of charge withdrawal using the type S.

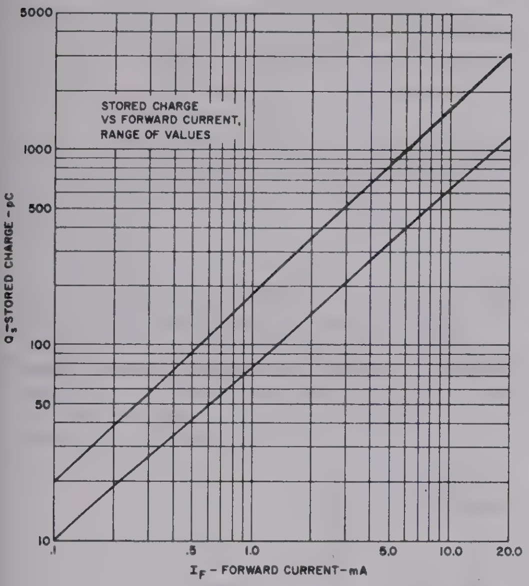


Figure 1

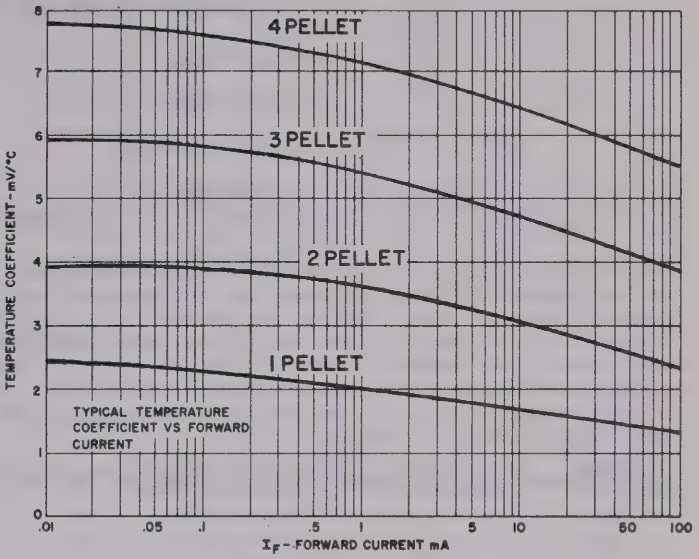


Figure 2

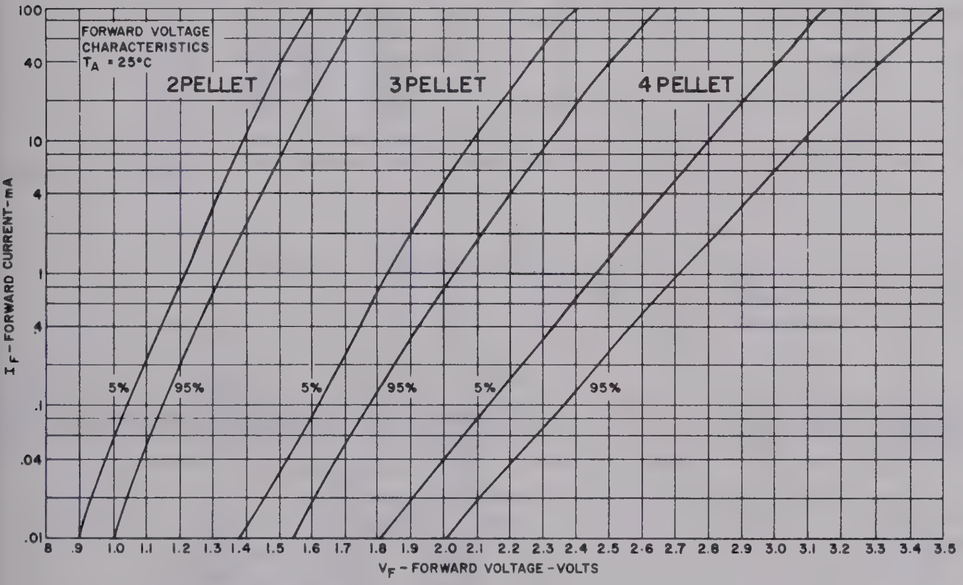


Figure 3

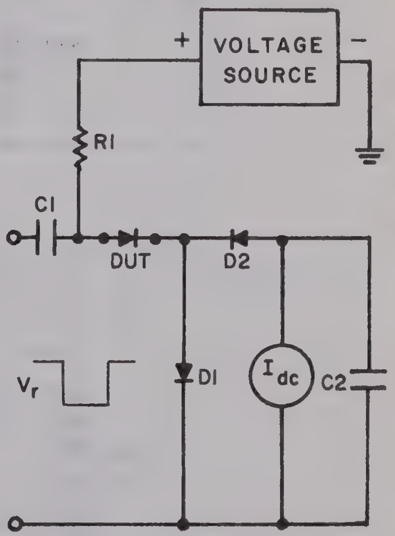
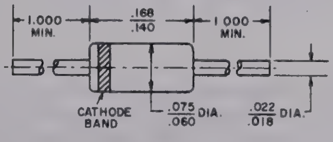
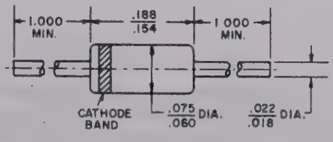

+
VOLTAGE
SOURCE
–
R1
C1
DUT
D2
D1
I_{dc}
C2
V_r

Figure 4

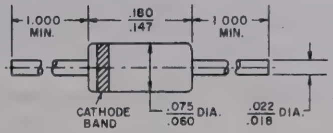
1N4453


1.000
MIN.
.168
.140
1.000
MIN.
CATHODE
BAND
.075
.060
DIA.
.022
.018
DIA.

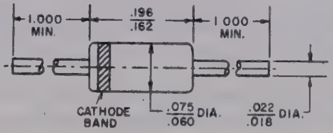
1N4830
1N4157
MPD300


1.000
MIN.
.188
.154
1.000
MIN.
CATHODE
BAND
.075
.060
DIA.
.022
.018
DIA.

1N4829
1N4156
MPD200


1.000
MIN.
.180
.147
1.000
MIN.
CATHODE
BAND
.075
.060
DIA.
.022
.018
DIA.

1N5179
MPD400


1.000
MIN.
.196
.162
1.000
MIN.
CATHODE
BAND
.075
.060
DIA.
.022
.018
DIA.

NOTES:

1. ALL DIMENSIONS ARE IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.
2. LEAD DIAMETER NOT CONTROLLED WITHIN .050" OF THE BODY.
3. BODY CONTOUR IS OPTIONAL WITHIN THE DIMENSIONS GIVEN. SLUGS, IF ANY, ARE INCLUDED WITHIN THIS CYLINDER AND ARE NOT SUBJECT TO THE MINIMUM BODY DIAMETER.
4. NOMINAL LEAD LENGTH IS 1.250.

TYPICAL APPLICATIONS

(Also—See Multi-pellet Diode Application Notes 90.60 and 90.61)

Level-shifting in DTL Circuits

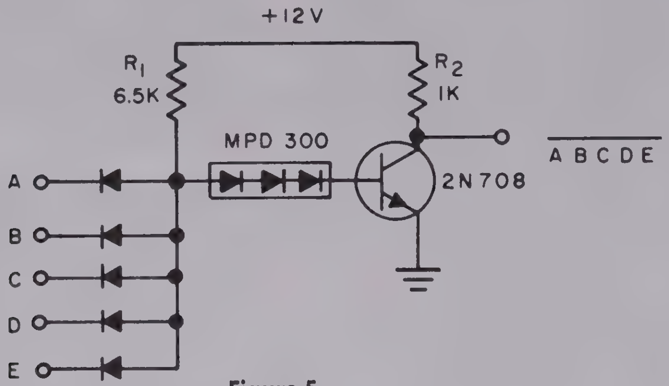
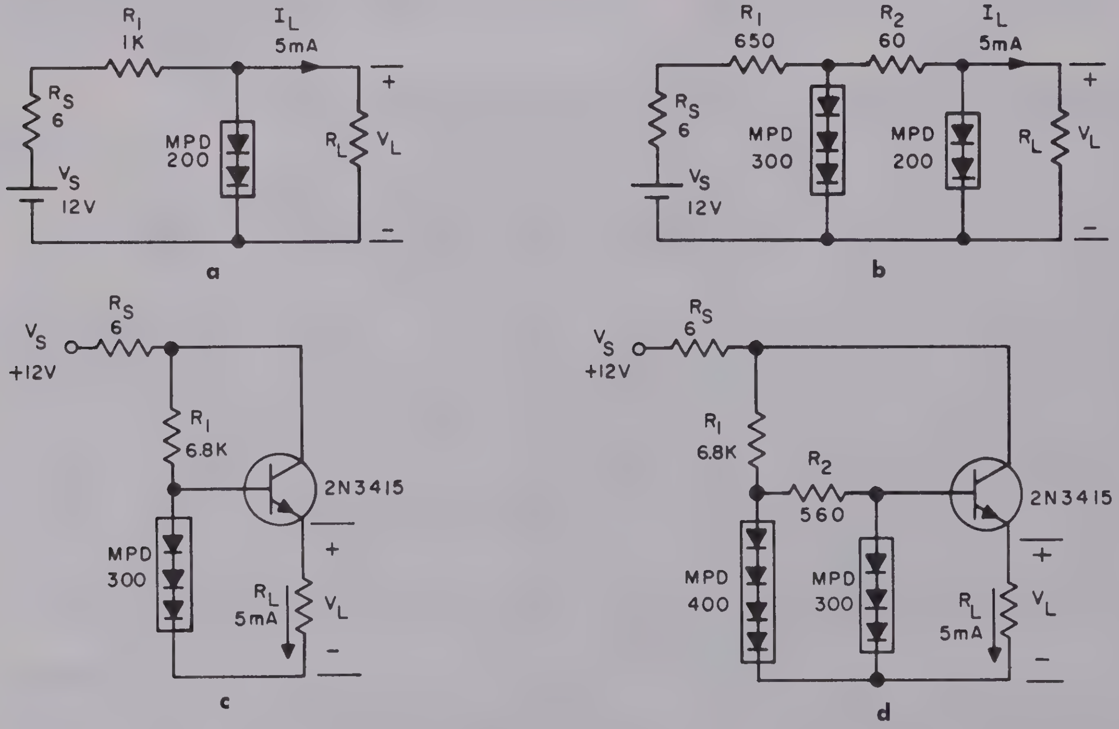


Figure 5

For the NAND gate in Fig. 5, the MPD300 multi-pellet diode provides for level-shifting so that only one power supply is required. Due to its high stored charge and the subsequent long recovery time, the MPD300 speeds up the transistor turn-off time by providing it with a reverse base current large enough to draw the stored charge out of the base of the transistor. Turn-off time is reduced by a factor of 2 to 3 compared to the use of 3 ordinary diodes in series. When a faster transistor, like the 2N2368 is used, similar improvement in performance is achieved. For a slow non-gold-doped type transistor, like the 2N3973 similar improvement is also obtained provided that a resistor in the vicinity of 1.5K is connected from the base to ground. In multi-level logic application, a propagation delay time of about 10 nsecs and with a fan-out of 1 to 5 is attainable when 2N708 or 2N2368 transistors are used.

Split Power Supply and Voltage Regulator for Transistor Circuits



a

b

c

d

Figure 6

The very simple voltage regulator in Fig. 6a provides good regulation against change in voltage source (about ½%) and has a low output impedance equal to dynamic impedance of the multi-pellet diode, which is approximately 5 ohms for this circuit. Efficiency is high compared to a resistive voltage divider regulator for the same output impedance. The latter regulator also gives no regulation against change in voltage source. In Fig. 6b, better regulation against change in voltage source is acquired by the use of a double diode shunt type configuration. Output impedance is the same as in Fig. 6a. Efficiency is lowered somewhat but a much better regulation against change in voltage source is achieved (about 0.07%).

In Fig. 6c and d an emitter follower is added to the output. Output impedance is a little higher than the 2 preceding circuits, but higher efficiency and higher regulation against change in voltage source are obtained.

DC Coupling for Multivibrators

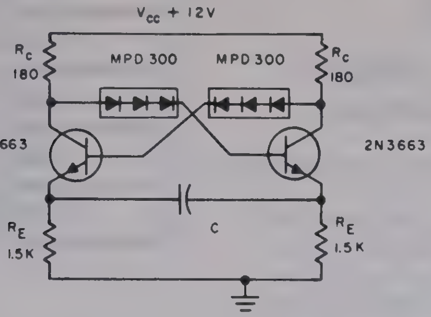

Vcc + 12V
Rc 180
MPD 300
MPD 300
Rc 180
2N3663
2N3663
C
RE 1.5K
RE 1.5K

Figure 7

The use of MPD300's in this astable multivibrator (Fig. 7) provides dc level-shifting to give the desired output voltage swing. Only one capacitor is required. Stable operation is achieved from a few cycles per second to about 10MHz. This circuit operates out of saturation region and switching transistors are not required. A risetime of about 5 nsecs is obtainable when high frequency transistors like the 2N3663's are used. Typical 2N3859's and 2N3901's will give risetimes of 10 and 20 nsecs respectively.

Temperature Compensated Constant Current Source

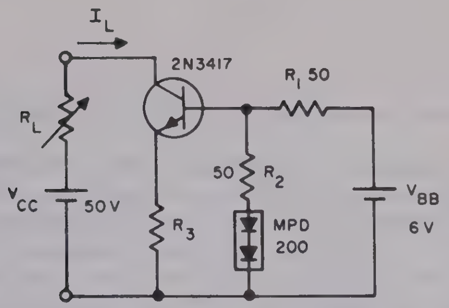

IL
2N3417
R1 50
RL
50 R2
VCC 50V
R3
MPD 200
VBB 6V

Figure 8

In Fig. 8 the 2-pellet diode is used to compensate for the variation of V_{BE} due to temperature changes. Output resistance is approximately h_{ob}, the collector output impedance of the transistor.

Biasing and Current Limiting for Push-pull Amplifiers

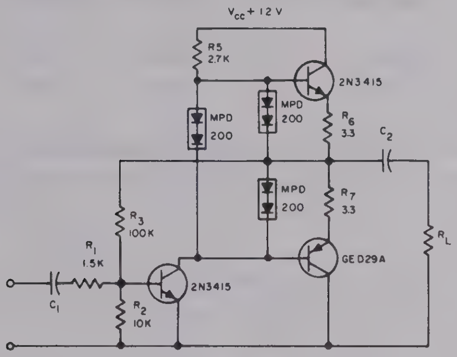

Vcc + 12 V
R5 2.7K
2N3415
MPD 200
MPD 200
R6 3.3
C2
MPD 200
R7 3.3
R3 100K
RL
R1 1.5K
GE D29A
2N3415
C1
R2 10K

Figure 9

The power amplifier in Fig. 9 is based upon a complementary push-pull operation driven by a class A driver amplifier. Ac and dc feedback is provided through R_3. A MPD200 not only biases the quiescent operating point so that crossover distortion is eliminated but also provides temperature compensation. The other 2 MPD200's limit the emitter current and hence protect the output transistors.

Signal Limiting

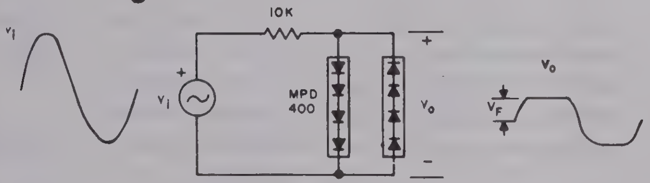

VI
10K
+
VI
MPD 400
VO
+
-
VO
VF

Figure 10

Using the multi-pellet diodes there is a variety of signal limiting at various thresholds (Fig. 10).

DC Coupling for Transistor Amplifiers

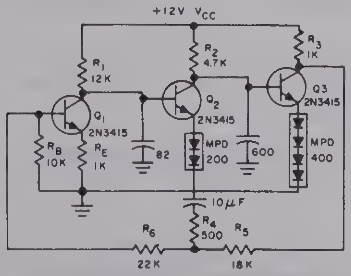

+12V VCC
R1 12K
R2 4.7K
R3 1K
Q1 2N3415
Q2 2N3415
Q3 2N3415
RB 10K
RE 1K
82
MPD 200
600
MPD 400
10μF
R6 22K
R4 500
R5 18K

Figure 11

Very simple amplifiers as shown in Fig. 11 can be built using MPD's to provide low ac impedance voltage bias. When feedback is appropriately applied, temperature stability can be obtained. Simplicity, compactness and good low frequency response are the main advantages of this type of circuit.

Current Limiting

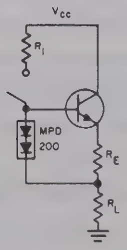

Vcc
R1
MPD 200
RE
RL

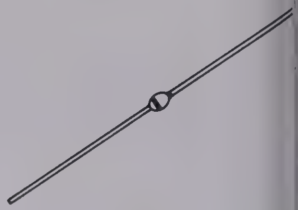
Figure 12

The emitter current is limited by the 2-pellet MPD200, thereby the transistor is protected (Fig. 12). The maximum emitter current is $(V_D - V_{BE})/R_E$ which is independent of load, base drive and power supply. Using this configuration, current limiting can be applied to switching circuits, amplifiers, voltage and current regulators.

Passivated
Rectifier

TRANSIENT VOLTAGE PROTECTED
2.5 Amps 200-1000 Volts

IN4245
IN4246
IN4247
IN4248
IN4249



THE GENERAL ELECTRIC 1N4245-49 SERIES ARE A14 TYPES, 2.5 AMPERE RATED, AXIAL-LEADED, GENERAL PURPOSE RECTIFIERS. DUAL HEAT-SINK CONSTRUCTION PROVIDES RIGID MECHANICAL SUPPORT FOR THE PELLET AND EXCELLENT THERMAL CHARACTERISTICS. PASSIVATION AND PROTECTION OF THE SILICON PELLETS PN JUNCTION ARE PROVIDED BY SOLID GLASS; NO ORGANIC MATERIALS ARE PRESENT WITHIN THE HERMETICALLY-SEALED PACKAGE.

The 1N4245-49 series (A14's) are "Transient-Voltage Protected." These devices will dissipate up to 1000 watts in the reverse direction without damage. Voltage transients generated by household or industrial power lines are dissipated.

absolute maximum ratings: (25°C unless otherwise specified)

	1N4245	1N4246	1N4247	1N4248	1N4249	
*Reverse Voltage (−65 to +160°C, T_J)						
Working Peak, V_{RWM}	200	400	600	800	1000	Volts
DC, V_R	200	400	600	800	1000	Volts
*Average Forward Current, I_O						
55°C ambient (see rating curves)	← 1.0 →					Amp
25°C " "	← 2.5 →					Amp
*Peak Surge Forward Current, I_{FSM} Non-repetitive, .0083 sec Half sine wave Full load JEDEC method	← 25 →					Amps
Peak Surge Forward Current, I_{FSM} Non-repetitive, .001 sec Half sine wave						
Full load 160°C, T_J	← 90 →					Amps
No Load (25°C Case)	← 100 →					Amps
*Junction Operating Temperature Range, T_J	← −65°C to +160°C →					
*Storage Temperature Range, T_{STG}	← −65°C to +200°C →					
I^2t, RMS for fusing, .001 to .01 sec.	← 4.0 →					Amps^2 sec.
Peak Non-Repetitive Reverse Power Rating, P_{RM} (20 μsec. half sine wave, at Max. T_J)	← 1000 →					Watts

Mounting: Any position. Lead temperature 290°C maximum to ⅛" from body for 5 seconds maximum during mounting.

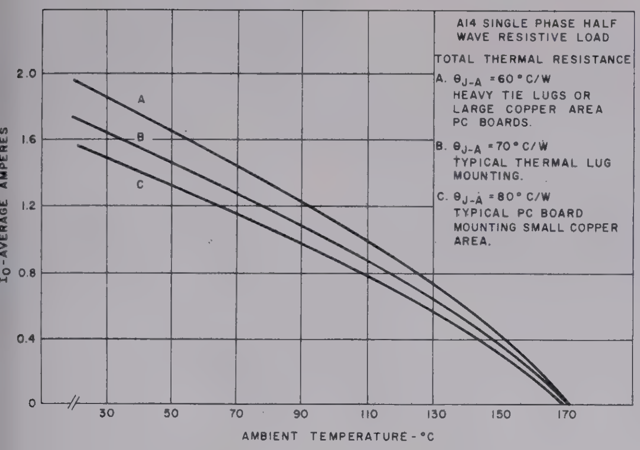
electrical characteristics: (25°C unless otherwise specified)

* Maximum Forward Voltage Drop, V_{FM} $I_F = 1.0A$, $T_A = +55°C$	← 1.2 →	Volts
* Maximum Reverse Current, I_{RM} at rated V_R		
$T_J = +25°C$	← 1.0 →	μA
$T_J = +125°C$	← 25 →	μA
Typical Reverse Recovery Time, t_{rr}	← 2.5 →	μsec
Maximum Reverse Recovery Time, t_{rr} (Recovery Circuit Per MIL-S-19500/286B)	← 5.0 →	μsec

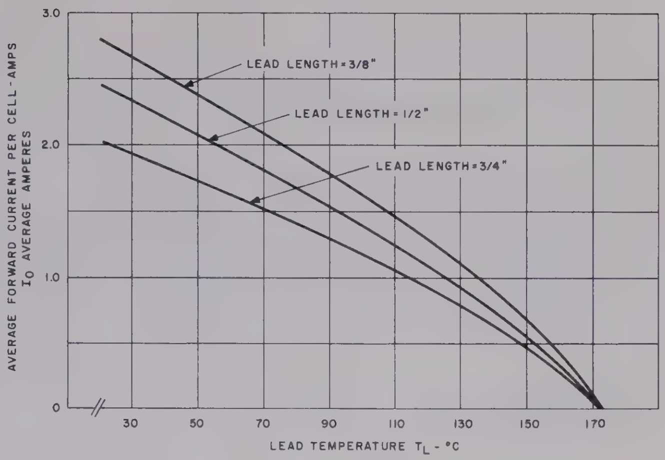
*JEDEC Registered data.

MAXIMUM ALLOWABLE DC OUTPUT CURRENT RATINGS

SINGLE PHASE
600 VOLTS & BELOW

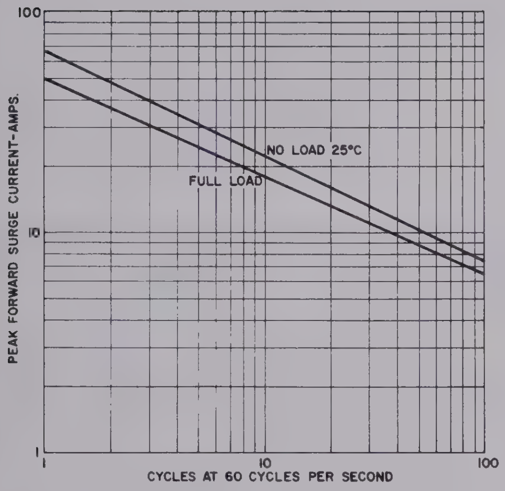


AMBIENT OPERATION
(See Typical Mounting Below)

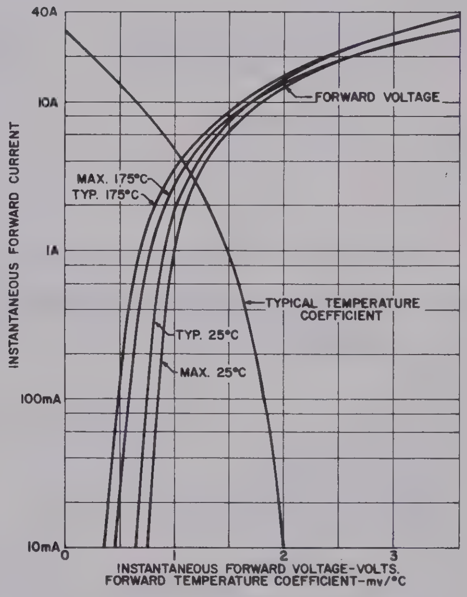


TIE POINT OPERATION

TYPICAL CHARACTERISTICS

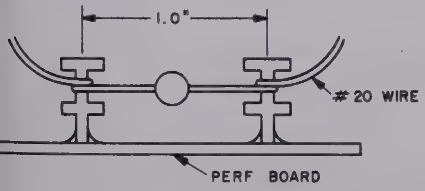


MAXIMUM NON-REPETITIVE MULTICYCLE FORWARD SURGE CURRENT

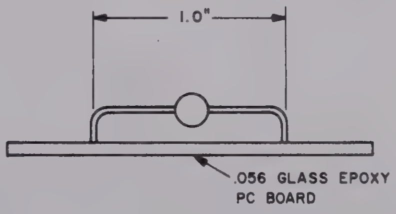


FORWARD CHARACTERISTICS

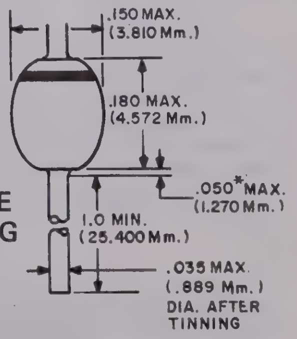
TYPICAL TIE LUG MOUNTS


1.0"
# 20 WIRE
PERF BOARD

TYPICAL PC BOARD MOUNTING


1.0"
.056 GLASS EPOXY PC BOARD

OUTLINE DRAWING

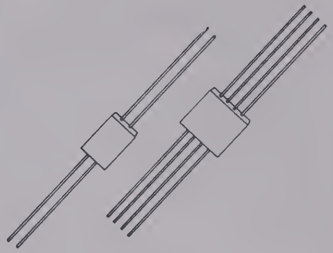

.150 MAX. (3.810 Mm.)
.180 MAX. (4.572 Mm.)
.050* MAX. (1.270 Mm.)
1.0 MIN. (25.400 Mm.)
.035 MAX. (.889 Mm.) DIA. AFTER TINNING

ALL DIMENTIONS ARE IN INCHES AND (METRIC)
*WELD AND SOLDER FLASH NOT CONTROLLED IN THIS AREA

Silicon Diodes

1N4306 MP-2
1N4307 MQ-2

The General Electric 1N4306, MP-2, 1N4307, and MQ-2 matched pairs and matched quads are assemblies made with very high speed, controlled high conductance planar epitaxial passivated silicon diodes. The forward boltages of th diodes in each assembly are closely matched over a wide range of forward current and ambient temperatures. These assemblies are intended for use in discriminators, gates, choppers, ring modulators where highest performance and reliability are required. The 1N4306 was formerly the MP-1. The 1N4307 was formerely the MQ-1.

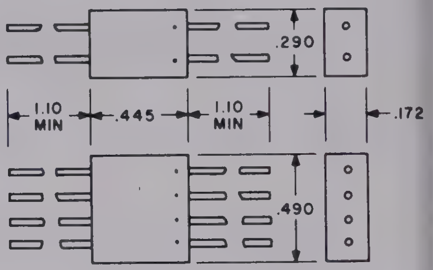


FEATURES:

- Matching Spec
- Controlled Conductance

absolute maximum ratings: (each diode)

	1N4306 1N4307	MP-2 MQ-2	
Voltage			
Reverse	50	30	volts
Current			
Average Rectified	75	75	ma
Forward Current Steady-state DC	115	115	ma
Recurrent Peak Forward Current	225	225	ma
Power			
Dissipation	250	250	mw
Temperature			
Operating	← −65 to +150 →		°C



1. DIMENSIONS ARE NOMINAL (INCHES)
2. DOTS OR LINE INDICATE CATHODE END
3. LEADS ARE GOLD PLATED, DIAMETER .020 ± .001, SPACING .100 NOMINAL

electrical characteristics (25°C)

(unless otherwise specified)

		1N4306 1N4307			MP-2 MQ-2			
		Min	Typ	Max	Min	Typ	Max	
Forward Voltage								
($I_F = .1$ ma)	V_F	.44		.55	.44		.55	volts
($I_F = 1$ ma)	V_F	.56		.67	.56		.67	volts
($I_F = 10$ ma)	V_F	.67		.81	.67		.81	volts
($I_F = 50$ ma)	V_F	.75		1.0	.75		1.0	volts
Voltage Difference Between Diodes in Pair or Quad, $T_A = -55°C$ to $+125°C$								
($I_F = 0.1$ to 10 ma)	Δ_{VF}			10			10	mv
($I_F = 10$ to 50 ma)	Δ_{VF}			20			50	mv
Breakdown Voltage ($I_R = 5\ \mu a$)	B_V	75			40			volts
Reverse Current								
($V_R = 30V$)	I_R					0.020	0.1	μamps
($V_R = 50V$)	I_R		0.015	.05				μamps
($V_R = 30V$, $T_A = 150°C$)	I_R					40	100	μamps
($V_R = 50V$, $T_A = 150°C$)	I_R		15	50				μamps
Reverse Recovery Time								
($I_f = 10$ ma, $I_r = 10$ ma, NOTE 1)	t_{rr}		2.8	4		3.0	4	nsec.
($I_f = 10$ ma, $V_r = 6V$, $R_L = 100\Omega$, NOTE 1)	t_{rr}			2			2	nsec.
Capacitance ($V_R = 0V$, NOTE 2)	C_o		1.0	2		1.5	2	pf
Rectification Efficiency @ 100 mc (NOTE 3)	R_E	45			45			%
Interdiode Leakage Resistance			10^{13}			10^{13}		ohms

NOTES:

1. Recovery time measured to I_r-1 ma in circuit of Figure 4.
2. Capacitance is measured on Boonton model 75A capacitance bridge at a signal level of 50 mv rms and a frequency of 1 mc using three-terminal configuration.
3. Rectification effciency is defined as the ratio of DC load voltage to peak rf imput voltage to the detector circuit. Measured with 2 v rms input to ths circuit, load resistance 5KΩ, load capacitance 20 pf.

1N4306 MP-2 IN4307 MQ-2

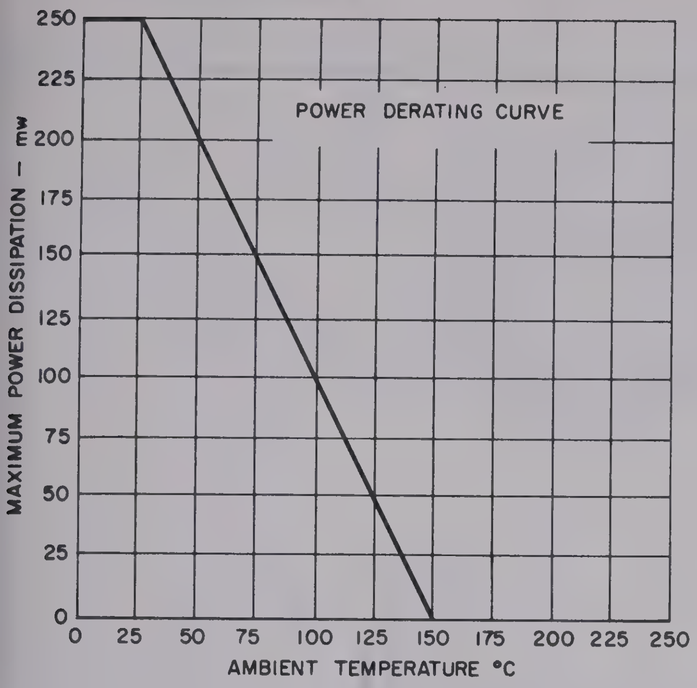


FIGURE 1

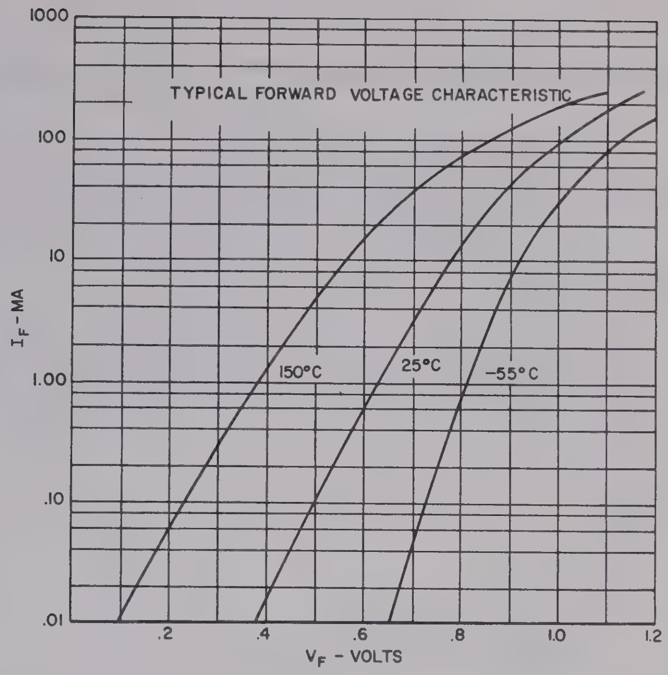


FIGURE 2

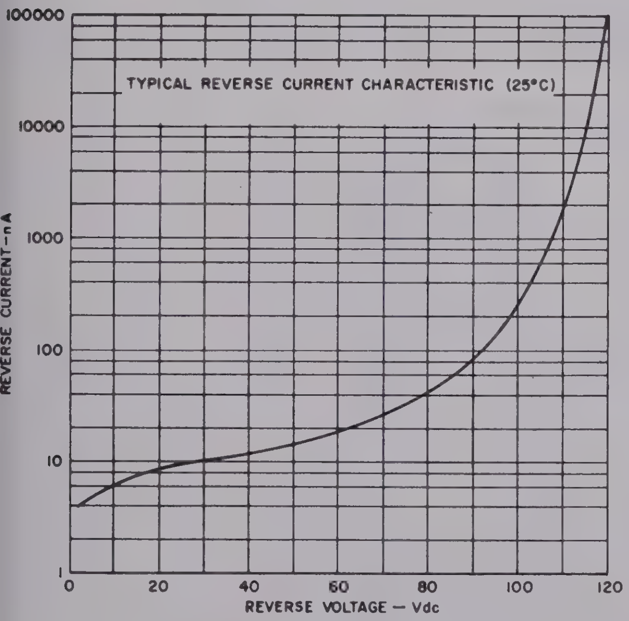
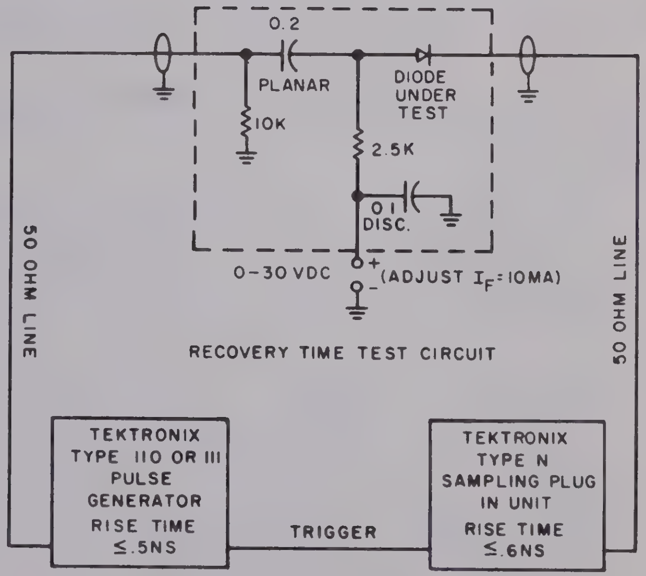


FIGURE 3



0.2
PLANAR
10K
DIODE UNDER TEST
2.5K
0.1 DISC.
0-30 VDC
+
-
(ADJUST I_F = 10MA)
50 OHM LINE
50 OHM LINE
RECOVERY TIME TEST CIRCUIT
TEKTRONIX TYPE 110 OR 111 PULSE GENERATOR RISE TIME ≤.5NS
TRIGGER
TEKTRONIX TYPE N SAMPLING PLUG IN UNIT RISE TIME ≤.6NS

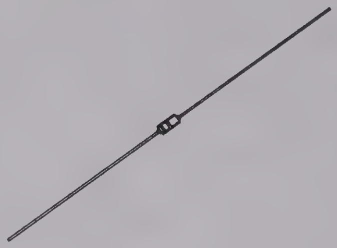
FIGURE 4

Silicon
Diode

1N4444

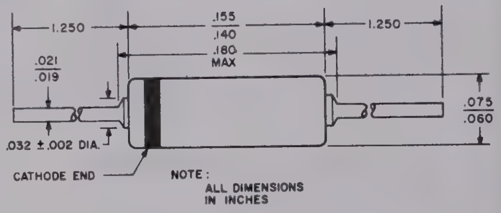
The General Electric 1N4444 Double Heatsink Diode is a low capacitance diode for low and high current high speed switching circuits and general purpose applications. The diode incorporates an oxide passivated planar structure built on a high resistivity, epitaxial layer grown on a low resistivity silicon substrate. The 1N4444 offers controlled conductance, minimum and maximum forward voltages at four levels of forward current. This closely controlled conductance is necessary for the design of clamping and logic circuits where tight tolerances on voltage levels are required.

All Double Heatsink Diodes receive a one hour glass anneal bake at 425°C. This processing optimizes DHD hermetic integrity under temperature cycling and thermal shock conditions exceeding MIL-S-19500C requirements. All DHD's then receive a 300°C stabilization bake for 168 hours to assure paramenter stability and reliability under maximum storage and operating junction temperature.



absolute maximum ratings:

	1N4444	
Voltage		
Reverse	50	volts
Current		
Average Rectified	200	ma
Recurrent Peak Forward	600	ma
Forward Steady-State DC	250	ma
Peak Forward Surge (1 μsec)	4	amps
Power		
Dissipation	500	mw
Temperature		
Operating	←−65 to +200→	°C
Storage	←−65 to +200→	°C
Lead, 1/16" ± 1/32" from case for 10 sec.	←300→	°C

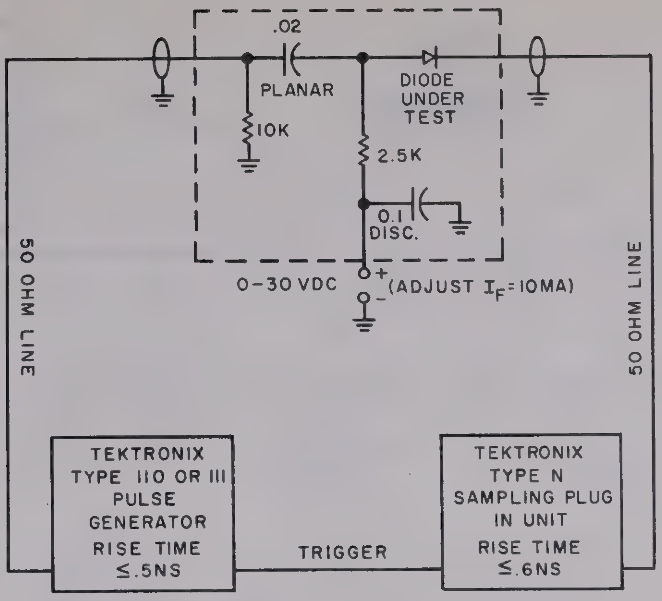


electrical characteristics: (25°C) (unless otherwise specified)

		1N4444 Min.	1N4444 Max.
Forward Voltage			
($I_F = 0.1$ ma)	V_F	440	550
($I_F = 1.0$ ma)	V_F	560	680
($I_F = 10$ ma)	V_F	690	820
($I_F = 100$ ma)	V_F	850	1000
Breakdown Voltage			
($I_R = 5$ μa)	B_V	70	
($I_R = 100$ μa)	B_V		
Reverse Current			
($V_R = 50$ V)	I_R		50
($V_R = 50$ V, $T_A = +150°C$)	I_R		50
($V_R = 80$ V)	I_R		
($V_R = 80$ V, $T_A = +150°C$)	I_R		
Capacitance			
($V_R = 0$ V) (Note 1)	C_o		2
Reverse Recovery Time			
($I_F = I_R = 10$ ma, Recover to 1 ma) (Fig. 1)	t_{rr}		7

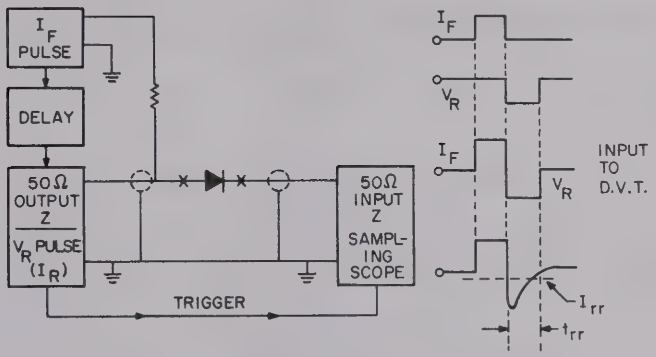
note:

(1) Capacitance as measured on Boonton Model 75A capacitance bridge at a signal level of 50 mv and a frequency of 1 mc.


.02
PLANAR
10K
DIODE UNDER TEST
2.5K
0.1 DISC.
0-30 VDC
+
-
(ADJUST I_F=10MA)
50 OHM LINE
50 OHM LINE
TEKTRONIX TYPE 110 OR 111 PULSE GENERATOR RISE TIME ≤.5NS
TRIGGER
TEKTRONIX TYPE N SAMPLING PLUG IN UNIT RISE TIME ≤.6NS

LOW CURRENT t_{rr} TEST CIRCUIT

FIGURE 1


I_F PULSE
DELAY
50Ω OUTPUT Z
V_R PULSE (I_R)
TRIGGER
50Ω INPUT Z
SAMPLING SCOPE
I_F
V_R
I_F
V_R
INPUT TO D.V.T.
I_{rr}
t_{rr}

HIGH CURRENT TEST CIRCUIT

FIGURE 2

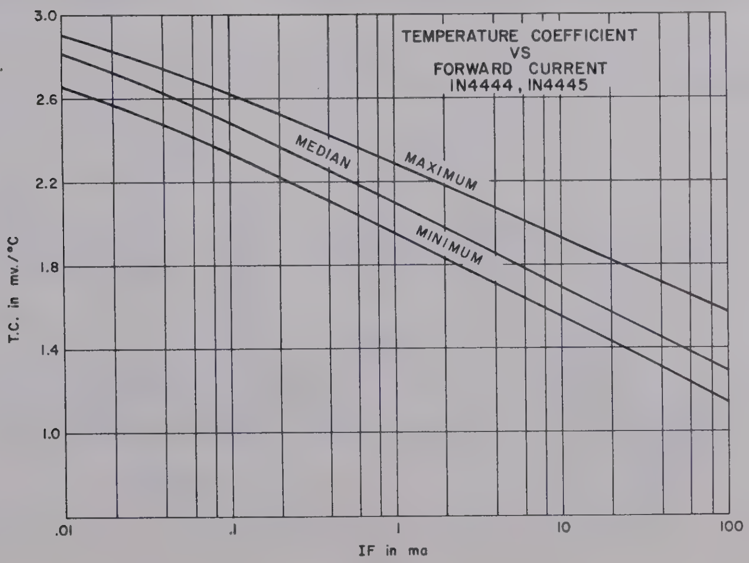


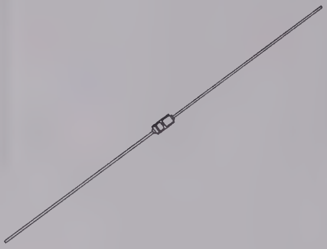
FIGURE 3

Silicon
Diodes

1N4451
1N4607,8

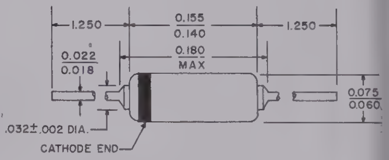
This family of General Electric Double Heatsink Diodes are high conductance, high speed switching units for logic, core and hammer driver circuits, and general purpose applications. These diodes incorporate an oxide passivated planar structure built in a high resistivity, epitaxial layer grown on a low resistivity silicon substrate.

The 1N4451, 1N4607, and 1N4608 feature controlled conductance with minimum and maximum forward voltages at four levels of forward current. This closely controlled conductance is necessary for the design of clamping and logic circuits where tight tolerances on voltage levels are required.



absolute maximum ratings: (25°C)

	1N4451	1N4607	1N4608	
Voltage				
Reverse	30	70	70	Volts
Current				
Average Rectified	← 200 →			mA
Recurrent Peak Forward	← 600 →			mA
Forward Steady-State DC	← 250 →			mA
Peak Forward Surge (1 μsec. pulse)	← 4 →			Amps
Power				
Dissipation*	← 500 →			mW
Temperature				
Operating	← −65 to +200 →			°C
Storage	← −65 to +200 →			°C



NOTE: ALL DIMENSIONS IN INCHES

*Derate 2.85 mW/°C for ambient temperatures above 25°C based on a maximum junction temperature of 200°C.

electrical characteristics: (25°C) (unless otherwise specified)

		1N4451		1N4607		1N4608		
		Min.	Max.	Min.	Max.	Min.	Max.	
Forward Voltage								
($I_F = 100\mu A$)	V_F	400	500	390	500	390	490	mV
($I_F = 1mA$)	V_F	510	610	500	610	500	600	mV
($I_F = 10mA$)	V_F	620	720	610	720	610	710	mV
($I_F = 100mA$)†	V_F	750	875	740	870	740	850	mV
($I_F = 250mA$)†	V_F			810	950	810	930	mV
($I_F = 300mA$)†	V_F		1000					mV
($I_F = 350mA$)†	V_F				1000	840	960	mV
($I_F = 400mA$)†	V_F				1100			mV
($I_F = 450mA$)†	V_F						1000	mV
($I_F = 500mA$)†	V_F						1100	mV
Breakdown Voltage								
($I_R = 5\mu A$)	B_V	40						Volts
($I_R = 100\mu A$)	B_V			85		85		Volts

1N4451
1N4607,8

electrical characteristics: (25°C) (unless otherwise specified)

		1N4451		1N4607		1N4608		
		Min.	Max.	Min.	Max.	Min.	Max.	
Reverse Current								
($V_R = 30V$)	I_R		50					nA
($V_R = 30V$, $T_A = 150°C$)	I_R		50					μA
($V_R = 50V$)	I_R				100		100	nA
($V_R = 50V$, $T_A = 100°C$)	I_R				25		25	μA
($V_R = 70V$)	I_R				250		250	nA
Capacitance								
($V_R = 0V$)‡	C_o		6		4		4	pF
Reverse Recovery Time								
($I_F = I_R = 10mA$, Recover to 1mA, Fig. 3)	t_{rr}		10		10		10	ns
($I_F = I_R = 500mA$, Recover to 50mA, Fig. 4)	t_{rr}				15		15	ns
Stored Charge (Note 1)								
($I_F = 10mA$)§	Q_S		64		64		64	pC

†Pulsed measurement. Pulse width ≤ 300 μsec. Duty Cycle ≤ 2%.

‡Capacitance as measured on Boonton Model 75A capacitance bridge at a signal level of 50 mV and a frequency of 1 MHz.

§Stored Charge as measured on B-Line Electronics Model QS-3 stored charge meter. Pulse amplitude = 5 volts, pulse width = 5 nsec., rise time = 0.4 nsec., source impedance = 10 ohms.

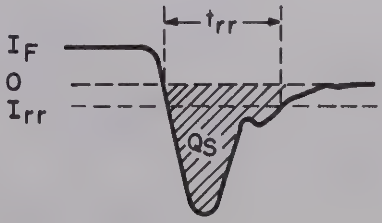
NOTE 1: STORED CHARGE

When a forward biased diode is subjected to a reverse voltage step a reverse current will flow for a short time as a result of the stored charge consisting of minority carriers in the vicinity of the junction. The typical waveform of reverse current vs time for a diode subjected to a large reverse voltage is shown in Figure 1. The time required for the diode to recover its reverse blocking condition will depend on the quantity of charge stored and the rate at which the charge is removed by recombination inside the diode and by current flowing in the external circuit. Conventionally, the speed of a diode is characterized by the reverse recovery time, t_{rr}, measured to some arbitrary current level as in Figure 1. However, for higher speed diodes reverse recovery time is not a satisfactory parameter for characterizing the speed of the diode since it is dependent on arbitrary circuit conditions and is very dependent on the construction of the test circuit. Stored charge, on the other hand, is measured by integrating the reverse current of the diode (as shown by the shaded area in Figure 1), and is consequently much less dependent on the construction of the test circuit and on arbitrary circuit conditions. Stored charge is a more ideal parameter for characterizing the speed of a diode since it represents an intrinsic characteristic of the diode and can be measured with good reproducibility on low cost instruments which have direct meter readout.

Stored charge can be correlated with reverse recovery time measurements on a specific t_{rr} test jig. Typical correlation curves are shown on the graph below.

References:

(1) JEDEC Proposed Method for Direct Measurement of Diode Stored Charge, JS-2-65-11
(2) "Measurement of Stored Charge in High Speed Diodes," T. P. Sylvan Application Note #90.30 (available on request)



TYPICAL REVERSE RECOVERY WAVEFORM FOR A HIGH SPEED DIODE

FIGURE 1

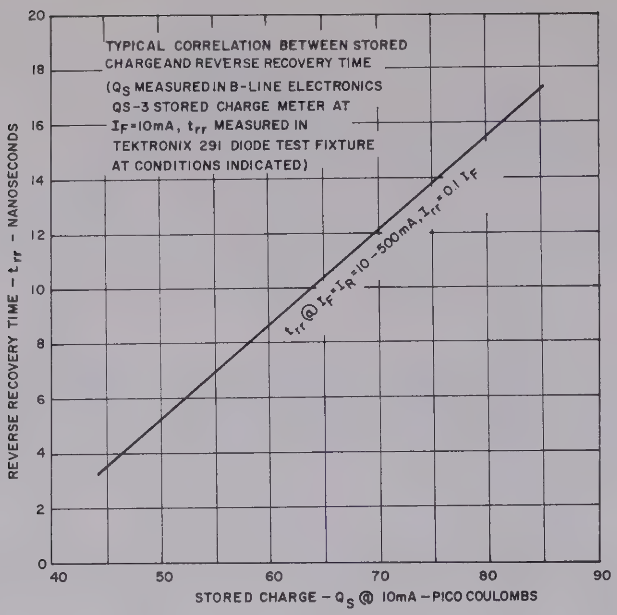
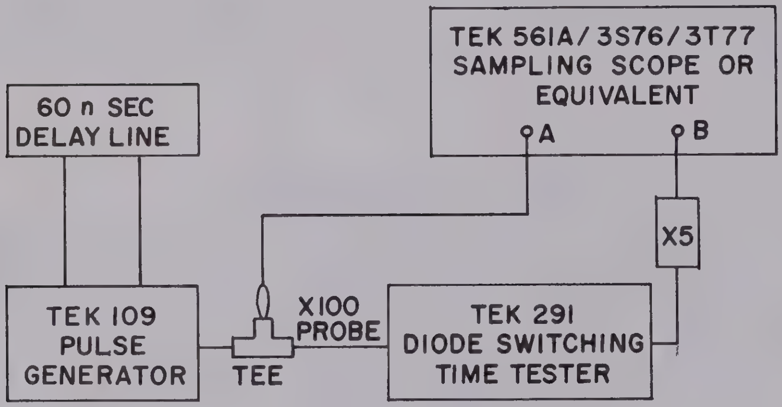
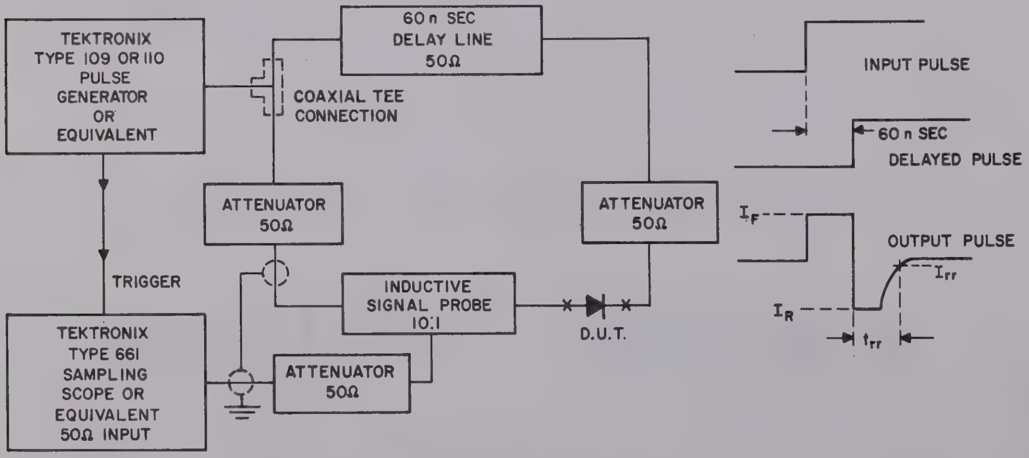


FIGURE 2


TEK 561A/3S76/3T77 SAMPLING SCOPE OR EQUIVALENT
A
B
60 n SEC DELAY LINE
X5
TEK 109 PULSE GENERATOR
TEE
X100 PROBE
TEK 291 DIODE SWITCHING TIME TESTER

LOW CURRENT REVERSE RECOVERY TEST CIRCUIT

FIGURE 3


TEKTRONIX TYPE 109 OR 110 PULSE GENERATOR OR EQUIVALENT
60 n SEC DELAY LINE 50Ω
COAXIAL TEE CONNECTION
INPUT PULSE
60 n SEC DELAYED PULSE
ATTENUATOR 50Ω
ATTENUATOR 50Ω
TRIGGER
INDUCTIVE SIGNAL PROBE 10:1
D.U.T.
I$_F$
OUTPUT PULSE
I$_{rr}$
I$_R$
t$_{rr}$
TEKTRONIX TYPE 661 SAMPLING SCOPE OR EQUIVALENT 50Ω INPUT
ATTENUATOR 50Ω

HIGH CURRENT REVERSE RECOVERY TEST CIRCUIT

FIGURE 4

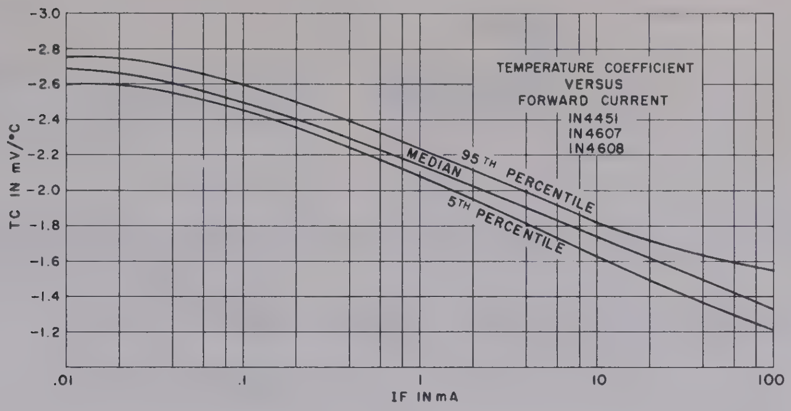


FIGURE 5

HEATSINK SPACING FROM END OF DIODE BODY	STEADY STATE THERMAL RESISTANCE °C/mW	POWER DISSIPATION AT 25°C mW†
	DHD	DHD
.062"	.250	700
.250"	.319	550
.500"	.380	460

FIGURE 6

† This power rating is based on a maximum junction temperature of 200°C.

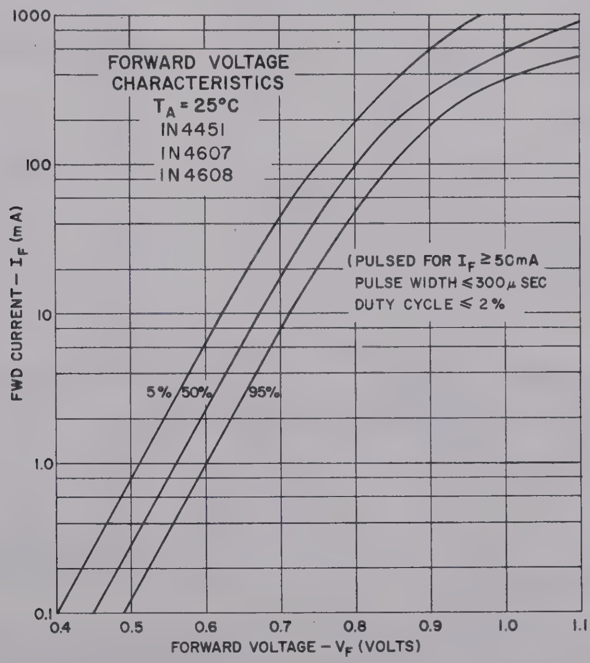


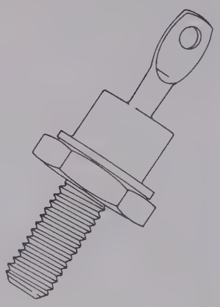
FIGURE 7

Silicon Rectifier

IN4506-11

CONTROLLED AVALANCHE RECTIFIERS FROM GENERAL ELECTRIC

Feature These Advances in Silicon Rectifier Diode Applications:



- Self-protection against normal voltage transients. Dissipates up to 3900 watts peak power in the reverse direction. Permits decreased PRV safety factors in equipment due to greatly reduced transient voltage vulnerability.
- Unmatched standards of reliability at PRV's up to 1200 volts, as well as at lower voltages.
- Protection of other circuit components against overvoltage through rigidly specified maximum/minimum avalanche characteristics.
- Make ideal voltage equalizing elements for series connected SCR's and conventional rectifier diodes. Also for anode triggering SCR's to prevent damage from voltage transients in the forward direction.
- Simplified series operation of rectifiers in high-voltage applications . . . no shunting resistors necessary for Controlled Avalanche Rectifiers. Makes possible compact high-voltage assemblies.
- Can operate in the avalanche breakdown region at high voltages . . . unharmed by hi-pot and megger tests.

To be designated *"Controlled Avalanche"* a GE silicon rectifier diode must:

1. Have rigidly specified maximum and minimum avalanche voltage characteristics;
2. Be able to operate in its avalanche region without damage at any junction temperature up to a maximum of 175°C; and
3. Be able to absorb momentary power surges in the avalanche region, and have ratings defining this capability at starting junction temperatures of 25°C and 175°C.

For information on the application of Controlled Avalanche Rectifiers, see Publication No. 200.27, "An Introduction To The Controlled Avalanche Silicon Rectifier". Copies may be obtained from: General Electric Company, Distribution Services, Bldg. 6, Room 208, 1 River Road, Schenectady, New York 12305.

MAXIMUM ALLOWABLE RATINGS

Type	Repetitive & Working Peak Reverse Voltage* V_{RM}(rep), V_{RM}(wkg) $T_J = -65°C$ to $+175°C$ (Note: 1)	MINIMUM Avalanche Breakdown Voltage, BV_R, (5 mA test current at $T_J = 25°C$)	MAXIMUM Avalanche Breakdown Voltage, BV_R, (5 mA test current at $T_J = 25°C$)	Full-Load Reverse Current (full-cycle avg., 135°C T_C, 1 ϕ), $I_{R(AV)}$
	Volts**	Volts	Volts	Milliamperes**
1N4506	200	250	515	2.5
1N4507	400	500	770	2.5
1N4508	600	750	1030	2.5
1N4509	800	1000	1290	2.0
1N4510	1000	1250	1550	1.75
1N4511	1200	1500	1930	1.5

Average Forward Current, I_O ($T_C = +135°C$, single phase)	12 Amperes**
Peak Once-Cycle Surge Current (non-repetitive), I_{FM} (surge)	240 Amperes**
Minimum I^2t Rating (see Curve 6)	67 Ampere^2 seconds
Reverse Power Surge (non-repetitive, 10 μsec., square wave)	
$T_J = +25°C$	3.9 Kilowatts
$T_J = +175°C$	1.5 Kilowatts
(For other conditions, see Curve 2)	
Average DC Reverse Power in Breakdown Region ($-65°C \leq T_C \leq +135°C$) (Note: 2)	10 Watts**
Peak Reverse Power in Breakdown Region (repetitive) (Note: 2)	50 Watts
Forward Peak Voltage Drop, V_{FM} ($T_C = +135°C$, $I_O = 12$ ampere avg.)	1.4 Volts**
Thermal Resistance, $\theta_{J\text{-}C}$	2.0°C/Watt
Operating Junction Temperature, T_J	−65°C to +175°C**
Storage Temperature, T_{stg}	−65°C to +200°C**
Stud Torque	12 Lb-in (Min), 15 Lb-in (Max) 14 Kg-cm (Min), 17.5 Kg-cm (Max)

*Maximum voltages apply with a heatsink thermal resistance of 10°C/watt. or less, at maximum rated junction temperature.

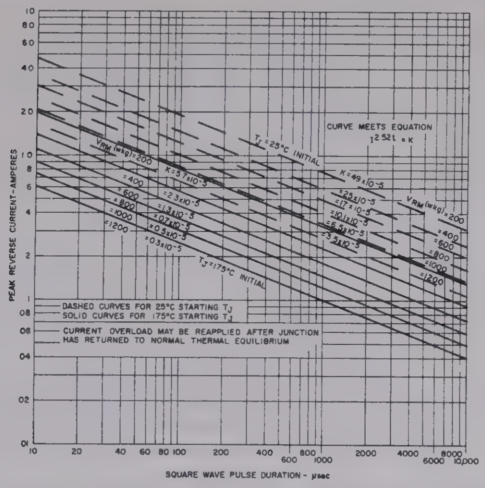
**Indicates values included in JEDEC Type Number Registration.

NOTES:

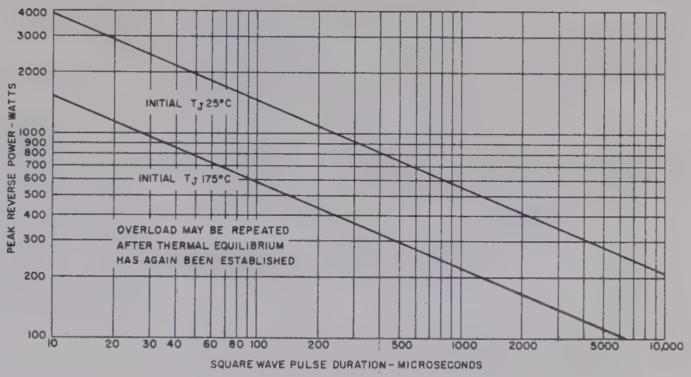
(1) V_{RM}(rep) applies for a conventional AC to DC conversion application. V_{RM}(rep) and V_{RM}(wkg) can be considered unlimited providing that the additional reverse power generation is taken into account by allowing for its influence on the forward current rating. Considerations similar to voltage regulator diode applications would apply.

(2) These ratings assume no forward power dissipation. In applications requiring both forward and reverse average power dissipation, reduce case temperature as determined from the maximum case temperature versus average forward current curve by 2.0°C for every watt of average reverse power dissipation.

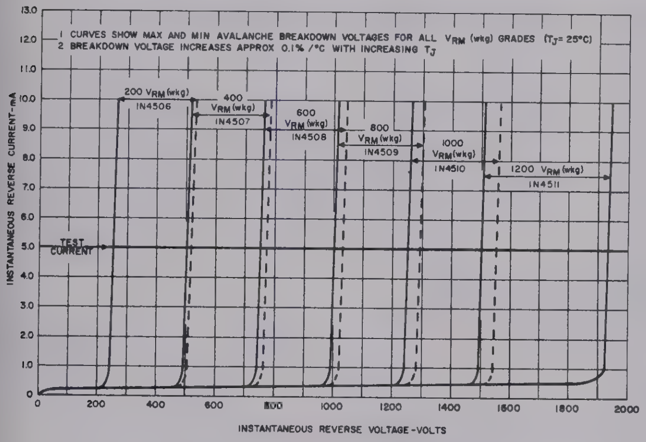
(3) Case temperature, T_C, is measured at the center of any one of the hex flats.



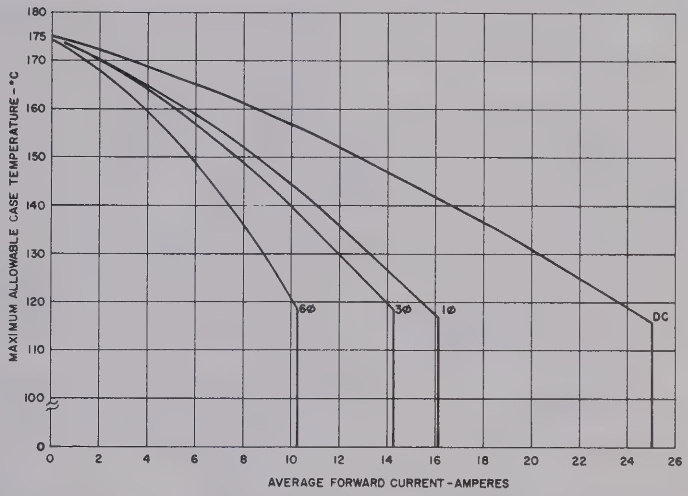
1. NON-RECURRENT REVERSE SURGE CURRENT RATINGS



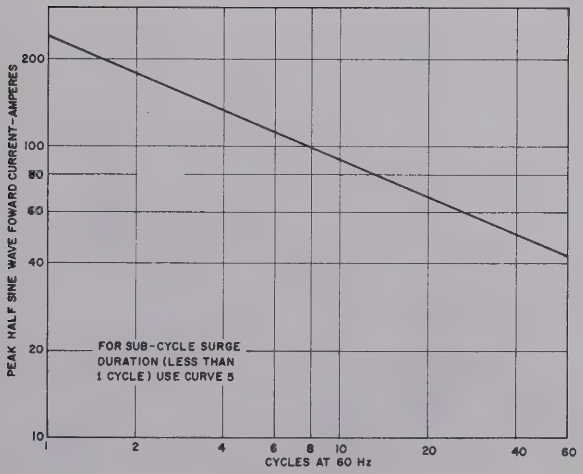
2. NON-RECURRENT REVERSE POWER SURGE



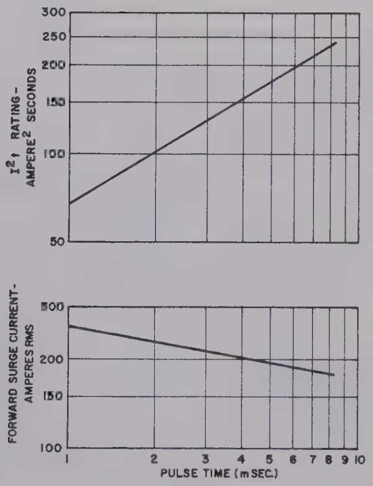
3. REVERSE CHARACTERISTICS



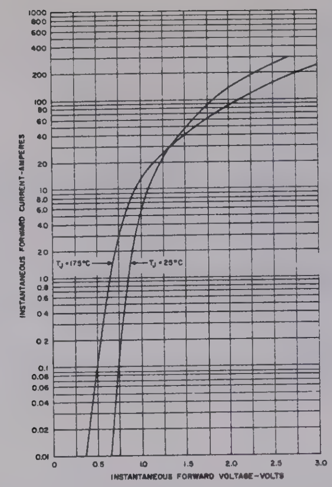
4. MAXIMUM CASE TEMPERATURE VS. AVERAGE FORWARD CURRENT



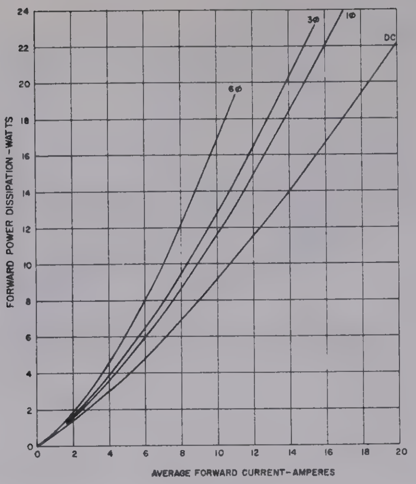
5. MAXIMUM FORWARD SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS



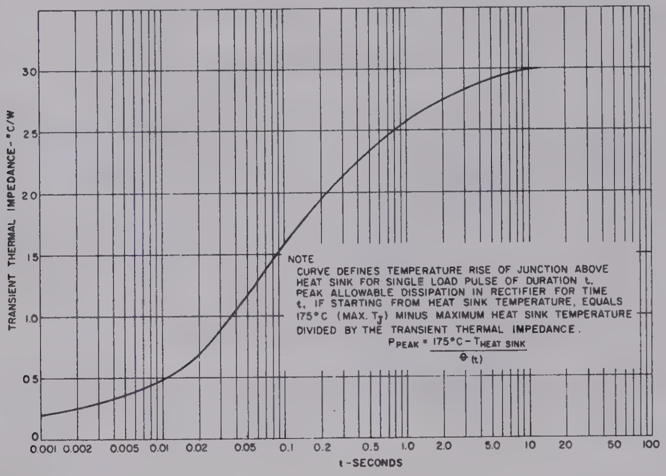
6. SUBCYCLE SURGE FORWARD CURRENT AND I^2t RATING FOLLOWING RATED LOAD CONDITIONS



7. MAXIMUM FORWARD CHARACTERISTICS



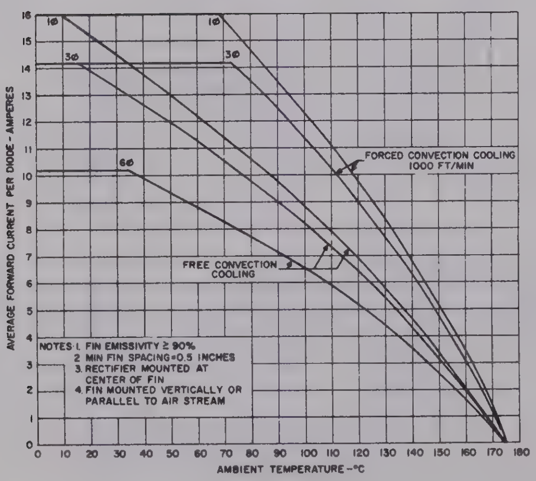
8. FORWARD POWER AS A FUNCTION OF AVERAGE FORWARD CURRENT ($T_J = +175°C$)



NOTE
CURVE DEFINES TEMPERATURE RISE OF JUNCTION ABOVE HEAT SINK FOR SINGLE LOAD PULSE OF DURATION t. PEAK ALLOWABLE DISSIPATION IN RECTIFIER FOR TIME t, IF STARTING FROM HEAT SINK TEMPERATURE, EQUALS 175°C (MAX. T_J) MINUS MAXIMUM HEAT SINK TEMPERATURE DIVIDED BY THE TRANSIENT THERMAL IMPEDANCE.

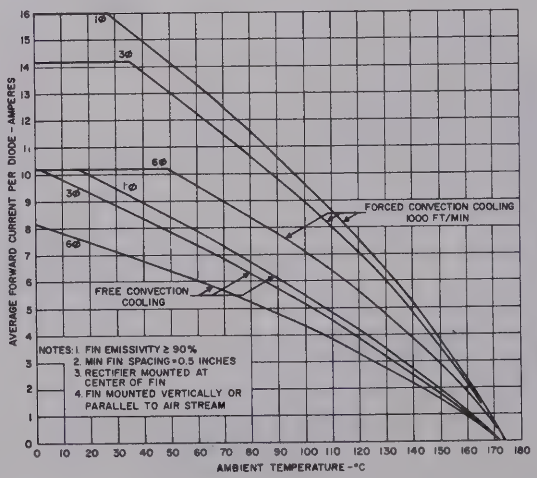
$$P_{PEAK} = \frac{175°C - T_{HEAT\ SINK}}{\theta(t)}$$

9. MAXIMUM TRANSIENT THERMAL IMPEDANCE—JUNCTION TO HEATSINK



NOTES: 1. FIN EMISSIVITY ≥ 90%
2. MIN FIN SPACING=0.5 INCHES
3. RECTIFIER MOUNTED AT CENTER OF FIN
4. FIN MOUNTED VERTICALLY OR PARALLEL TO AIR STREAM

10. CURRENT RATING FOR DEVICE MOUNTED ON A 5" x 5" x 0.050" COPPER FIN



NOTES: 1. FIN EMISSIVITY ≥ 90%
2. MIN FIN SPACING=0.5 INCHES
3. RECTIFIER MOUNTED AT CENTER OF FIN
4. FIN MOUNTED VERTICALLY OR PARALLEL TO AIR STREAM

11. CURRENT RATING FOR DEVICE MOUNTED ON A 2½" x 2½" x 0.043" COPPER FIN

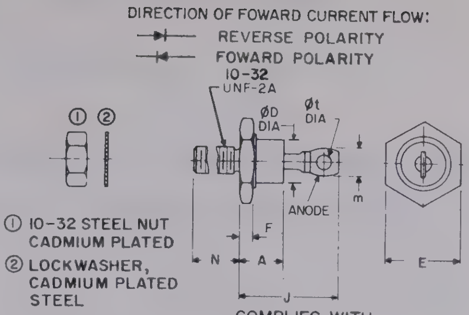
1N4506-11

OUTLINE DRAWING

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A		.405		10.29	
ϕD		.424		10.77	
E	.424	.437	10.77	11.10	
F	.075	.175	1.91	4.45	
J		.800		20.32	
m		.250		6.35	1
N	.422	.453	10.72	11.51	
ϕt	.060		1.52		
W					2

NOTES:

1. Angular orientation of this terminal is undefined.
2. 10-32 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter (.1697", 4.29 MM). Ref: (Screw thread standards for Federal Services 1957) Handbook H28, P1

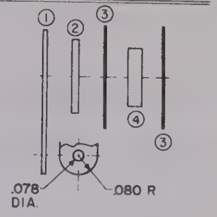

DIRECTION OF FOWARD CURRENT FLOW:
REVERSE POLARITY
FOWARD POLARITY
10-32
UNF-2A
ØD
DIA
Øt
DIA
ANODE
m
F
N
A
J
E
①
②

① 10-32 STEEL NUT CADMIUM PLATED

② LOCKWASHER, CADMIUM PLATED STEEL

COMPLIES WITH
EIA REGISTERED OUTLINE DO-4

INSULATING HARDWARE KIT*


①
②
③
④
③
.078
DIA.
.080 R

① COPPER TERMINAL, .016 THICK, TIN PLATED

② BRASS WASHER, .035 THICK NICKEL PLATED

③ MICA WASHERS, TWO, .625 O.D., .204 I.D., .005 THICK

④ TEFLON WASHER, .270 O.D. .204 I.D., .050 THICK

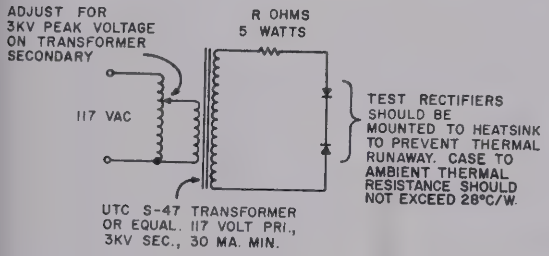
* AVAILABLE UPON REQUEST

TRY THESE SIMPLE TESTS TO PROVE HOW SUPERIOR *CONTROLLED AVALANCHE RECTIFIERS* ARE COMPARED TO OTHER RECTIFIERS:

True Controlled Avalanche Rectifiers Will Not Be Damaged In Any Way By These Tests.

STEADY-STATE

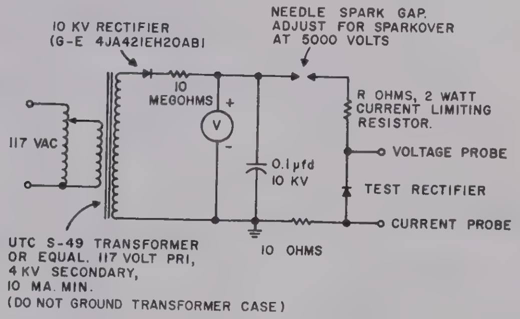
This test operates the rectifier in its high voltage avalanche region at a continuous power dissipation level of approximately 5 watts, at avalanche voltages over 800 volts. This is a test for surface stability at high voltage.


ADJUST FOR 3KV PEAK VOLTAGE ON TRANSFORMER SECONDARY
R OHMS 5 WATTS
117 VAC
TEST RECTIFIERS SHOULD BE MOUNTED TO HEATSINK TO PREVENT THERMAL RUNAWAY. CASE TO AMBIENT THERMAL RESISTANCE SHOULD NOT EXCEED 28°C/W.
UTC S-47 TRANSFORMER OR EQUAL. 117 VOLT PRI., 3KV SEC., 30 MA. MIN.

Test Rectifier	R Ohms
1N4506	50K
1N4507	75K
1N4508	100K
1N4509	100K
1N4510	100K
1N4511	100K

REVERSE IMPULSE

This tests the ability of the rectifier to withstand high transient voltages and to dissipate high levels of peak power in the reverse direction. Peak reverse power for rectifiers with avalanche voltages above 800 volts is over 250 watts in this circuit.


10 KV RECTIFIER (G-E 4JA421EH20AB1
NEEDLE SPARK GAP. ADJUST FOR SPARKOVER AT 5000 VOLTS
10 MEGOHMS
+
V
-
117 VAC
R OHMS, 2 WATT CURRENT LIMITING RESISTOR.
VOLTAGE PROBE
0.1 μfd 10 KV
TEST RECTIFIER
CURRENT PROBE
10 OHMS
UTC S-49 TRANSFORMER OR EQUAL. 117 VOLT PRI, 4 KV SECONDARY, 10 MA. MIN. (DO NOT GROUND TRANSFORMER CASE)

Test Rectifier	R Ohms
1N4506	6K
1N4507	8K
1N4508	12K
1N4509	12K
1N4510	12K
1N4511	12K

The impulse voltage and current in the test rectifier can be viewed by connecting a scope between the indicated voltage and current taps and ground.

FACTORY CONTROL TESTS

General Electric Controlled Avalanche Rectifiers are subjected to rigorous tests to assure capability to the bove conditions. In addition, production units undergo tests to control:

- Minimum/maximum avalanche voltage
- Elevated temperature reverse current
- Package leaks (helium leak test)
- Internal thermal resistance
- 5 temperature cycles (−65°C to +175°C)
- 240 ampere forward surge current capability
- Forward voltage drop
- Reverse power surge

1N4525-30

CONTROLLED AVALANCHE

Silicon Rectifier

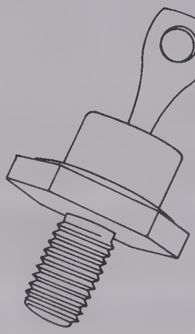
35A Avg. Up to 1200V

CONTROLLED AVALANCHE RECTIFIERS FROM GENERAL ELECTRIC

Feature These Advances in Silicon Rectifier Diode Applications:

Self-protection against normal voltage transients. Dissipates up to 12,000 watts peak power in the reverse direction. Permits decreased PRV safety factors in equipment due to greatly reduced transient voltage vulnerability.

- Unmatched standards of reliability at PRV's up to 1200 volts, as well as at lower voltages.
- Protection of other circuit components against overvoltage through rigidly specified maximum/minimum avalanche characteristics.
- Make ideal voltage equalizing elements for series connected SCR's and conventional rectifier diodes. Also for anode triggering SCR's to prevent damage from voltage transients in the forward direction.
- Simplified series operation of rectifiers in high-voltage applications . . . no shunting resistors necessary for Controlled Avalanche Rectifiers. Makes possible compact high-voltage assemblies.
- Can operate in the avalanche breakdown region at high voltages . . . unharmed by hi-pot and megger tests.



To be designated *"Controlled Avalanche"* a GE silicon rectifier diode must:

1. Have rigidly specified maximum and minimum avalanche voltage characteristics;
2. Be able to operate in its avalanche region without damage at any junction temperature up to a maximum of 175°C; and
3. Be able to absorb momentary power surges in the avalanche region, and have ratings defining this capability at starting junction temperatures of 25°C and 175°C.

For information on the application of Controlled Avalanche Rectifiers, see Publication No. 200.27, "An Introduction To The Controlled Avalanche Silicon Rectifier". Copies may be obtained from: General Electric Company, Distribution Services, Bldg. 6, Room 208, 1 River Road, Schenectady, New York 12305.

MAXIMUM ALLOWABLE RATINGS

Type	Repetitive & Working Peak Reverse Voltage* V_{RM}(rep), V_{RM}(wkg) $T_J = -65°C$ to $+175°C$ (Note: 1)	MINIMUM Avalanche Breakdown Voltage, BV_R, (5 mA test current at $T_J = 25°C$)	MAXIMUM Avalanche Breakdown Voltage, BV_R, (5 mA test current at $T_J = 25°C$)	Full-Load Reverse Current (full-cycle avg., 115°C T_C, 1 ϕ), $I_{R(AV)}$
	Volts**	Volts	Volts	Milliamperes**
1N4525	200	250	515	3.5
1N4526	400	500	770	3.5
1N4527	600	750	1030	3.5
1N4528	800	1000	1290	3.0
1N4529	1000	1250	1550	2.5
1N4530	1200	1500	1930	2.0

Average Forward Current, I_O ($T_C = +115°C$, single phase)	35 Amperes**
Peak One-Cycle Surge Current (non-repetitive), I_{FM} (surge)	500 Amperes**
Minimum I^2t Rating (see Curve 6)	500 Ampere² seconds
Reverse Power Surge (non-repetitive, 10 μsec., square wave)	
$T_J = +25°C$	12 Kilowatts
$T_J = +175°C$	4.5 Kilowatts
(For other conditions, see Curve 2)	
Average DC Reverse Power in Breakdown Region ($-65°C \leq T_C \leq +115°C$) (Note: 2)	20 Watts**
Peak Reverse Power in Breakdown Region (repetitive) (Note: 2)	100 Watts
Forward Peak Voltage Drop, V_{FM} ($T_C = +115°C$, $I_O = 12$ ampere avg.)	1.4 Volts**
Thermal Resistance, $\theta_{J\text{-}C}$	1.0°C/Watt
Operating Junction Temperature, T_J	−65°C to +175°C**
Storage Temperature, T_{stg}	−65°C to +200°C**
Stud Torque	30 Lb-in 35 Kg-cm

*Maximum voltages apply with a heatsink thermal resistance of 8°C/watt, or less, at maximum rated junction temperature.

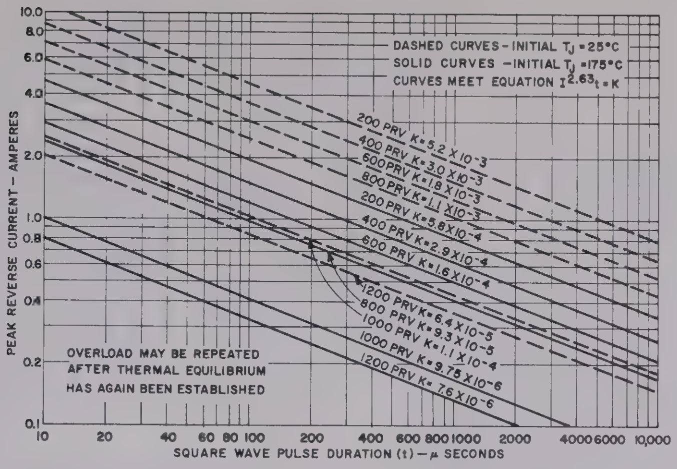
**Indicates values included in JEDEC Type Number Registration.

NOTES:

(1) V_{RM}(rep) applies for a conventional AC to DC conversion application. V_{RM}(rep) and V_{RM}(wkg) can be considered unlimited providing that the additional reverse power generation is taken into account by allowing for its influence on the forward current rating. Considerations similar to voltage regulator diode applications would apply.

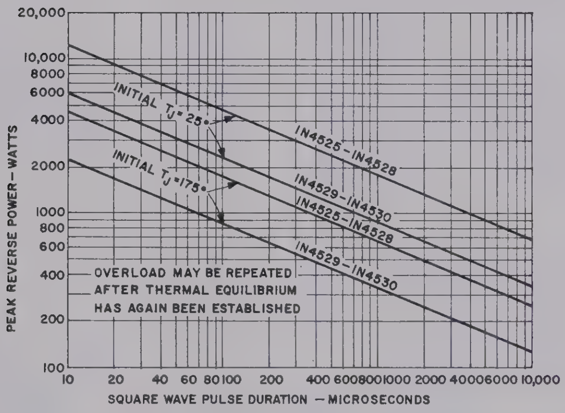
(2) These ratings assume no forward power dissipation. In applications requiring both forward and reverse average power dissipation, reduce case temperature as determined from the maximum case temperature versus average forward current curve by 2.0°C for every watt of average reverse power dissipation.

(3) Case temperature, T_C, is measured at the center of any one of the hex flats.



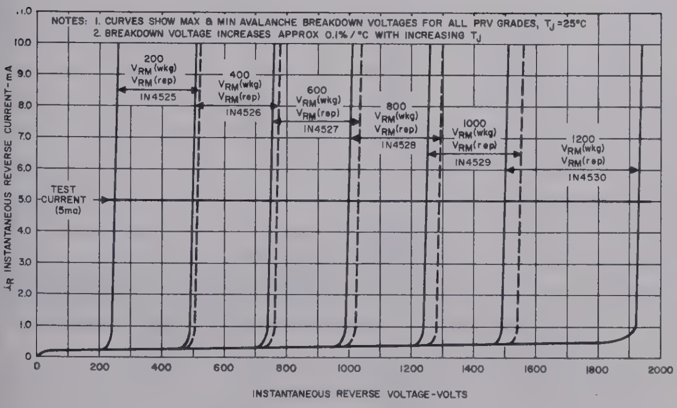
OVERLOAD MAY BE REPEATED AFTER THERMAL EQUILIBRIUM HAS AGAIN BEEN ESTABLISHED

1. NON-RECURRENT REVERSE SURGE CURRENT RATINGS



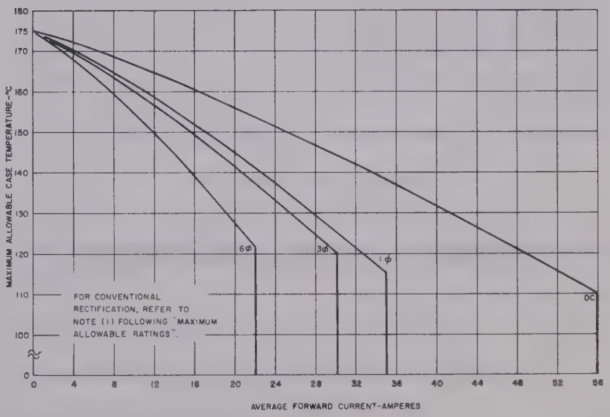
OVERLOAD MAY BE REPEATED AFTER THERMAL EQUILIBRIUM HAS AGAIN BEEN ESTABLISHED

2. NON-RECURRENT REVERSE POWER SURGE



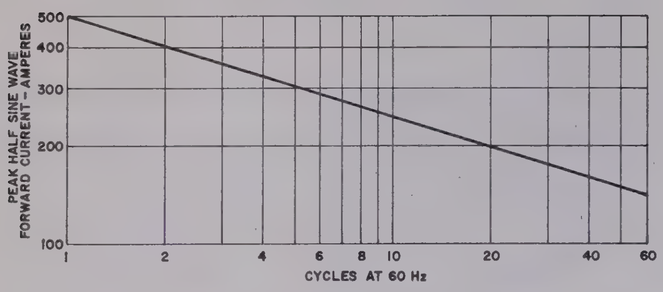
NOTES: 1. CURVES SHOW MAX & MIN AVALANCHE BREAKDOWN VOLTAGES FOR ALL PRV GRADES, T_J = 25°C
2. BREAKDOWN VOLTAGE INCREASES APPROX 0.1% / °C WITH INCREASING T_J

3. REVERSE CHARACTERISTICS

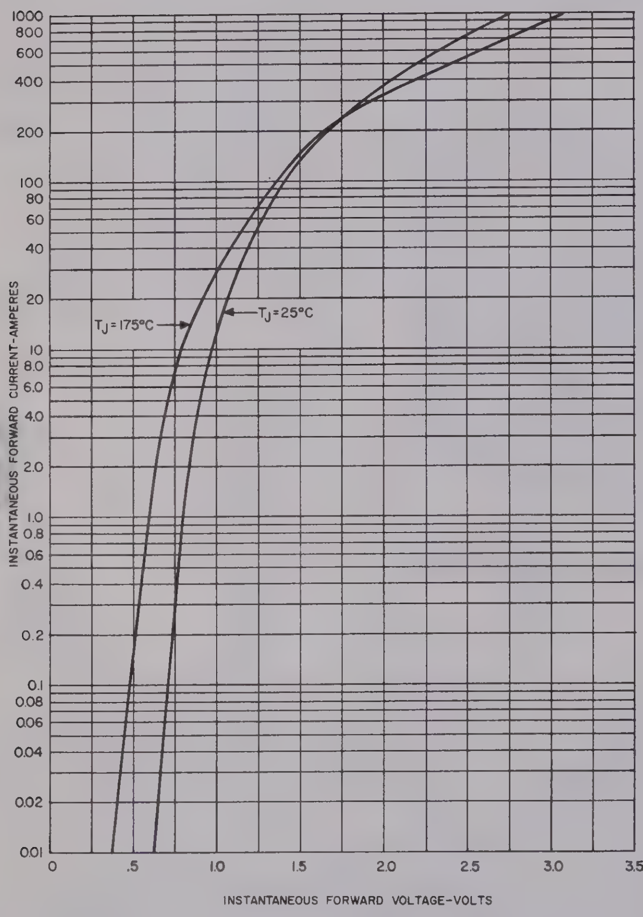


FOR CONVENTIONAL RECTIFICATION, REFER TO NOTE (1) FOLLOWING "MAXIMUM ALLOWABLE RATINGS".

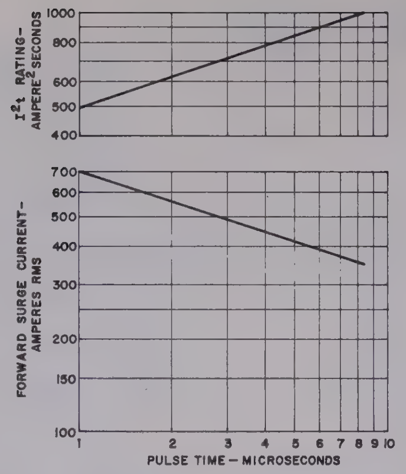
4. MAXIMUM CASE TEMPERATURE VS. AVERAGE FORWARD CURRENT



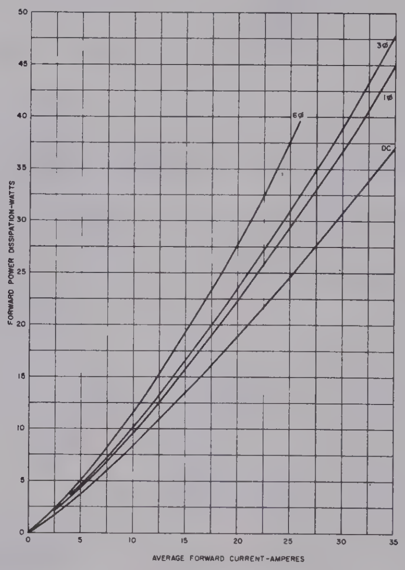
5. MAXIMUM FORWARD SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS



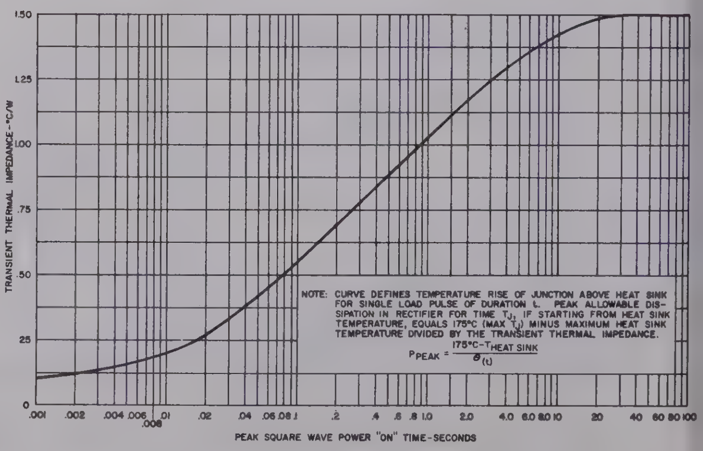
7. MAXIMUM FORWARD CHARACTERISTICS



6. SUBCYCLE SURGE FORWARD CURRENT AND I^2t RATING FOLLOWING RATED LOAD CONDITIONS



8. FORWARD POWER AS A FUNCTION OF AVERAGE FORWARD CURRENT (T_J = +175°C)



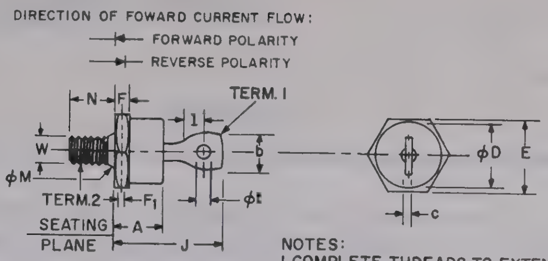
NOTE: CURVE DEFINES TEMPERATURE RISE OF JUNCTION ABOVE HEAT SINK FOR SINGLE LOAD PULSE OF DURATION t. PEAK ALLOWABLE DISSIPATION IN RECTIFIER FOR TIME T_J, IF STARTING FROM HEAT SINK TEMPERATURE, EQUALS 175°C (MAX T_J) MINUS MAXIMUM HEAT SINK TEMPERATURE DIVIDED BY THE TRANSIENT THERMAL IMPEDANCE.

$$P_{PEAK} = \frac{175°C - T_{HEAT\ SINK}}{\theta_{(t)}}$$

9. MAXIMUM TRANSIENT THERMAL IMPEDANCE—JUNCTION TO HEATSINK

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A		.450		11.43	
b		.375		9.53	2
c		.080		2.03	
ϕD		.667		16.94	
E	.667	.687	16.94	17.45	
F	.115	.200	2.92	5.08	
F_1	.060		1.52		
J		1.000		25.40	
l	.156		3.96		4
ϕM	.220	.249	5.59	6.32	1
N	.422	.453	10.72	11.51	
ϕt	.140	.175	3.56	4.45	
W					1,3

OUTLINE DRAWING


DIRECTION OF FOWARD CURRENT FLOW:
FORWARD POLARITY
REVERSE POLARITY
N
F
TERM. I
l
W
ϕM
b
ϕD
E
TERM.2
F_1
ϕt
SEATING PLANE
A
J
c

NOTES:
1. COMPLETE THREADS TO EXTEND TO WITHIN 2-1/2 THREADS OF SEATING PLANE.
2. ANGULAR ORIENTATION OF TERMINAL IS UNDEFINED.
3. 1/4-28 UNF-2A. MAXIMUM PITCH DIAMETER OF PLATED THREADS SHALL BE BASIC PITCH DIAMETER (.2268", 5.74 MM) REF. (SCREW THREAD STANDARDS FOR FEDERAL SERVICES 1957) HANDBOOK H28 1957 P1.
4. MINIMUM FLAT.

EIA-NEMA STANDARD OUTLINE, NEMA SK-51-EIA RS-241.
INSULATING HARDWARE IS AVAILABLE UPON REQUEST.

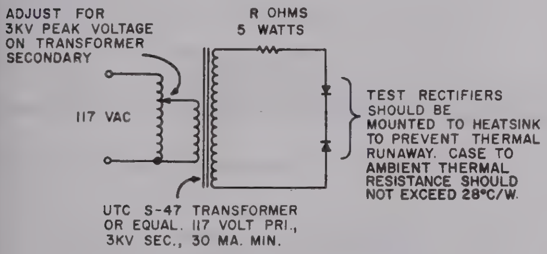
COMPLIES WITH EIA REGISTERED OUTLINE DO-5

TRY THESE SIMPLE TESTS TO PROVE HOW SUPERIOR *CONTROLLED AVALANCHE RECTIFIERS* ARE COMPARED TO OTHER RECTIFIERS:

True Controlled Avalanche Rectifiers Will Not Be Damaged In Any Way By These Tests.

STEADY-STATE

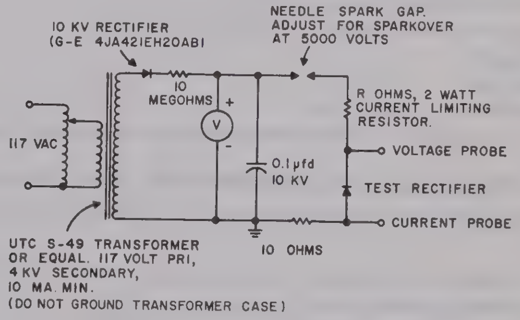
This test operates the rectifier in its high voltage avalanche region at a continuous power dissipation level of approximately 10 watts, at avalanche voltages over 800 volts. This is a test for surface stability at high voltage.


ADJUST FOR 3KV PEAK VOLTAGE ON TRANSFORMER SECONDARY
R OHMS 5 WATTS
117 VAC
TEST RECTIFIERS SHOULD BE MOUNTED TO HEATSINK TO PREVENT THERMAL RUNAWAY. CASE TO AMBIENT THERMAL RESISTANCE SHOULD NOT EXCEED 28°C/W.
UTC S-47 TRANSFORMER OR EQUAL. 117 VOLT PRI., 3KV SEC., 30 MA. MIN.

Test Rectifier	R Ohms
1N4525	25K
1N4526	37K
1N4527	50K
1N4528	50K
1N4529	50K
1N4530	50K

REVERSE IMPULSE

This tests the ability of the rectifier to withstand high transient voltages and to dissipate high levels of peak power in the reverse direction. Peak reverse power for rectifiers with avalanche voltages above 800 volts is over 500 watts in this circuit.


10 KV RECTIFIER (G-E 4JA421EH20AB1
NEEDLE SPARK GAP. ADJUST FOR SPARKOVER AT 5000 VOLTS
10 MEGOHMS
+
V
-
117 VAC
R OHMS, 2 WATT CURRENT LIMITING RESISTOR.
VOLTAGE PROBE
0.1 μfd 10 KV
TEST RECTIFIER
CURRENT PROBE
UTC S-49 TRANSFORMER OR EQUAL. 117 VOLT PRI, 4 KV SECONDARY, 10 MA. MIN. (DO NOT GROUND TRANSFORMER CASE)
10 OHMS

Test Rectifier	R Ohms
1N4525	3K
1N4526	4.5K
1N4527	6K
1N4528	6K
1N4529	6K
1N4530	6K

The impulse voltage and current in the test rectifier can be viewed by connecting a scope between the indicated voltage and current taps and ground.

FACTORY CONTROL TESTS

General Electric Controlled Avalanche Rectifiers are subjected to rigorous tests to assure capability to the above conditions. In addition, production units undergo tests to control:

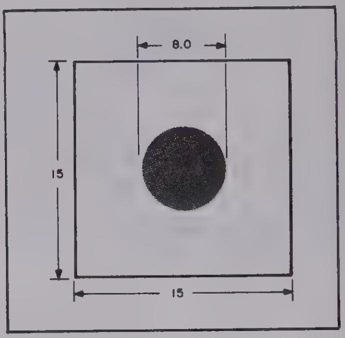
- Minimum/maximum avalanche voltage
- Elevated temperature reverse current
- Package leaks (helium leak test)
- Internal thermal resistance
- 5 temperature cycles (−65° to +175°C)
- 500 ampere forward surge current capability
- Forward voltage drop
- Reverse power surge

Silicon
Diode Chips

1N4606 (Chip)

(M79P-X501)

This General Electric silicon planar oxide-passivated diode chip is designed primarily for high conductance, high-speed switching in logic, core, hammer driver circuits and general purpose applications. The chip features controlled conductance, maximum and minimum forward voltages, specified at five forward currents from 1 mA to 200 mA.



General specifications:
- Gold cathode contact backing, minimum thickness—3000Å
- Aluminum anode contact metalization
- Maximum conditions for mounting chips—425°C for 5 minutes (Max.) in an inert atmosphere
- Shipping containers: Glass vials sealed with a nitrogen back-fill
  Maximum of 10k chips per vial
  Egg crate containers available at extra cost
- Chip drawing dimensions are in mils
- Chip thickness = 5.0 ±2 mils

absolute maximum ratings: ($T_A = 25°C$)

	Symbol		
Voltage			
Reverse	V_R	70	V
Current			
Average Rectified		200	mA
Recurrent Peak Forward		600	mA
Forward Steady State D.C.		250	mA
Peak Forward Surge (1 μsec. pulse)		4	A
Temperature			
Storage	T_{STG}	−65°C to +200°C	
Operating	T_J	−65°C to +200°C	

electrical characteristics: 100% Probe ($T_A = 25°C$)

Tested at outgoing acceptance to a 10% LTPD with a maximum accept number of 3.

	Symbol	Min.	Max.	
Reverse Breakdown Voltage ($I_R = 100\ \mu A$)	BV_R	85	—	V
Forward Voltage Drop ($I_F = 20$ mA)	V_F	—	1.05	V
Reverse Current ($V_R = 50V$)	I_R	—	100	nA

specifications: ($T_A = 25°C$)

Product yield is at least 93% to each of the following parameters:

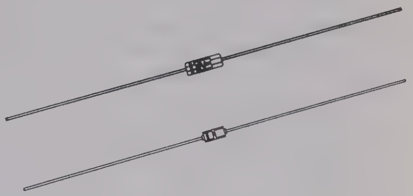
	Symbol	Min.	Max.	
Junction Capacitance	C_o			
($V_R = 0$, $e_s = 50$ mV, f = 1 MHz)		—	2.5	pF
Maximum Reverse Recovery Time	t_{rr}			
($I_F = 10$ mA, $I_R =$ mA, Recover to $I_{rr} = 0.1$ mA)		—	6	nsec.
Forward Voltage	V_F			
($I_F = 1$ mA)		0.54	0.66	V
($I_F = 10$ mA)		0.65	0.77	V
*($I_F = 50$ mA)		0.74	0.86	V
*($I_F = 100$ mA)		0.79	0.92	V
*($I_F = 200$ mA)		0.86	1.0	V

Silicon Diodes

1N4726,7

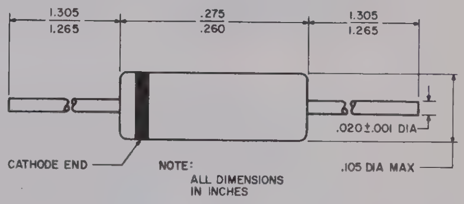
he General Electric types 1N4726 and 1N4727 are very high speed silicon planar epitaxial passivated iodes for computer circuits, switching circuits and general purpose applications. They feature maximum imits on junction capacitance and stored charge to ensure reproducible performance in high speed switching circuits.

he A291 is a power silicon rectifier diode for use in applications requiring blocking voltages up to 2000 olts and forward current ratings up to 250 amperes average in single phase applications. This device was ormerly known as 6RW51, and is reverse polarity device. The stud is the anode.

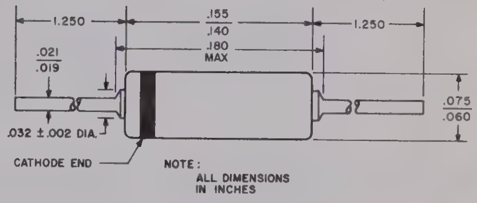


absolute maximum ratings: (25°C) (unless otherwise specified)

	1N4726	1N4727	
Voltage			
Reverse (continuous operating)	20	20	volts
Current			
Average Rectified	60	75	mA
Forward Steady-State DC	90	115	mA
Recurrent Peak Forward	175	225	mA
Peak Forward Surge (1 μsec. @ 1% Duty Cycle)	1000	2000	mA
Power			
(with Heatsinking .250″ from end of diode body)			
Dissipation (Note 1)	250	500	mW
Dissipation (125°C) (Note 2)	100	200	mW
Temperature			
Operating	← −65 to +175 →		°C
Storage	← −65 to +200 →		°C
Lead (1/16 ± 1/32 inch from case for 10 sec.)	← 300 →		°C
Derate			
Note 1: For ambient temperature above 25°C	1.5	3.0	mW/°C
Note 2: For ambient temperature above 125°C	2.0	4.0	mW/°C



1N4726, DO-7



1N4727, DHD

electrical characteristics: (25°C) (unless otherwise specified)

		Min.	1N4726 1N4727 Typ.	Max.	
Breakdown Voltage ($I_R = 5\ \mu A$)	B_V	30			Volts
Forward Voltage ($I_F = 10$ mA)	V_F		0.79	0.85	Volts
Reverse Current ($V_R = 20V$)	I_R		.02	0.1	μamp
($V_R = 20V$, $T_A = 100°C$)	I_R		3	10	μamp
Stored Charge (Note 5) ($I_F = 10$ mA) (Note 3)	Q_S		24	40	pCoul
Capacitance ($V_R = 0V$) (Note 4)	C_o		1.5	4	pf

Note 3: Stored charge as measured on B-Line Electronics model QS-3 Stored Charge Meter (pulse amplitude = 5 volts, pulse width = 50 ns, rise time = 0.4 ns, source impedance = 10 ohms)

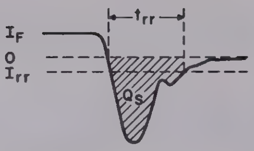
Note 4: Capacitance as measured on Boonton Electronics model 75A Capacitance Bridge at a signal level of 50 mv rms and a frequency of 1 mc.

IN4726,7

NOTE 5: STORED CHARGE

When a forward biased diode is subjected to a reverse voltage step a reverse current will flow for a short time as a result of the stored charge consisting of minority carriers in the vicinity of the junction. The typical waveform of reverse current vs time for a diode subjected to a large reverse voltage is shown in Figure 1. The time required for the diode to recover its reverse blocking condition will depend on the quantity of charge stored and the rate at which the charge is removed by recombination inside the diode and by current flowing in the external circuit. Conventionally, the speed of a diode is characterized by the reverse recovery time, t_{rr}, measured to some arbitrary current level as in Figure 1. However, for higher speed diodes reverse recovery time is not a satisfactory parameter for characterizing the speed of the diode since it is dependent on arbitrary circuit conditions and is very dependent on the construction of the test circuit. Stored charge, on the other hand, is measured by integrating the reverse current of the diode (as shown by the shaded area in Figure 1), and is consequently much less dependent on the construction of the test circuit and on arbitrary circuit conditions. Stored charge is a more ideal parameter for characterizing the speed of a diode since it represents an intrinsic characteristic of the diode and can be measured with good reproducibility on low cost instruments which have direct meter readout.

Stored charge can be correlated with reverse recovery time measurements on a specific t_{rr} test jig. Typical correlation curves are shown on the graph below.

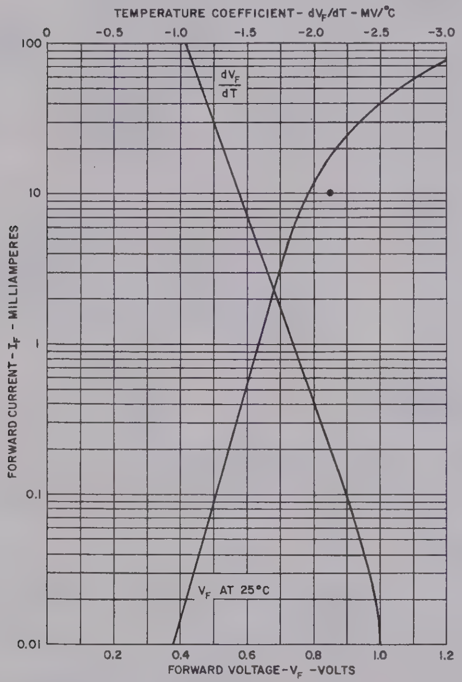


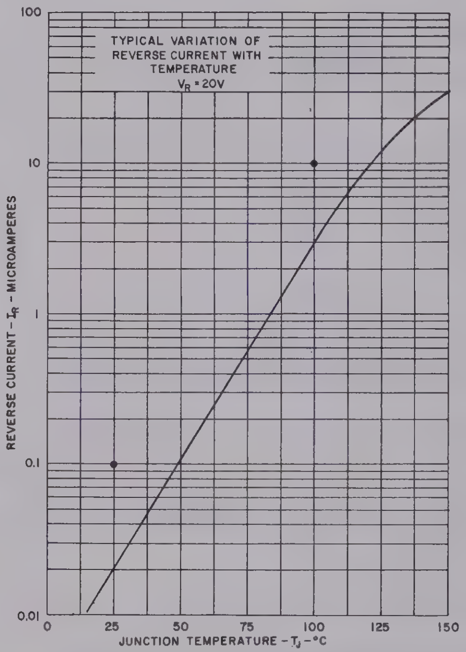
TYPICAL REVERSE RECOVERY WAVEFORM FOR A HIGH SPEED DIODE

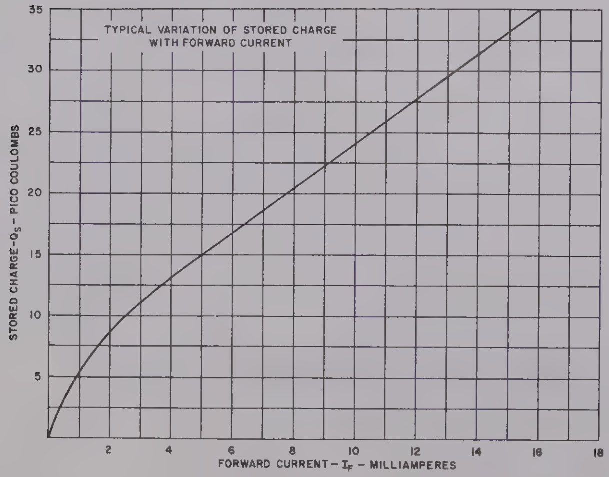
FIGURE 1

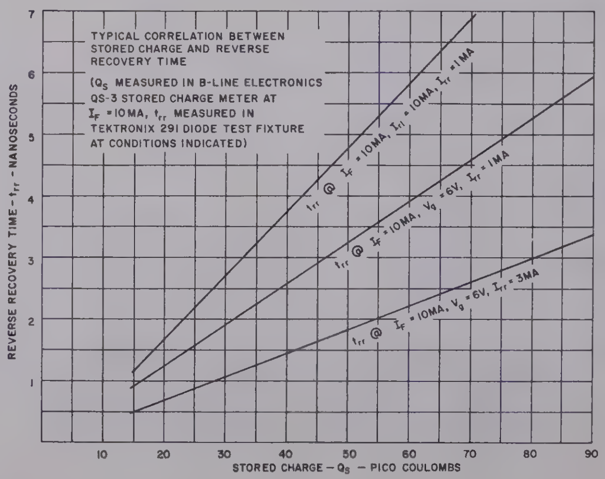
References:

(1) JEDEC Proposed Method for Direct Measurement of Diode Stored Charge, JS-2-65-11
(2) "Measurement of Stored Charge in High Speed Diodes," T. P. Sylvan Application Note #90.30 (available on request)







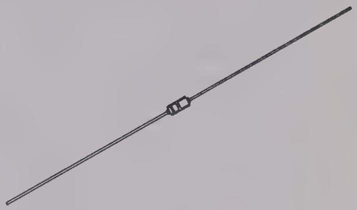


Silicon Diodes

1N4863,4

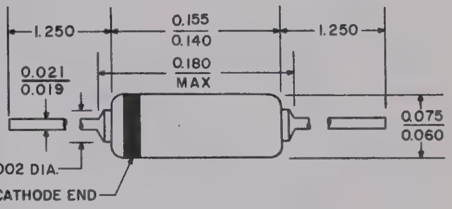
The General Electric 1N4863 and 1N4864 Double Heatsink Diodes are high voltage, low capacitance diodes for low and high current high speed switching circuits and general purpose applications. These diodes incorporate an oxide passivated planar structure built on a high resistivity, epitaxial layer grown on a low resistivity silicon substrate. The 1N4863 and 1N4864 offer controlled conductance, minimum and maximum forward boltages at four levels of forward current. This closely controlled conductance is necessary for the design of clamping and logic circuits where tight tolerances on voltage levels are required.

All Doubled Heatsink Diodes receive a one hour glass anneal bake at 425°C. This processing optimizes DHD hermetic integrity under temperature cycling and thermal shock conditions exceeding MIL-S-19 19500C requirements. All DHD's then receive a 300°C stabilization bake for 168 hours to assure parameter stability and reliability under maximum storage and operating junction temperature.



absolute maximum ratings:

	1N4863	1N4864	
Voltage			
Reverse (Continuous)	50	80	volts
Current			
Average Rectified	200	200	ma
Recurrent Peak Forward	600	600	ma
Forward Steady-State DC	250	250	ma
Peak Forward Surge (1 µsec)	4	4	amps
Power			
Dissipation	500	500	mw
Temperature			
Operating	←−65 to +200→		°C
Storage	←−65 to +200→		°C
Lead, 1/16" ± 1/32" from case for 10 sec.	←300→		°C



NOTE: ALL DIMENSIONS IN INCHES

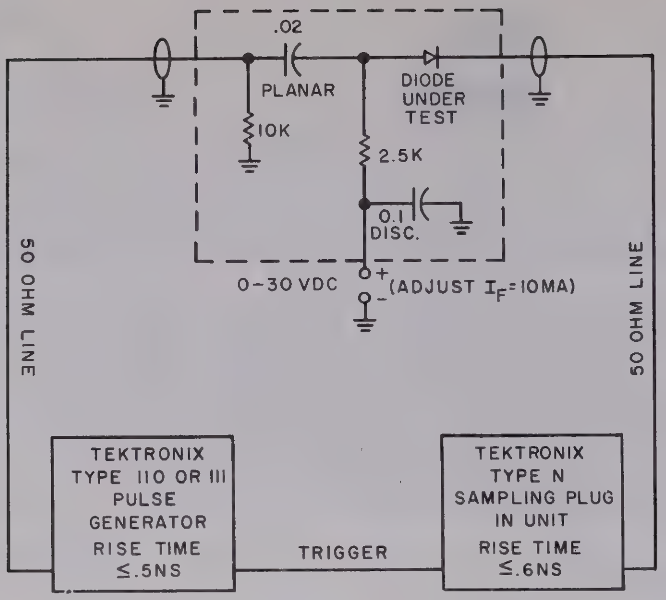
electrical characteristics: (25°C) (unless otherwise specified)

		1N4863		1N4864		
		Min.	Max.	Min.	Max.	
Forward Voltage						
($I_F = 0.1$ ma)	V_F	440	550	440	550	mv
($I_F = 1.0$ ma)	V_F	560	680	560	680	mv
($I_F = 10$ ma)	V_F	690	820	690	820	mv
($I_F = 100$ ma)(Note 1)	V_F	830	1200	830	1100	mv
Breakdown Voltage						
($I_R = 5$ µa)	B_V	70				volts
($I_R = 100$ µa)	B_V			125		volts
Reverse Current						
($V_R = 50$ V)	I_R		50			na
($V_R = 50$ V, $T_A = +150$°C)	I_R		50			µa
($V_R = 80$ V)	I_R				100	na
($V_R = 80$ V, $T_A = +150$°C)	I_R				100	µa
Capacitance						
($V_R = 0$ V) (Note 2)	C_o		2		1.3	pf
Reverse Recovery Time						
($I_F = I_R = 10$ ma, Recover to 1 ma) (Fig. 1)	t_{rr}		7			nsec
($I_F = 10$ ma, $V_R = 6$ V, $R_L = 100\Omega$, Recover to 1 ma) (Fig. 1)	t_{rr}				4	nsec
($I_F = I_R = 100$ ma, Recover to 10 ma) (Fig. 2)	t_{rr}				9	nsec

note:

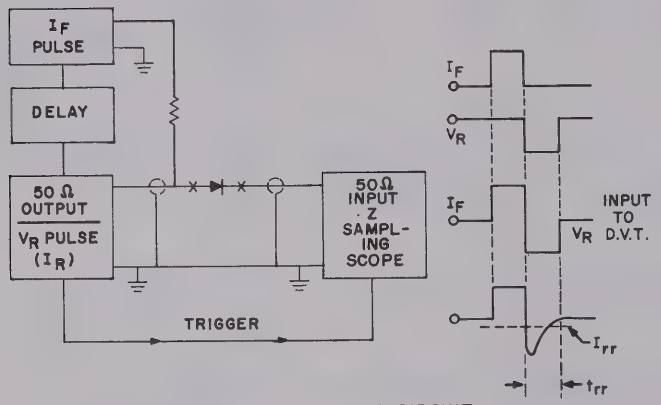
(1) Pulsed measurement (Pulse width ≤ 300 µsec, Duty cycle ≤ 2%).

(2) Capacitance as measured on Boonton Model 75A capacitance bridge at a signal level of 50 mv and a frequency of 1 mc.


.02
PLANAR
DIODE UNDER TEST
10K
2.5K
0.1 DISC.
0-30 VDC
+
-
(ADJUST I_F=10MA)
50 OHM LINE
50 OHM LINE
TEKTRONIX TYPE 110 OR 111 PULSE GENERATOR RISE TIME ≤.5NS
TRIGGER
TEKTRONIX TYPE N SAMPLING PLUG IN UNIT RISE TIME ≤.6NS

LOW CURRENT t_{rr} TEST CIRCUIT

FIGURE 1


I_F PULSE
DELAY
50 Ω OUTPUT
V_R PULSE (I_R)
50Ω INPUT Z SAMPLING SCOPE
TRIGGER
I_F
V_R
I_F
V_R
INPUT TO D.V.T.
I_{rr}
t_{rr}

HIGH CURRENT TEST CIRCUIT

FIGURE 2

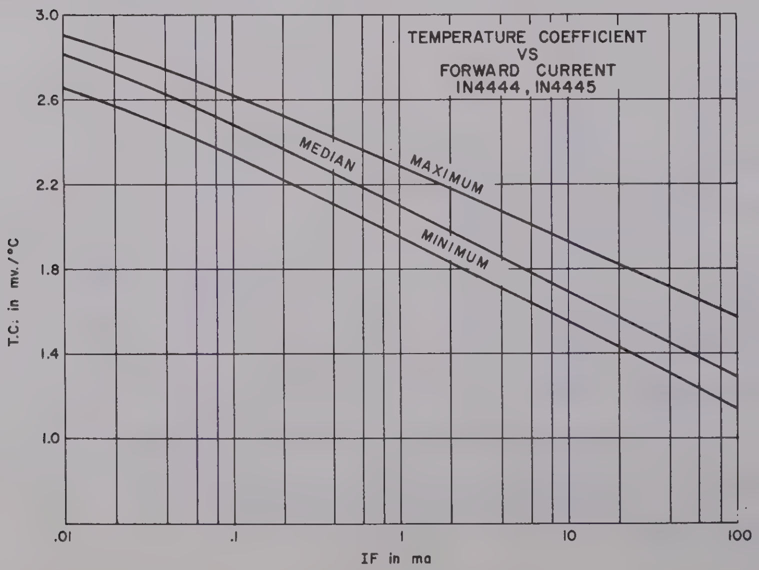
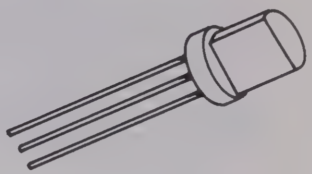


FIGURE 3

Silicon
Diode

1N4951,2

The General Electric 1N4951 and 1N4952 are matched pairs of silicon planar passivated diodes designed primarily for T. V. horizontal phase discriminator applications.

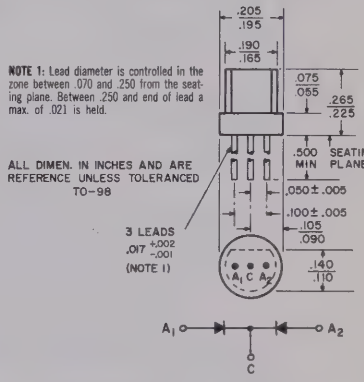


Features: Low Cost, Common Cathode, Single Pellet, inherent match and High Efficiency.

ABSOLUTE MAXIMUM RATINGS: (25°C unless otherwise specified)

Reverse Voltages		
1N4951	V_R	20 volts
1N4952		50 volts
Forward Current		
Steady State D.C. Each Diode	I_F	25 mA
Power Dissipation		
25°C ambient*	P	200 mW
55°C ambient*		120 mW
Temperatures		
Storage	T_{stg}	−55 to +125°C
Operating	T_J	+100°C
Lead Soldering, 1/16″ ± 1/32″ from case for 10 seconds max.	T_L	+260°C

*Derate 2.67 mW/°C increase in ambient temperature above 25°C. Rating is for total of both diodes and may be shared in any manner.



NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED
TO-98

ELECTRICAL CHARACTERISTICS EACH DIODE: (25°C unless otherwise specified)

	Symbol	Typ.	Max.	Units
Forward Voltage ($I_F = 1$ mA D.C.)	V_F	.72	.85	VDC
Reverse Current, 1N4951 ($V_R = 20$V D.C.)	I_R	.0001	0.1	μADC
1N4952 ($V_R = 50$V D.C.)		.002	0.1	μADC
Reverse Current (100°C), 1N4951 ($V_R = 20$V D.C.)	I_R	.01	2.0	μADC
1N4952 ($V_R = 50$V D.C.)		.04	2.0	μADC
Capacitance (f = 1 MHz†, $V_R = 0$)	C_o	2.3	4.0	pF
Capacitance (f = 1 MHz†, $V_R = 10$V)	C_o	1.1		pF
Capacitance unbalance (f = 1 MHz†, $V_R = 0$)	$\triangle C_o$	.05		pF
Stored Charge ($I_F = 10$ mA)	Q_S	625		pC

Typically 90% of these dual diodes are forward voltage balanced to 6 millivolts or less with I_{F1} and I_{F2} at 1 mAD. C.; and to 10 millivolts or less over the 1μA to 2 mA range.

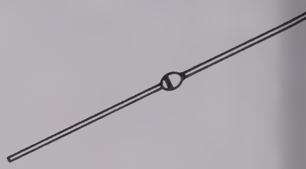
† Hz = Cycles per second.

Passivated Rectifier

TRANSIENT VOLTAGE PROTECTED

2.5 Amps 200-1000 Volts

A14 SERIES
1N5059
1N5060
1N5061
1N5062
A14P



THE GENERAL ELECTRIC A14 IS A 2.5 AMPERE RATED, AXIAL-LEADED GENERAL PURPOSE RECTIFIER. DUAL HEATSINK CONSTRUCTION PROVIDES RIGID MECHANICAL SUPPORT FOR THE PELLET AND EXCELLENT THERMAL CHARACTERISTICS. PASSIVATION AND PROTECTION OF THE SILICON PELLETS PN JUNCTION ARE PROVIDED BY SOLID GLASS; NO ORGANIC MATERIALS ARE PRESENT WITHIN THE HERMETICALLY SEALED PACKAGE.

The A14 is "Transient-Voltage Protected." This device will dissipate up to 1000 watts in the reverse direction without damage. Voltage Transients generated by household or industrial power lines are dissipated.

absolute maximum ratings: (25°C unless otherwise specified)

	1N5059 (A14B)	1N5060 (A14D)	1N5061 (A14M)	1N5062 (A14N)	A14P	
*Reverse Voltage (−65°C to +175°C, T_J) (−65°C to +165°C for 1N5062 and A14P)						
Working Peak, V_{RWM}	200	400	600	800	1000	Volts
DC, V_R	200	400	600	800	1000	Volts
*Average Forward Current, I_O						
*100°C Ambient (90°C for 1N5062 and A14P)	←		1.0		→	Amp
25°C Ambient (See Rating Curves)	←		2.5		→	Amp
*Peak Surge Forward Current, I_{FSM} Non-repetitive, .0083 sec., half sine wave,						
Full Load JEDEC Method	←		50		→	Amps
No Load (25°C Case)	←		65		→	Amps
Peak Surge Forward Current, I_{FSM} Non-repetitive, .001 sec., half sine wave,						
Full Load	←		90		→	Amps
No Load (25°C Case)	←		100		→	Amps
*Junction Operating and Storage Temperature Range, T_J & T_{STG}	← −65 to +175		←	→ −65 to +165	→	°C
I^2t, RMS (for fusing), .001 to .01 sec.	←		4.0		→	Amps^2 sec
Maximum Avalanche Voltage	←		1600		→	Volts
Peak Non-repetitive Reverse Power Rating, P_{RM}						
20 μsec., half sine wave, at Max. T_J	←		1000		→	Watts
*100 μsec., JEDEC	←		450		→	Watts

*Mounting: Any position. Lead Temperature 290°C maximum to ⅛ inch from body for 5 seconds maximum durin mounting.

electrical characteristics: (25°C unless otherwise specified)

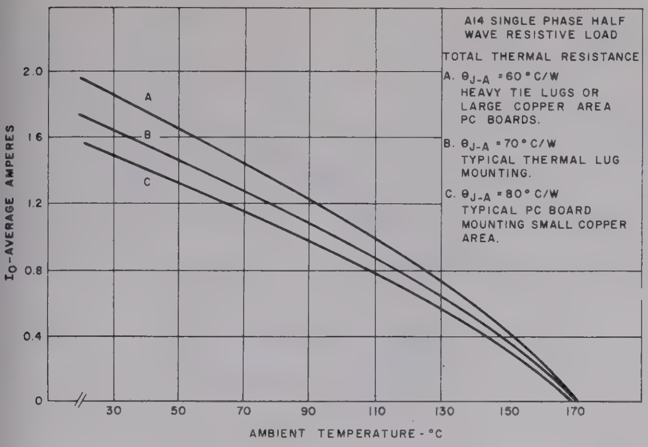
	1N5059	1N5060	1N5061	1N5062	A14P	
Maximum Forward Voltage Drop, V_F, 1A, $T_J = 25°C$	←		1.0		→	Volt
*Maximum Forward Voltage Drop, V_F, 1A, $T_J = 75°C$	←		1.2		→	Volts
Maximum Reverse Current, I_R, at Rated V_{RRM}:						
$T_J = 25°C$	←		5.0		→	μA
*$T_J = 165°C$	—	—	—	200	200	μA
*$T_J = 175°C$	300	300	200	—	—	μA
Typical Reverse Current, I_R, at Rated V_{RRM}	←		1.0		→	μA
Typical Reverse Current, I_R						
$T_J = 25°C$	0.2	0.2	0.3	0.5	0.5	μA
$T_J = 100°C$	20	20	20	30	30	μA
Typical Reverse Recovery Time, T_{RR}	←		3		→	μsec.
Maximum Reverse Recovery Time, T_{RR}	←		6		→	μsec.

*JEDEC Registered data.

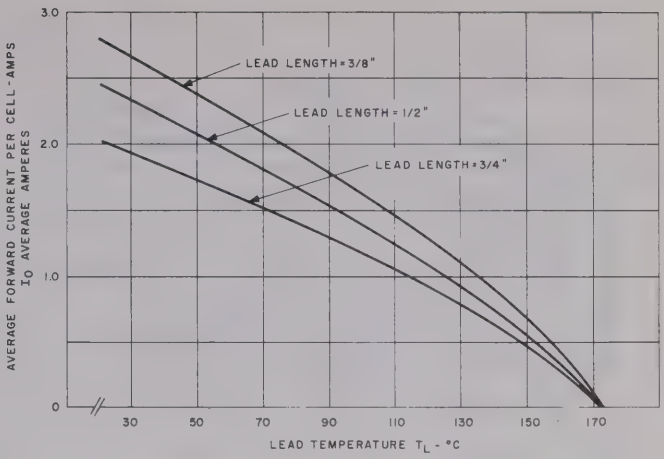
MAXIMUM ALLOWABLE DC OUTPUT CURRENT RATINGS

SINGLE PHASE

600 VOLTS & BELOW



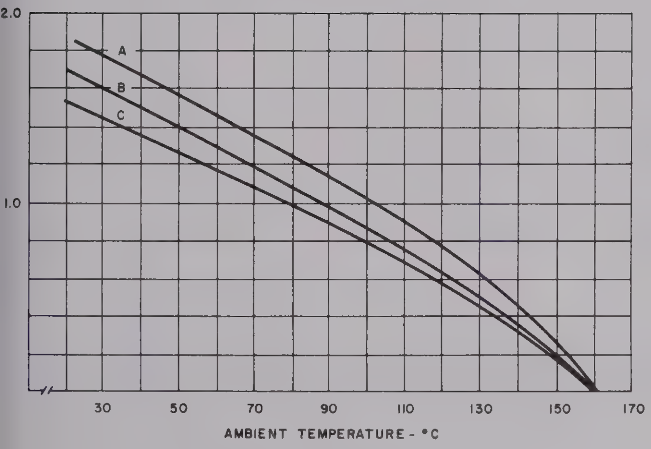
AMBIENT OPERATION



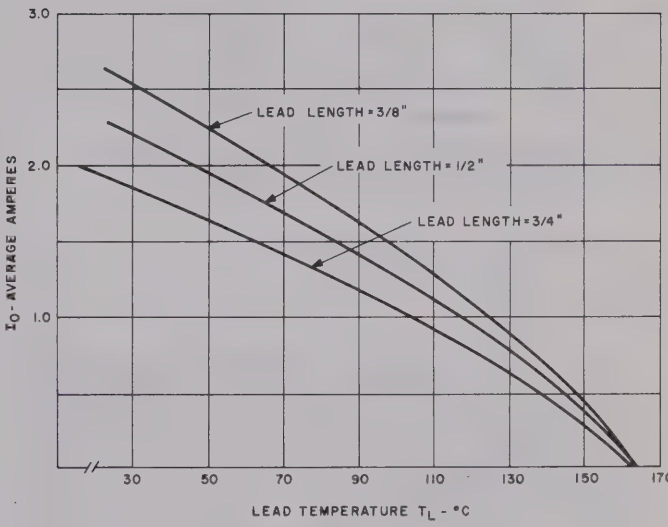
TIE POINT OPERATION

RESISTIVE OR INDUCTIVE LOAD

800 AND 1000 VOLTS

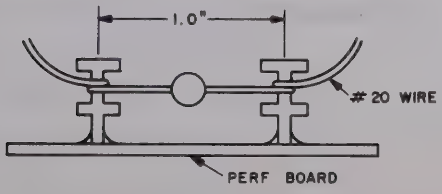


AMBIENT OPERATION

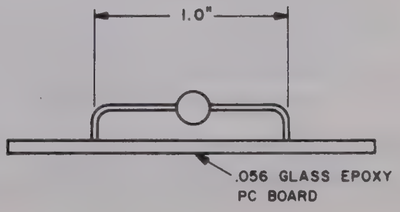


TIE POINT OPERATION

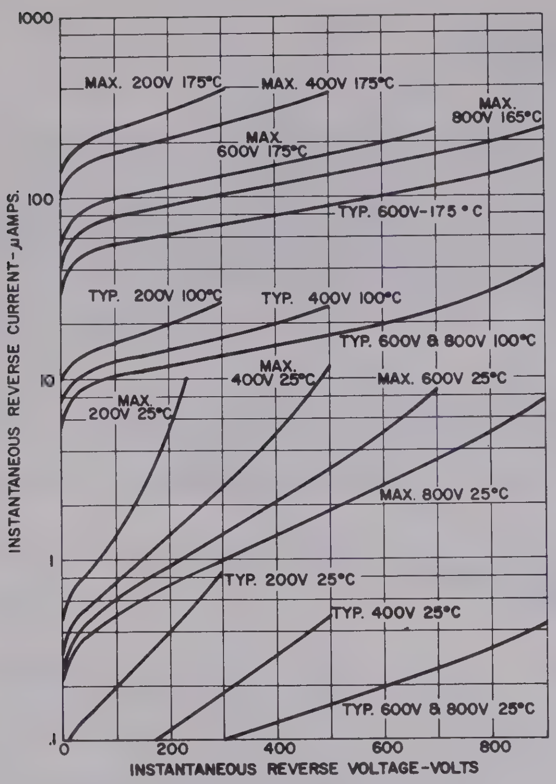
TYPICAL TIE LUG MOUNTS


1.0"
# 20 WIRE
PERF BOARD

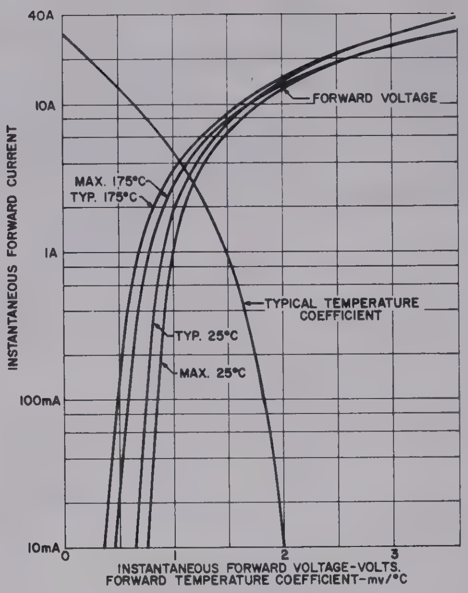
TYPICAL PC BOARD MOUNTING


1.0"
.056 GLASS EPOXY PC BOARD

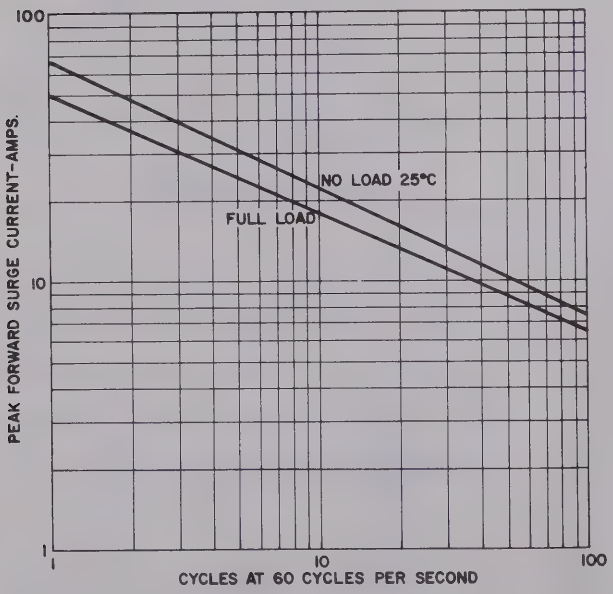
TYPICAL CHARACTERISTICS



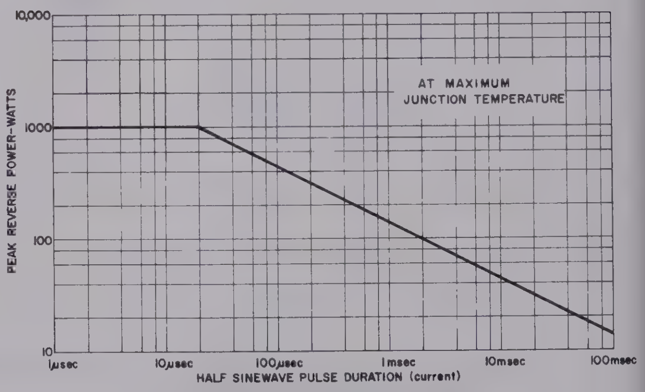
REVERSE CHARACTERISTICS AT SELECTED JUNCTION TEMPERATURES



FORWARD CHARACTERISTICS



MAXIMUM NON-REPETITIVE MULTICYCLE FORWARD SURGE CURRENT



MAXIMUM NON-REPETITIVE AVALANCHE SURGE POWER

CAPACITIVE LOADS

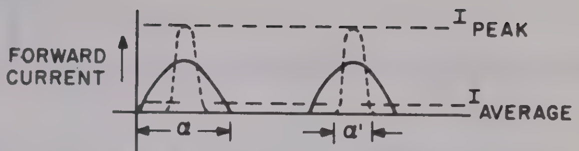
Current Derating (capacitive load)

Average forward current as specified under MAXIMUM RATINGS page 1 and derating curves for high temperature operation page 2, must be corrected for applications with capacitive loads. As the current conduction angle, ∝′, is decreased, the peak current required to maintain the *same average current* increases, i.e., the peak-to-average current ratio increases from 3.14. Figure 9 gives the derating required based on this increase in peak to average current ratio for sine wave operation. For more complete information consult Application Note 200.30.

METHOD:
1. Determine conduction angle ∝′ in degrees for *particular circuit as designed.*
2. Enter Figure 9 for the particular conduction angle and read corresponding percent of forward current per cell.
3. Multiply this value times average forward current for resistive load from figures on page 2 as given for the actual ambient or tiepoint temperature required.

TYPICAL EXAMPLES (25°C Ambient Temperature)

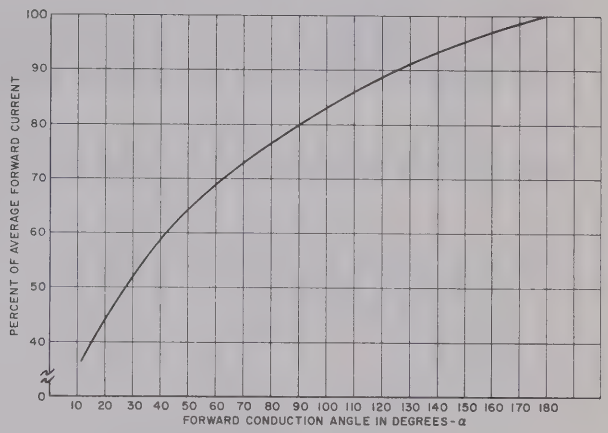
	Example No. 1	Example No. 2	Example No. 3	Example No. 4	Units
Input Voltage	100	100	300	300	Volts
D.C. (Average) Output Voltage	34	75	180	270	Volts
Surge Resistor	1	1	3.5	3.5	Ohms
Load Current	0.5	0.5	0.5	0.5	Amps.
Input Filter Capacitance	30	100	30	100	μF.
Conduction Angle	170	70	90	50	Degrees
Rated Average Current (Resistive Load)	1	1	1	1	Amp.
Rated Average Current (Capacitive Load)	0.98	0.73	0.80	0.65	Amp.



α = CONDUCTION ANGLE (180°)

α' = SHORTENED CONDUCTION ANGLE

OSCILLOSCOPE PRESENTATION

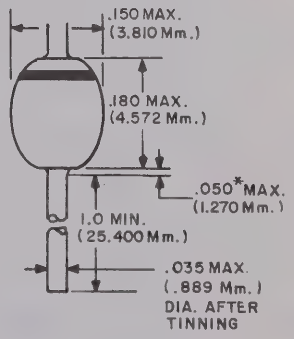


9. DERATING FOR SHORTENED CONDUCTION ANGLE

INTERNAL CONSTRUCTION

1. Dual heatsink design for maximum heat dissipation under both surge and continuous duty. No fragile "whiskers" or S leads with their potential trouble spots.
2. Glass Package. No internal cavity to act as potential source of moisture or contamination on junction. Temperature coefficient of the glass is matched with the internal parts.
3. Diffused silicon junction passivated surface.

Marking band to appear on cathode end.



OUTLINE DRAWING

ALL DIMENTIONS ARE IN INCHES AND (METRIC)

*WELD AND SOLDER FLASH NOT CONTROLLED IN THIS AREA

TYPICAL APPLICATIONS

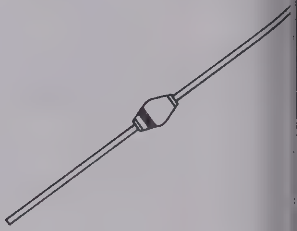
- FREE-WHEELING RECTIFIERS
- TIME DELAY CIRCUITS
- POWER LOGIC CIRCUITS
- ARC SUPPRESSION
- BATTERY CHARGERS
- TV DAMPER DIODES
- TV AND RADIO POWER SUPPLIES
- COMMUNICATION EQUIPMENT
- S.C.R. TRIGGER CIRCUITS
- SMALL PORTABLE APPLIANCES
- GENERAL PURPOSE POWER SUPPLIES
- LOW LEVEL LIMITERS

Lead Mounted
Rectifier

TRANSIENT VOLTAGE PROTECTED
5.0 Amps 200-800 Volts

A15 SERIES
1N5624
1N5625
1N5626
1N5627

THE GENERAL ELECTRIC A15 IS A 5.0 AMPERE RATED, AXIAL LEADED GENERAL PURPOSE RECTIFIER. ITS DUAL HEATSINK CONSTRUCTION PROVIDES RIGID MECHANICAL SUPPORT FOR THE PELLET AND EXCELLENT THERMAL CHARACTERISTICS. PASSIVATION AND PROTECTION OF THE SILICON PELLET'S PN JUNCTION ARE PROVIDED BY SOLID GLASS; NO ORGANIC MATERIALS ARE PRESENT WITHIN THE HERMETICALLY SEALED PACKAGE.



The A15 is "Transient Voltage Protected." This device will dissipate up to 1000 watts in the reverse direction without damage. Voltage Transients generated by household or industrial power lines are dissipated.

absolute maximum ratings: (25°C unless otherwise specified)

<table>
<tr><th></th><th>1N5624
(A15B)</th><th>1N5625
(A15D)</th><th>1N5626
(A15M)</th><th>1N5627
(A15N)</th><th></th></tr>
<tr><td>*Reverse Voltage (−65°C to +175°C, T_J)</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Working Peak, V_{RWM}</td><td>200</td><td>400</td><td>600</td><td>800</td><td>Volts</td></tr>
<tr><td>Repetitive Peak, V_{RRM}</td><td>200</td><td>400</td><td>600</td><td>800</td><td>Volts</td></tr>
<tr><td>DC, V_R</td><td>200</td><td>400</td><td>600</td><td>800</td><td>Volts</td></tr>
<tr><td>Average Forward Current, I_O</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>*70°C ambient, see rating curves</td><td colspan="4">3.0</td><td>Amps</td></tr>
<tr><td>25°C ambient, see rating curves</td><td colspan="4">5.0</td><td>Amps</td></tr>
<tr><td>*Peak Surge Forward Current, I_{FSM}
Non repetitive, .0083 sec., half sine wave,
Full Load JEDEC Method</td><td colspan="4">125</td><td>Amps</td></tr>
<tr><td>Peak Surge Forward Current, I_{FSM}
Non-repetitive, .001 sec., half sine wave,
Full load 175°C, T_J</td><td colspan="4">225</td><td>Amps</td></tr>
<tr><td>*Junction Operating Temperature Range</td><td colspan="4">−65 to +175</td><td>°C</td></tr>
<tr><td>*Storage Temperature Range</td><td colspan="4">−65 to +200</td><td>°C</td></tr>
<tr><td>I^2t, RMS for fusing .001 to .01 sec.</td><td colspan="4">25</td><td>Amp^{2}s</td></tr>
<tr><td>Peak Non-repetitive Reverse Power Rating</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>20 μsec half sine wave at Max T_J</td><td colspan="4">1000</td><td>Watts</td></tr>
<tr><td>*100 μsec., JEDEC</td><td colspan="4">450</td><td>Watts</td></tr>
</table>

*Mounting: Any position. Lead temperature 290°C maximum to 1/8″ from body for 5 seconds maximum during mounting.

electrical characteristics:

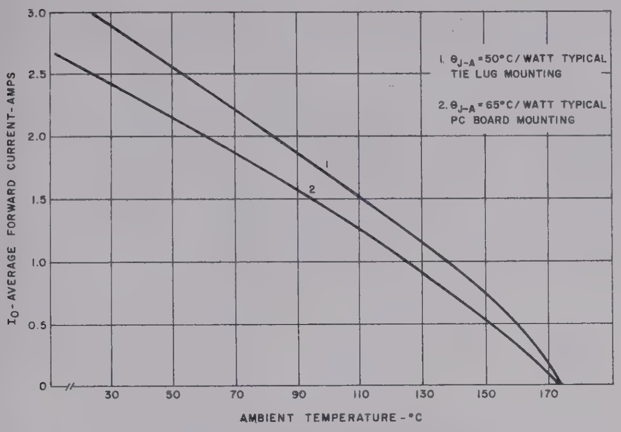
<table>
<tr><td>Maximum Forward Voltage Drop, V_F</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>$I_F = 3.0A, T_A = 25°C$</td><td colspan="4">1.0</td><td>Volts</td></tr>
<tr><td>*$I_F = 3.0A, T_A = 70°C$</td><td colspan="4">0.95</td><td>Volts</td></tr>
<tr><td>Maximum Reverse Current, I_R, at rated V_{RRM}</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>$T_J = 25°C$</td><td colspan="4">5.0</td><td>μA</td></tr>
<tr><td>*$T_J = 175°C$</td><td>300</td><td>300</td><td>200</td><td>200</td><td>μA</td></tr>
<tr><td>Typical Reverse Current @ 25°C</td><td colspan="4">1.0</td><td>μA</td></tr>
<tr><td>Typical Reverse Recovery Time, T_{RR}</td><td colspan="4">2.5</td><td>μsec</td></tr>
<tr><td>Maximum Reverse Recovery Time, T_{RR}
Recovery Circuit Per MIL-S-19500/286C</td><td colspan="4">5.0</td><td>μsec</td></tr>
</table>

*JEDEC Registered data.

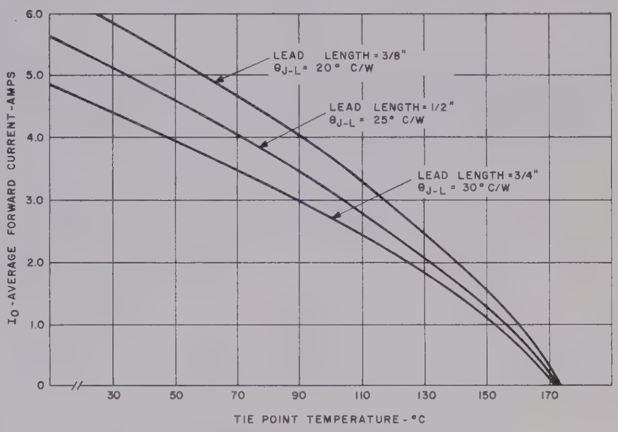
CIRCUIT DESIGN INFORMATION

MAXIMUM ALLOWABLE DC OUTPUT CURRENT RATINGS

SINGLE PHASE, RESISTIVE AND INDUCTIVE LOADS

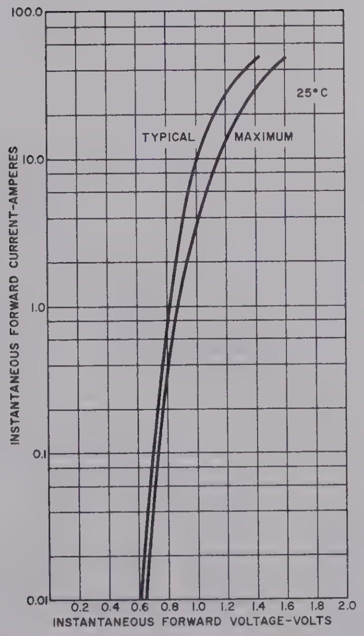


AMBIENT OPERATION
(See Tie Point Mounting Below)

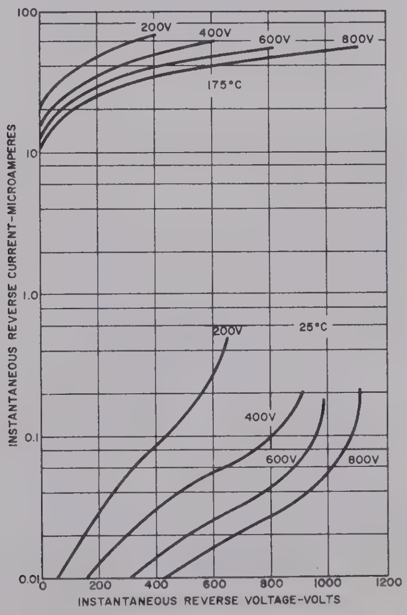


TIE POINT OPERATION

TYPICAL CHARACTERISTICS

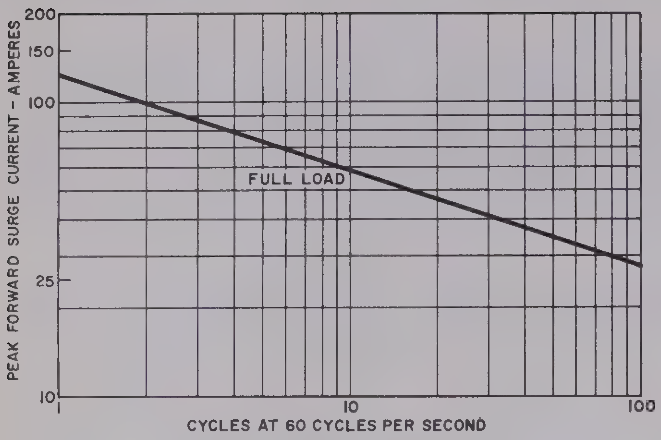


FORWARD CHARACTERISTICS

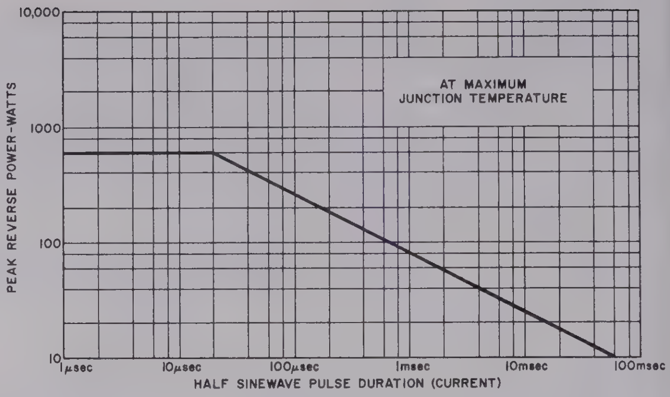


REVERSE CHARACTERISTICS

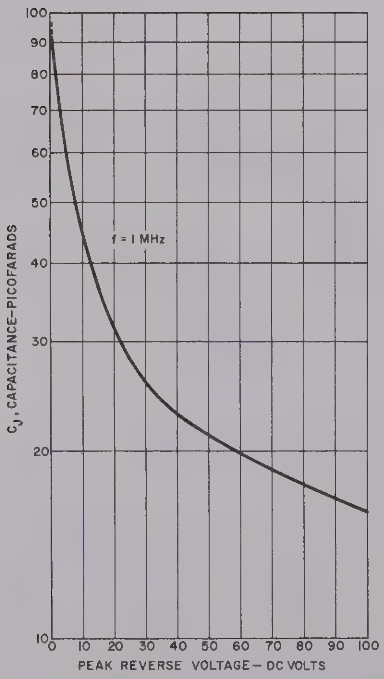
TYPICAL CHARACTERISTICS



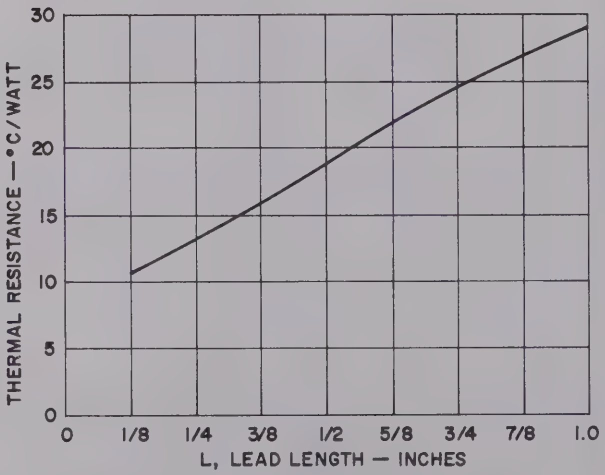
MAXIMUM NON-REPETITIVE MULTICYCLE FORWARD SURGE CURRENT



MAXIMUM NON-REPETITIVE AVALANCHE SURGE POWER



JUNCTION CAPACITANCE



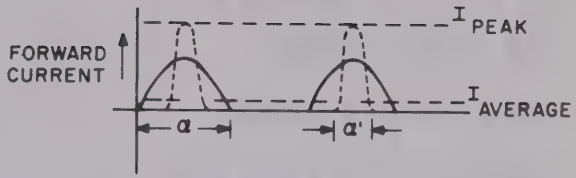
STEADY STATE THERMAL RESISTANCE

Current Derating (capacitive load)

Average forward current as specified under maximum ratings, page 1, and derating curves for high temperature operation, above, must be corrected for applications with capacitive loads. As the current conduction angle, α′, is decreased, the peak current required to maintain the *same average current* increases, i.e., the peak-to-average current ratio increases from 3.14. Figure 3 gives the derating required based on this increase in peak to average current ratio for sine wave operation. For more complete information consult Application Note 200.30.

METHOD:
1. Determine conduction angle α′ in degrees for *particular circuit as designed.*
2. Enter Figure 3 for the particular conduction angle and read corresponding percent of forward current per cell.
3. Multiply this value times average forward current for resistive load from Figures 1 and 2 as given for the actual ambient or tiepoint temperature required.

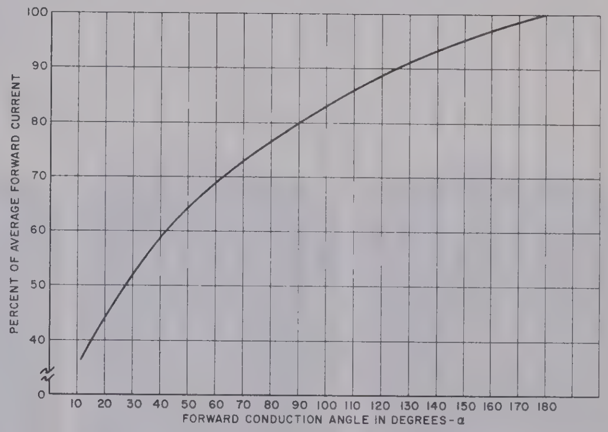
See Typical Examples Below


FORWARD CURRENT
I PEAK
I AVERAGE
α
α'

α = CONDUCTION ANGLE (180°)
α' = SHORTENED CONDUCTION ANGLE

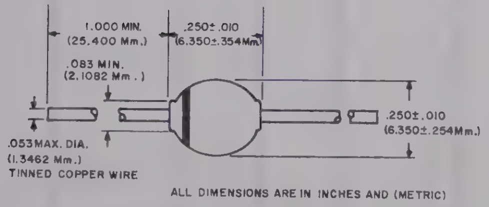
OSCILLOSCOPE PRESENTATION

TYPICAL EXAMPLES (25°C Ambient Temperature)					
	Example No. 1	Example No. 2	Example No. 3	Example No. 4	Units
Conduction Angle (α)	170	110	130	70	Degrees
Rated Average Current (Resistive Load)	3	3	3	3	Amp.
% of Average Current	0.98	0.86	0.92	0.73	%
Rated Average Current (Capacitive Load)	2.9	2.6	2.8	2.2	Amps.

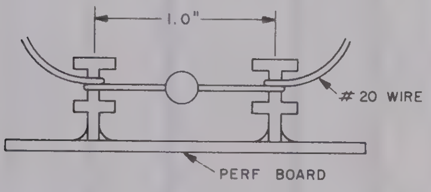


DERATING FOR SHORTENED CONDUCTION ANGLE

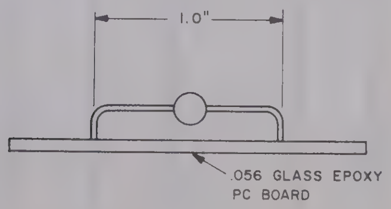
OUTLINE DRAWING


1.000 MIN.
(25.400 Mm.)
.250±.010
(6.350±.354Mm)
.083 MIN.
(2.1082 Mm.)
.250±.010
(6.350±.254Mm.)
.053MAX. DIA.
(1.3462 Mm.)
TINNED COPPER WIRE
ALL DIMENSIONS ARE IN INCHES AND (METRIC)

TYPICAL TIE LUG MOUNTS


1.0"
# 20 WIRE
PERF BOARD

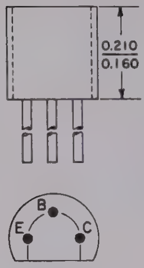
TYPICAL PC BOARD MOUNTING


1.0"
.056 GLASS EPOXY
PC BOARD

GET

a new source of reliable epoxy case replacements for TO-18 transistors

The General Electric GET transistor series is your new answer to circuit design problems. GET is the most recent member of GE's proved epoxy encapsulated transistor family dating back to 1962 . . . over 6 years of epoxy experience.



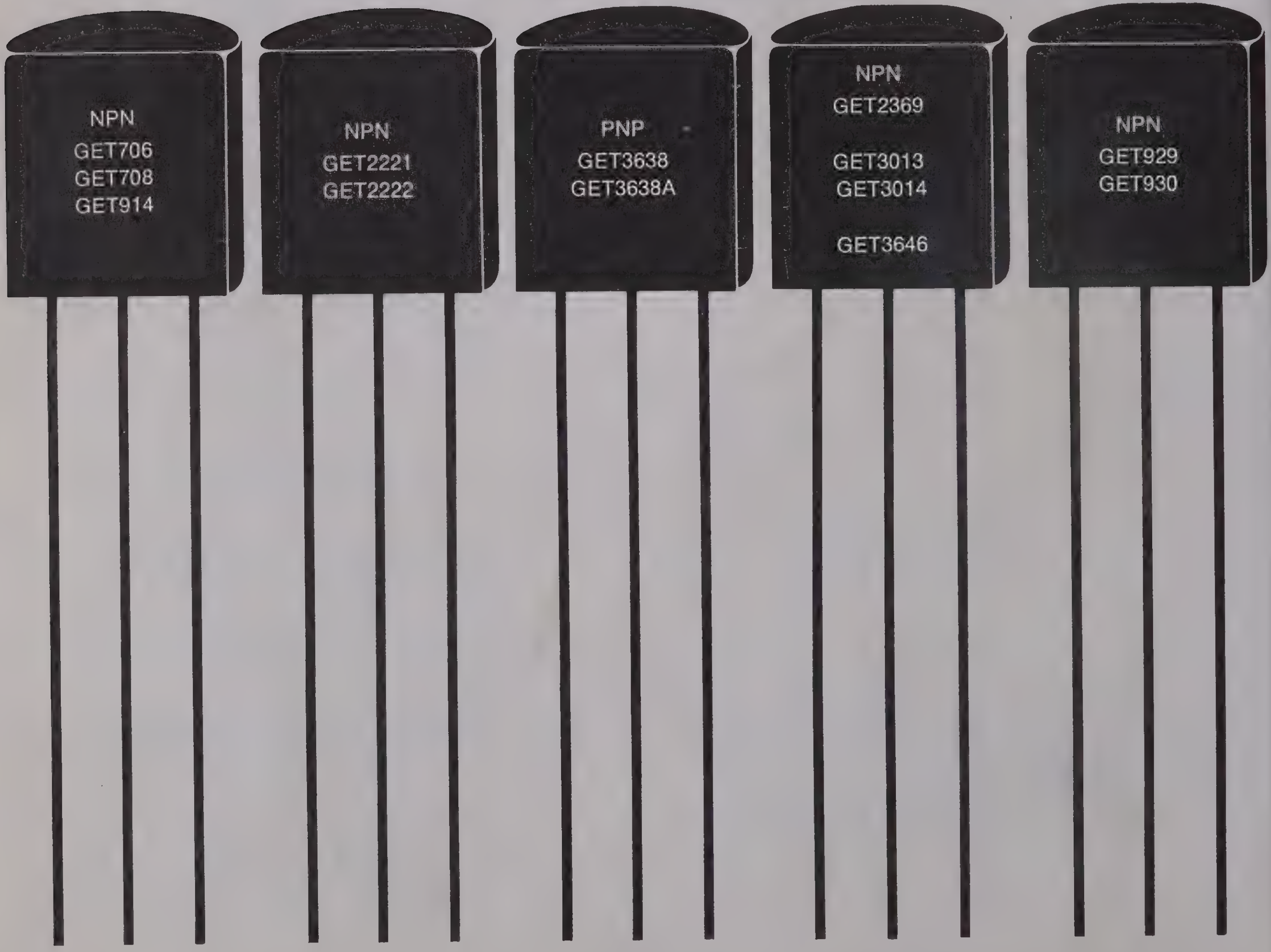
GET's package design conforms to TO-18 mounting patterns in existing PC boards. It's the ideal epoxy replacement for "hermetic devices" . . . no expensive redesign necessary.

These new units use the same industry proved production methods and quality epoxy that made our TO-98 (D16) series so successful. GE epoxy plastic forms a true chemical bond with metal to curb moisture permeation, eliminate internal wire lead fatigue failures, and vibration destruction. Low profile package design means smaller circuits and lower cost.

General Electric epoxy has the ability to contend successfully with a wide range of environmental conditions as shown in the extensive Reliability Evaluation Program described in Pub. 95.36A. Failures experienced with hermetic devices under these levels of shock, acceleration and stress have been eliminated with GE's solid epoxy encapsulant.

Standard NPN and PNP devices are available now through GE distributors. Five family groups representing GE's new epoxy transistor lines are shown below. Additional family types are being added. For more information on GET's for all applications, plus GE's "specials" capability, call or write your GE sales representative or distributor, or write General Electric Company, Section 220-69, 1 River Road, Schenectady, N.Y. 12305. In Canada: Canadian General Electric, 189 Dufferin Street, Toronto, Ont. Export: Electronic Component Sales, IGE Export Division, 159 Madison Avenue, New York, N.Y. 10016.

GENERAL ELECTRIC



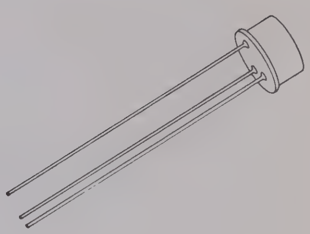
(Pages 321-400 reserved for future use)

Germanium Transistors

PNP

2N404,A

The General Electric types 2N404 and 2N404A germanium PNP alloy transistors are intended for industrial and military medium speed switching applications. All units are aged at 100°C for 100 hours, and all receive a hermeticity test. These processes ensure stability of parameters under severe environmental conditions. All units are "gettered" to guard against changes in parameters which otherwise could occur with "outgassing" of internal parts.



absolute maximum ratings: (25°C)—unless otherwise noted)

		2N404	2N404A	
Voltages				
Collector to Base	V_{CBO}	−25	−40	volts
Emitter to Base	V_{EBO}	−12	−25	volts
Collector to Emitter	V_{CE}*	−24	−35	volts
Current				
Collector	I_C	100	150	ma
Dissipation				
Power				
$T_A = 25°C$	P_T	150	150	mw
$T_A = 55°C$	P_T	75	90	mw
$T_A = 71°C$	P_T	35	60	mw
Temperature				
Storage	T_{STG}	−65 to +100	−65 to +100	°C

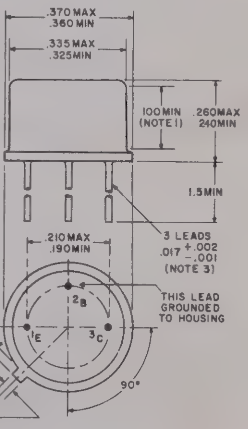
DIMENSIONS WITHIN
JEDEC OUTLINE
TO-5

NOTE 1: This zone is controlled for automatic handling. The variation in actual diameter within this zone shall not exceed .010.

NOTE 2: Measured from max. diameter of the actual device.

NOTE 3: The specified lead diameter applies in the zone between .050 and .250 from the base seat. Between .250 and .5 maximum of .021 diameter is held. Outside of these zones the lead diameter is not controlled. Leads may be inserted, without damage, in .031 holes while transistor enters .371 hole concentric with lead hole circle.

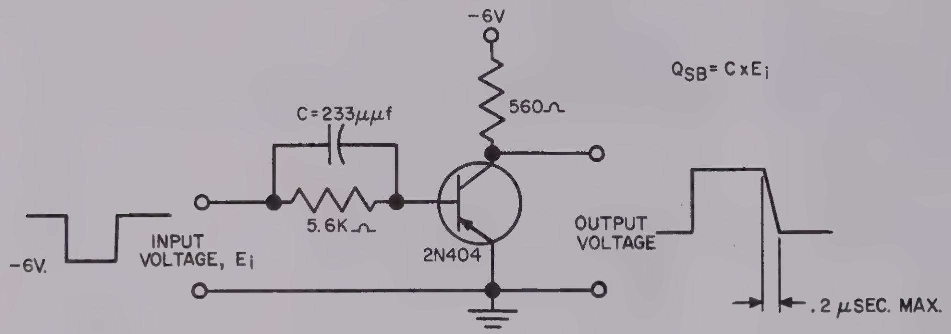
APPROX WEIGHT: .05 OZ
ALL DIMENSIONS IN INCHES



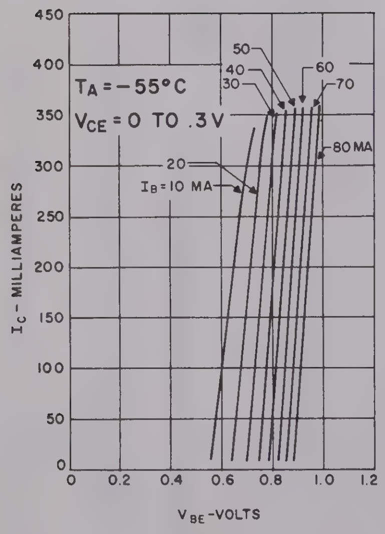
electrical characteristics: (25°C)—unless otherwise noted)

D. C. CHARACTERISTICS		2N404 Min.	2N404 Max.	2N404A Min.	2N404A Max.	
Collector to Base Voltage ($I_C = -20\ \mu a$)	V_{CBO}	−25		−40		volts
Emitter to Base Voltage ($I_E = -20\ \mu a$)	V_{EBO}	−12		−25		volts
***Reach through Voltage**	V_{RT}	−24		−35		volts
Collector Cutoff Current ($V_{CB} = -12v$)	I_{CBO}		−5		−5	μa
Collector Cutoff Current ($V_{CB} = -12v$, $T_A = 80°C$)	I_{CBO}		−90		−90	μa
Emitter Cutoff Current ($V_{EB} = -2.5v$)	I_{EBO}		−2.5		−2.5	μa
Saturation Voltage						
($I_B = .4$ ma, $I_C = -12$ ma)	$V_{CE(SAT)}$		−.15		−.15	volts
($I_B = 1$ ma, $I_C = -24$ ma)	$V_{CE(SAT)}$		−.2		−.2	volts
Base Input Voltage						
($I_B = .4$ ma, $I_C = -12$ ma)	V_{BE}		−.35		−.35	volts
($I_B = 1$ ma, $I_C = -24$ ma)	V_{BE}		−.4		−.4	volts
HIGH FREQUENCY CHARACTERISTICS						
Alpha Cutoff Frequency	f_{hfb}	4		4		mcs
Collector Capacitance (f = 2 mcs)	C_{ob}		20		20	pf
Stored Base Charge						
($I_B = 1$ ma, $I_C = -10$ ma) (See Circuit)	QSB		1400		1400	picocoulombs
			Typical			
Base spreading resistance	r′b		100			ohms
Input Resistance	h_{ie}		2700			ohms
Noise Figure (1 kc 1 cycle wide)	NF		3.5			db
LOW FREQUENCY CHARACTERISTICS (COMMON EMITTER)						
			Typical	Typical		
Output admittance	h_{oe}		400	400		μmhos
Voltage feedback ratio	h_{re}		8.4	8.4		$X10^{-4}$
Forward current transfer ratio	h_{fe}		86	86		
Input impedance	h_{ie}		450	450		ohms

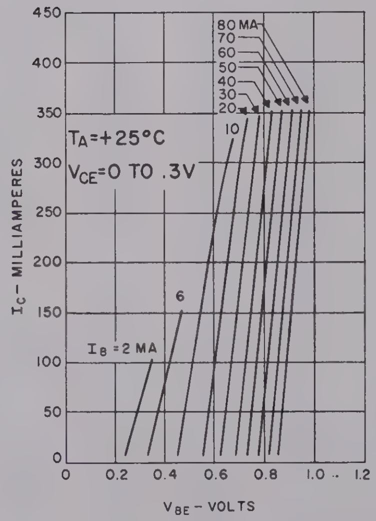
circuit for measuring stored base charge


−6V
560Ω
$Q_{SB} = C \times E_i$
C=233μμf
5.6KΩ
−6V.
INPUT VOLTAGE, E_i
2N404
OUTPUT VOLTAGE
.2 μSEC. MAX.

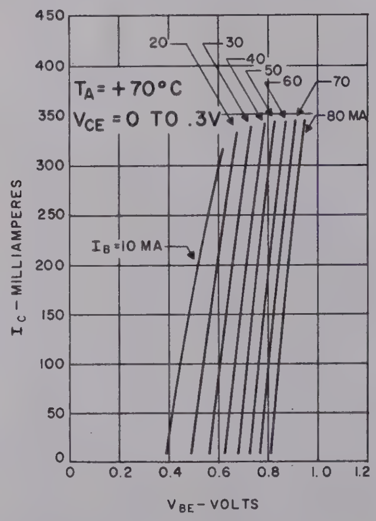
TYPICAL BASE – EMITTER CHARACTERISTICS
2N404 – 2N404A



T_A = −55°C

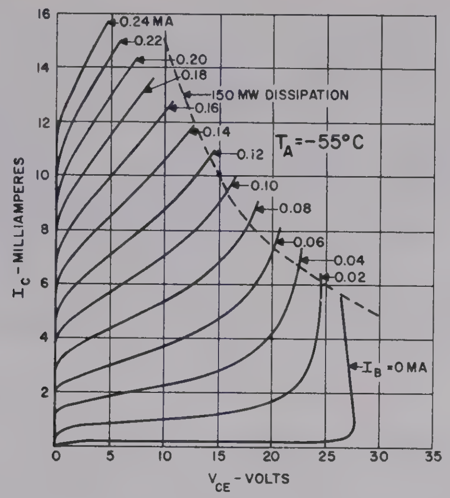


T_A = +25°C

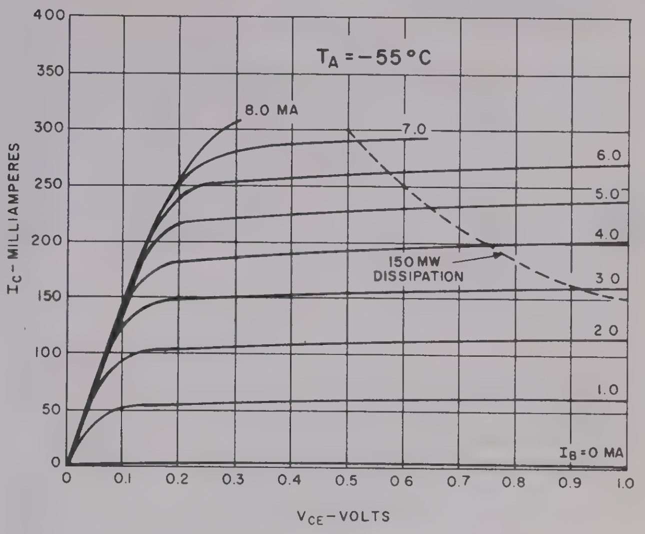


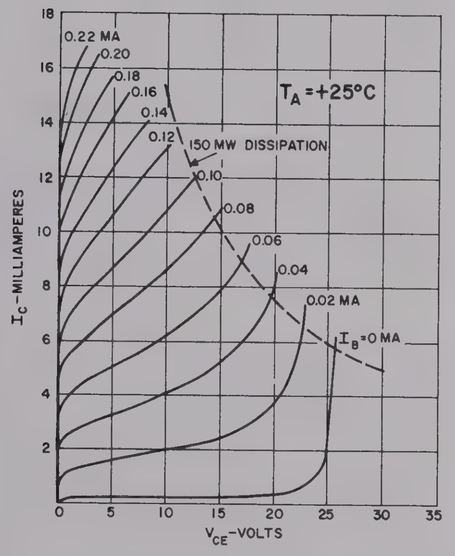
T_A = +70°C

TYPICAL COLLECTOR – EMITTER CHARACTERISTICS
2N404 – 2N404A

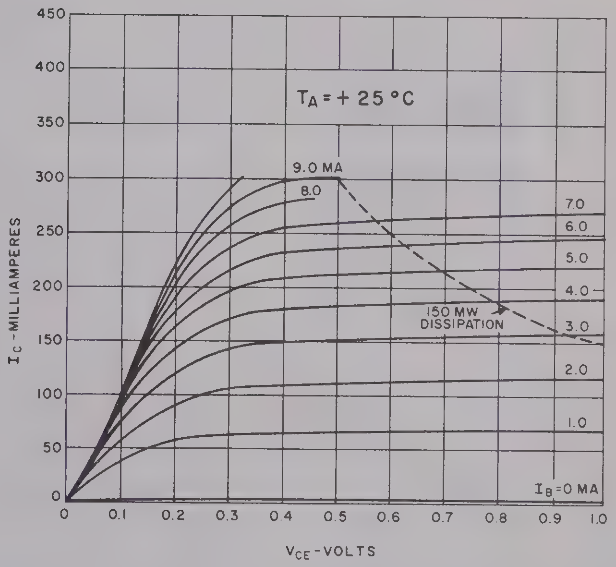


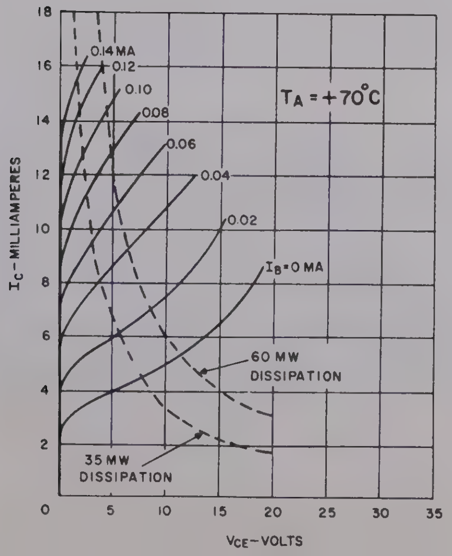
T_A = − 55°C



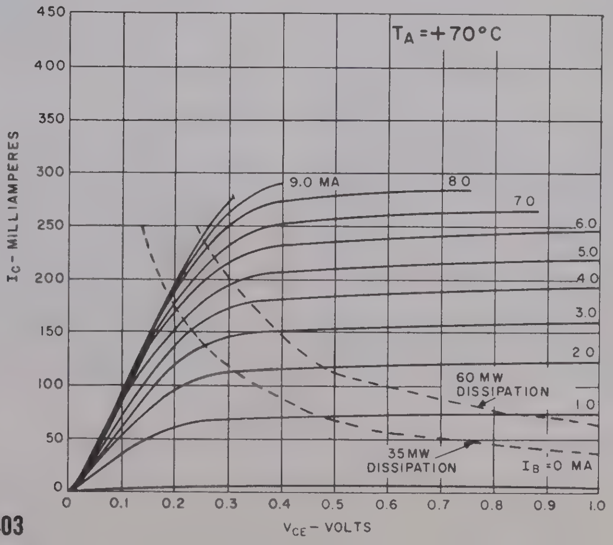


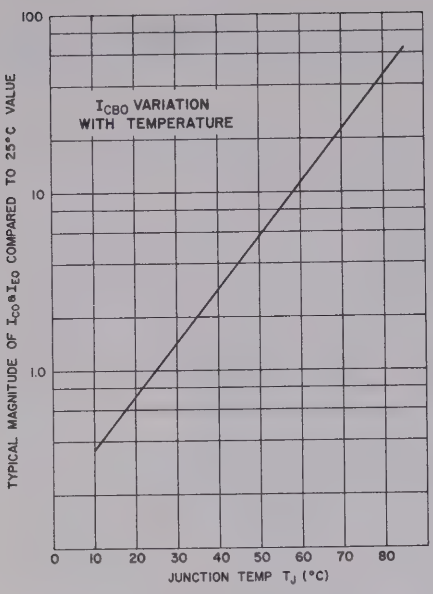
T_A = + 25°C

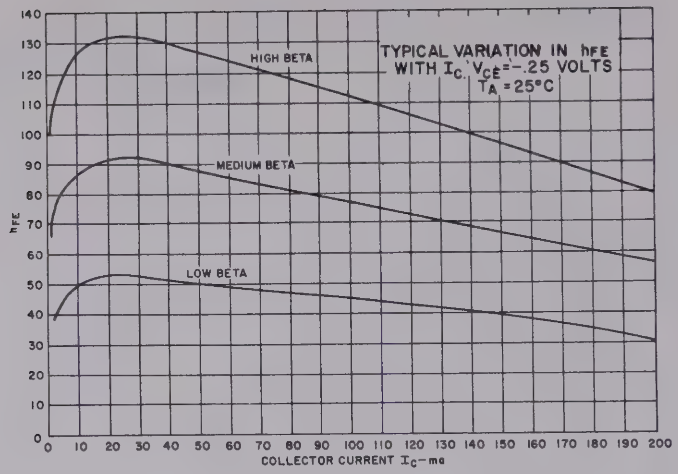




T_A = + 70°C

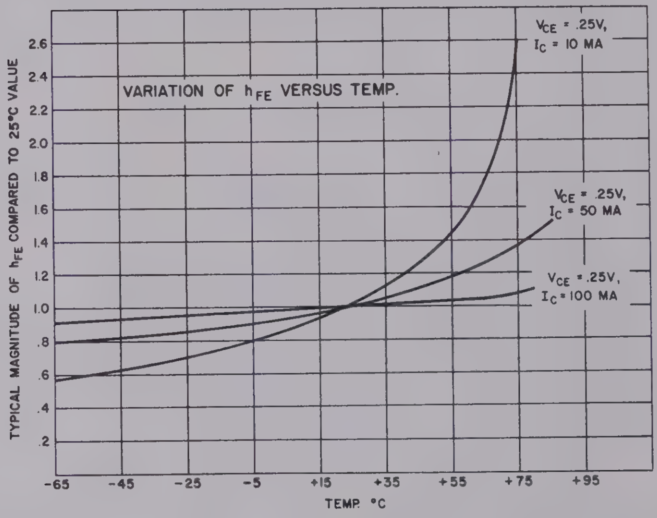


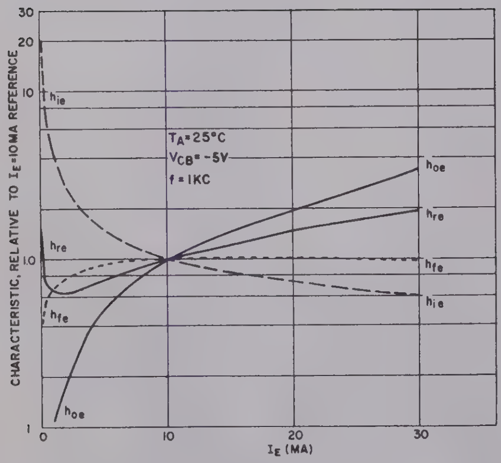


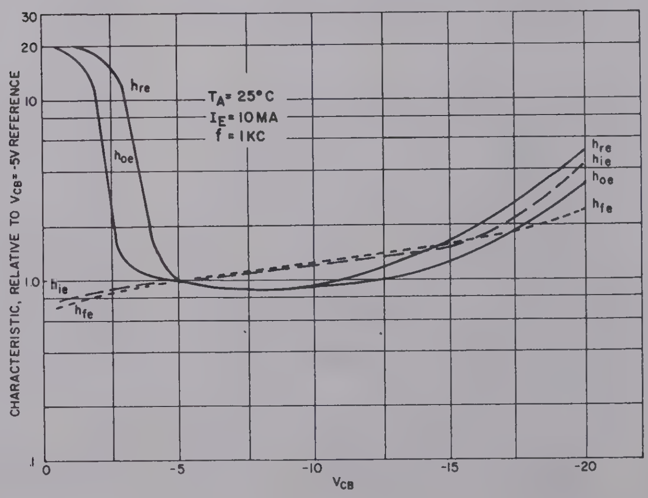


2N404

2N404A





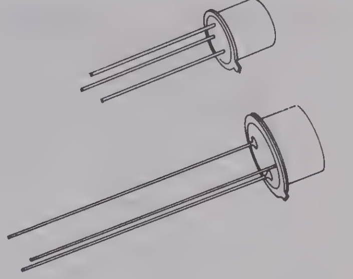


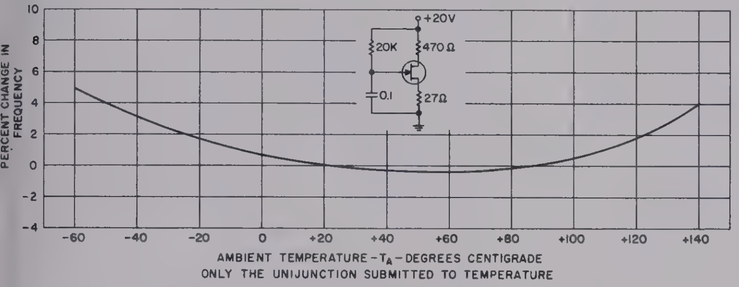
Silicon
Transistors

NPN

2N2417-22,A,B
2N489-94,A,B

The General Electric Silicon Unijunction Transistors are three-terminal devices having a stable "N" type negative resistance characteristic over a wide temperature range. A stable peak point and a high peak current rating make these devices useful in oscillators, timing circuits, trigger circuits, and bistable circuits, where it can serve the purpose of two conventional silicon transistors. General Electric's Fixed'Bed Construction makes these transistors extremely reliable under severe conditions of mechanical shock, vibration, centrifugal force, and thermal shock. It also provides a lower terminal resistance and improved uniformity of electrical characteristics. These transistors are hermetically sealed in welded cases. Types 2N489 through 2N494 are housed in TO-5 size cases with special lead configuration (TO-33), and types 2N2417 through 2N2422 are electrical equivalents housed in TO-18 size packages.




PERCENT CHANGE IN FREQUENCY
10
8
6
4
2
0
-2
-4
-60
-40
-20
0
+20
+40
+60
+80
+100
+120
+140
AMBIENT TEMPERATURE – T_A – DEGREES CENTIGRADE
ONLY THE UNIJUNCTION SUBMITTED TO TEMPERATURE
+20V
20K
470 Ω
0.1
27Ω

FEATURES

- **Stable Operation over Wide Temperature Range**
- **Low Leakage Current**
- **Low Peak Point Current**
- **Guaranteed Minimum Pulse Voltage**

absolute maximum ratings*

	2N489, A, B THROUGH 2N494, A, B	2N2417, A, B THROUGH 2N2422, A, B	
Total RMS Power Dissipation—Unstabilized[3]	450[1]	300[2]	mw
Total RMS Power Dissipation—Stabilized[3]	600[1]	350[2]	mw
RMS Emitter Current	←70→		ma
Peak Emitter Current[3, 4] ($T_J = 150°C$)	←2→		amps
Emitter Reverse Voltage ($T_J = 150°C$)	←60→		volts
Operating Temperature Range	← −65 to +140 →		°C
Operating Temperature Range—Stabilized[3]	← −65 to +175 →		°C
Storage Temperature Range	← −65 to +175 →		°C

1. Derate 3.9 mw/°C increase in amb. temp. (Thermal resistance to case = 0.16°C/mw)
2. Derate 2.6 mw/°C increase in amb. temp. (Thermal resistance to case = 0.08°C/mw)
3. Under normal operation, thermal runaway conditions cannot exist with the UJT up to a junction temperature of 140°C since the temperature coefficient of R_{BB} is positive below this temperature and I_{EO} is negligible. For this reason an unstabilized power rating can be used with the UJT which is derated to zero at 140°C. The UJT can be used at temperatures above 140°C but in this case external resistance must be used in the emitter and interbase circuits to limit the power dissipation and prevent thermal runaway. The power rating for this condition is the stabilized power rating and is derated to zero at 175°C. It is also important to provide circuit stabilization in the interbase circuit when the UJT is used in pulse type applications since the instantaneous temperature of the silicon could rise to a high enough value to permit runaway.
4. Emitter peak current should be limited to two amperes for discharge capacitances up to 10µfd, with a peak point voltage of 30 volts. For higher values of C or V_P, resistance must be added in series with the capacitor to protect the emitter circuit.

description

General Electric's Silicon Unijunction Transistor consists of an "N" type silicon bar mounted between two ohmic base contacts with a "P" type emitter near base-two. The device operates by conductivity modulation of the silicon between the emitter and base-one when the emitter is forward biased. In the cutoff, or standby condition, the emitter and interbase power supplies establish potentials between the base contacts, and at the emitter, such that the emitter is back biased. If the emitter potential is increased sufficiently to overcome this bias, holes (minority carriers) are injected into the silicon bar. These holes are swept toward base-one by the internal field in the bar. The increased charge concentration, due to these holes, decreases the resistance and hence decreases the internal voltage drop from the emitter to base-one. The emitter current then increases regeneratively until it is limited by the emitter power supply. The effect of this conductivity modulation is also noticed as an effective modulation of the interbase current.

*25°C, unless otherwise specified.

DIMENSIONS WITHIN JEDEC OUTLINE TO-5 EXCEPT FOR LEAD CONFIGURATION

TO-5

NOTE 1: Lead diameter is controlled in the zone between .050 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

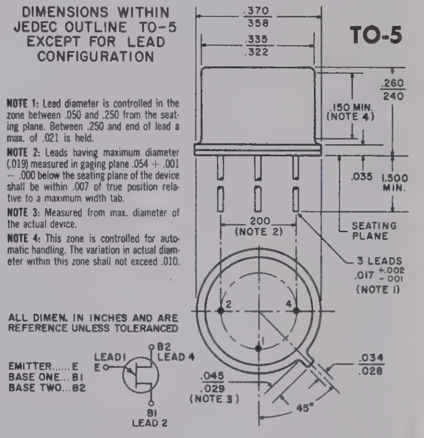
NOTE 2: Leads having maximum diameter (.019) measured in gaging plane .054 + .001 − .000 below the seating plane of the device shall be within .007 of true position relative to a maximum width tab.

NOTE 3: Measured from max. diameter of the actual device.

NOTE 4: This zone is controlled for automatic handling. The variation in actual diameter within this zone shall not exceed .010.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

EMITTER......E
BASE ONE...B1
BASE TWO...B2



2N489, A, B THROUGH **2N494, A, B**

DIMENSIONS WITHIN JEDEC OUTLINE TO-18 EXCEPT FOR LEAD CONFIGURATION

TO-18

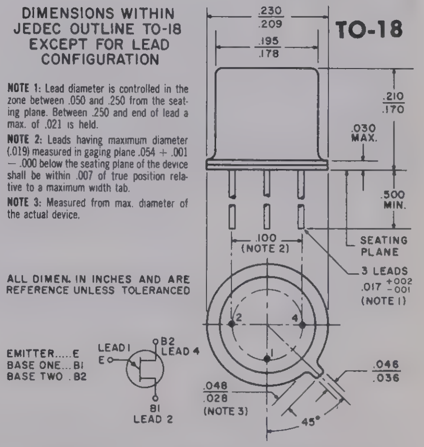
NOTE 1: Lead diameter is controlled in the zone between .050 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

NOTE 2: Leads having maximum diameter (.019) measured in gaging plane .054 + .001 − .000 below the seating plane of the device shall be within .007 of true position relative to a maximum width tab.

NOTE 3: Measured from max. diameter of the actual device.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

EMITTER.....E
BASE ONE...B1
BASE TWO .B2



2N2417, A, B THROUGH **2N2422, A, B**

2N2417-22,A,B 2N489-94,A,B

electrical characteristics: (at 25°C unless otherwise noted)

General Electric Unijunction Transistors are specified primarily in three ranges of stand-off ratio and two ranges of interbase resistance. Each range of stand-off ratio has limits of ±10% from the center value and each range of interbase resistance has limits of ±20% from the center value.

Type No.		Intrinsic Standoff Ratio		Interbase Resistance		Modulated Interbase Current		MAXIMUM					MINIMUM	
								Emitter Saturation Voltage	Emitter Reverse Current			Peak Point Current	Valley Point Current	Base One Peak Pulse Voltage
		(See note 1) $V_{BB} = 10V$		(See note 2) $V_{BB} = 3V$		$I_E = 50$ ma $V_{BB} = 10V$		$I_E = 50$ ma $V_{BB} = 10V$	$V_{B2E} = 60V$	$T_J = 150°C$ $V_{B2E} = 10V$	$V_{B2E} = 30V$	$V_{BB} = 25V$	$R_{B2} = 100\Omega$ $V_{BB} = 20V$	(See note 3)
		η		R_{BBO} ohms		$I_{B2(MOD)}$ ma		$V_{E(SAT)}$ volts	I_{EB20} μa	I_{EB20} μa	I_{EB20} μa	I_P μa	I_V ma	V_{OB1} volts
TO-5	TO-18	Min.	Max.	Min.	Max.	Min.	Max.							
2N489	2N2417	.51	.62	4.7	6.8	6.8	22	5	2	20		12	8	
2N489A	2N2417A	.51	.62	4.7	6.8	6.8	22	4	2	20		12	8	3
2N489B	2N2417B	.51	.62	4.7	6.8	6.8	22	4	2	20	0.2	6	8	3
2N490	2N2418	.51	.62	6.2	9.1	6.8	22	5	2	20		12	8	
2N490A	2N2418A	.51	.62	6.2	9.1	6.8	22	4	2	20		12	8	3
2N490B	2N2418B	.51	.62	6.2	9.1	6.8	22	4	2	20	0.2	6	8	3
2N491	2N2419	.56	.68	4.7	6.8	6.8	22	5	2	20		12	8	
2N491A	2N2419A	.56	.68	4.7	6.8	6.8	22	4.3	2	20		12	8	3
2N491B	2N2419B	.56	.68	4.7	6.8	6.8	22	4.3	2	20	0.2	6	8	3
2N492	2N2420	.56	.68	6.2	9.1	6.8	22	5	2	20		12	8	
2N492A	2N2420A	.56	.68	6.2	9.1	6.8	22	4.3	2	20		12	8	3
2N492B	2N2420B	.56	.68	6.2	9.1	6.8	22	4.3	2	20	0.2	6	8	3
2N493	2N2421	.62	.75	4.7	6.8	6.8	22	5	2	20		12	8	
2N493A	2N2421A	.62	.75	4.7	6.8	6.8	22	4.6	2	20		12	8	3
2N493B	2N2421B	.62	.75	4.7	6.8	6.8	22	4.6	2	20	0.2	6	8	3
2N494	2N2422	.62	.75	6.2	9.1	6.8	22	5	2	20		12	8	
2N494A	2N2422A	.62	.75	6.2	9.1	6.8	22	4.6	2	20		12	8	3
2N494B	2N2422B	.62	.75	6.2	9.1	6.8	22	4.6	2	20	0.2	6	8	3

notes:

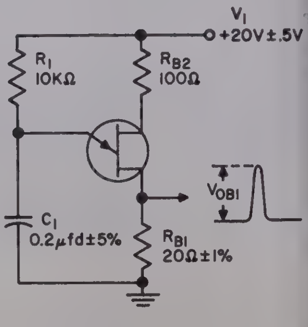
1. The intrinsic standoff ratio, η, is essentially constant with temperature and interbase voltage. η is defined by the equation:

$$V_P = \eta V_{BB} + \frac{200}{T_J}$$

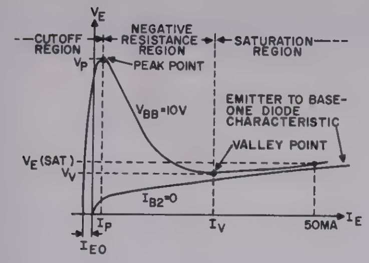
Where
V_P = Peak point emitter voltage
V_{BB} = Interbase voltage
T_J = Junction Temperature (Degrees Kelvin)

2. The interbase resistance is nearly ohmic and increases with temperature in a well defined manner. The temperature coefficient at 25°C is approximately 0.8%/°C.

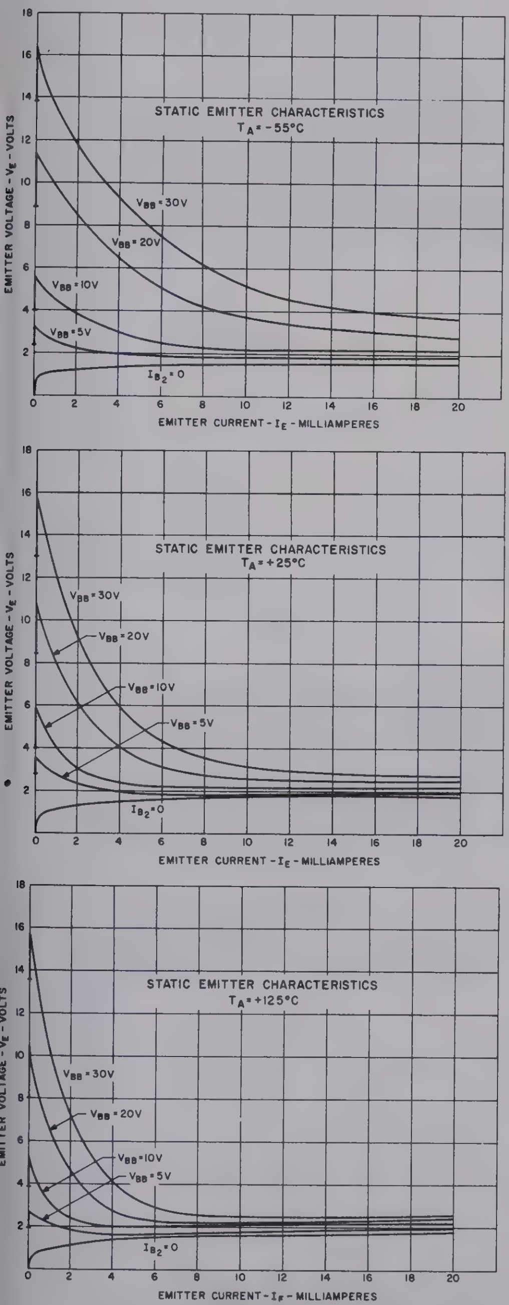
3. The base-one peak pulse voltage is measured in the circuit at right. This specification on the A and B versions is used to ensure a minimum pulse amplitude for applications in SCR firing circuits and other types of pulse circuits.



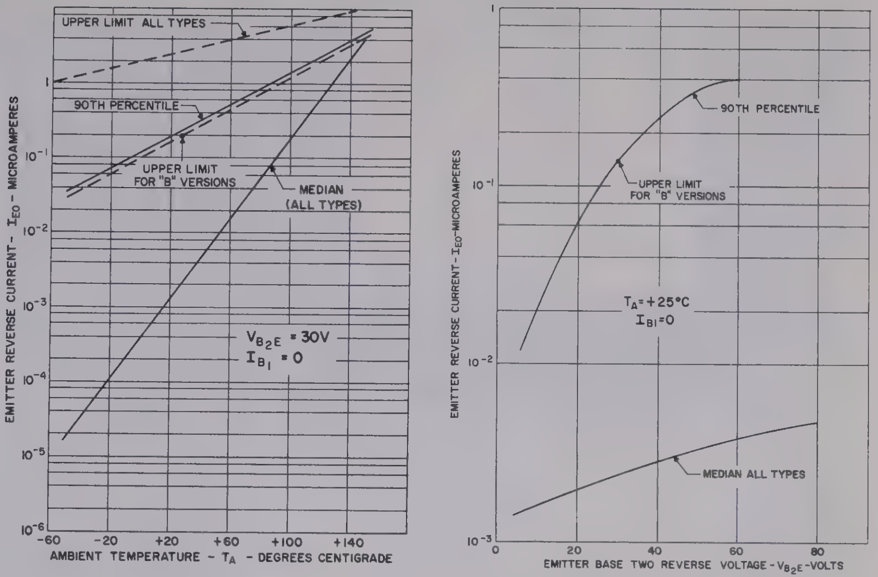
EMITTER CHARACTERISTICS



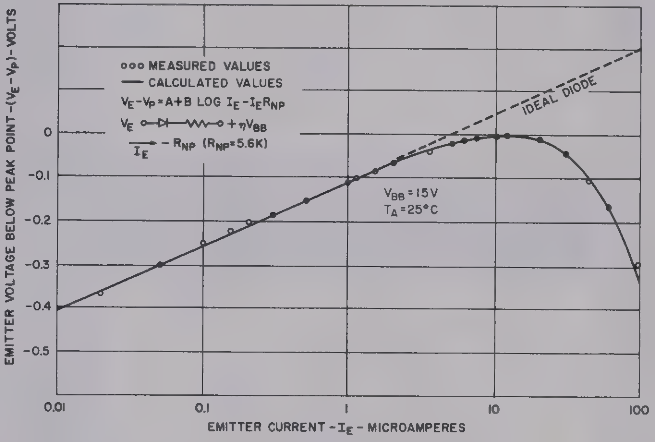
Static Emitter Characteristic curves showing important parameters and measurement points (exaggerated to show details).



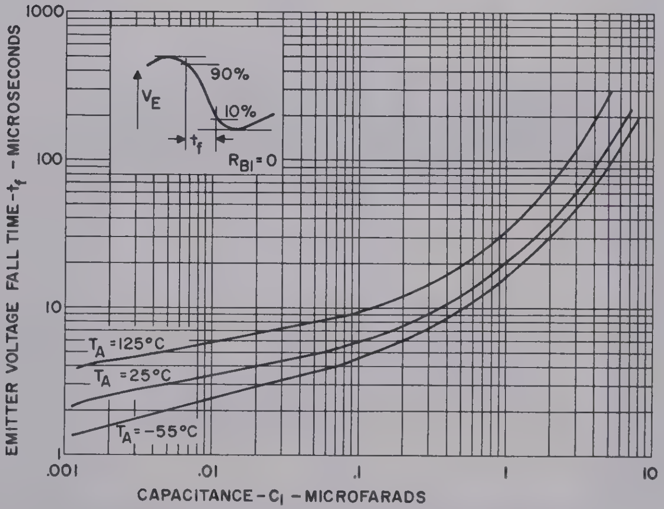
STATIC EMITTER CHARACTERISTICS



EMITTER REVERSE CURRENT CHARACTERISTICS

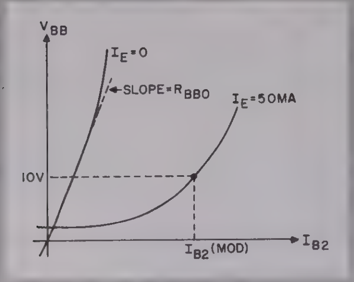


STATIC EMITTER CHARACTERISTICS AT PEAK POINT

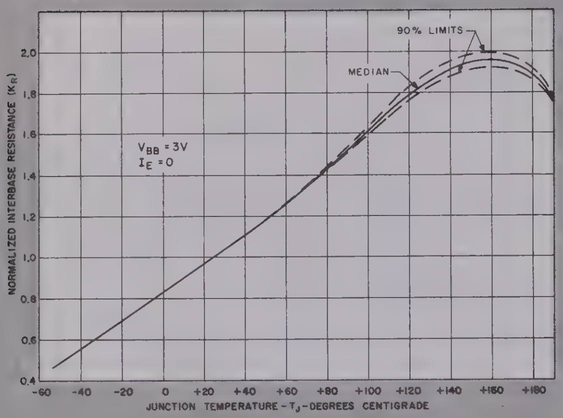


EMITTER VOLTAGE FALL TIME VS. CAPACITANCE IN RELAXATION OSCILLATOR

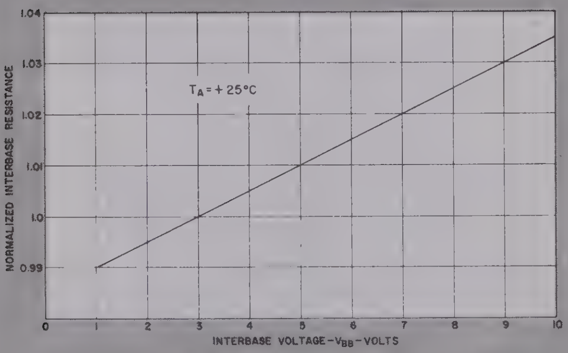
INTERBASE CHARACTERISTICS



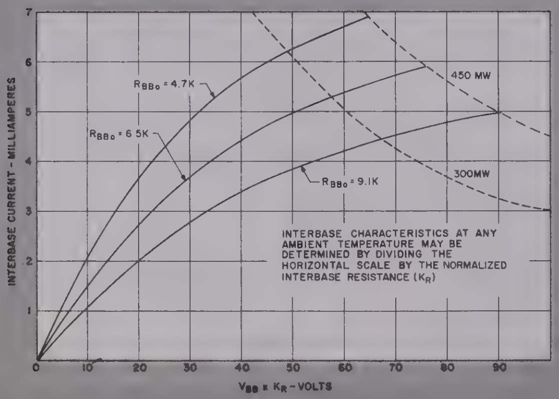
Static interbase characteristic curves showing important parameters and measurement points.



VARIATION OF R_{BB} WITH TEMPERATURE

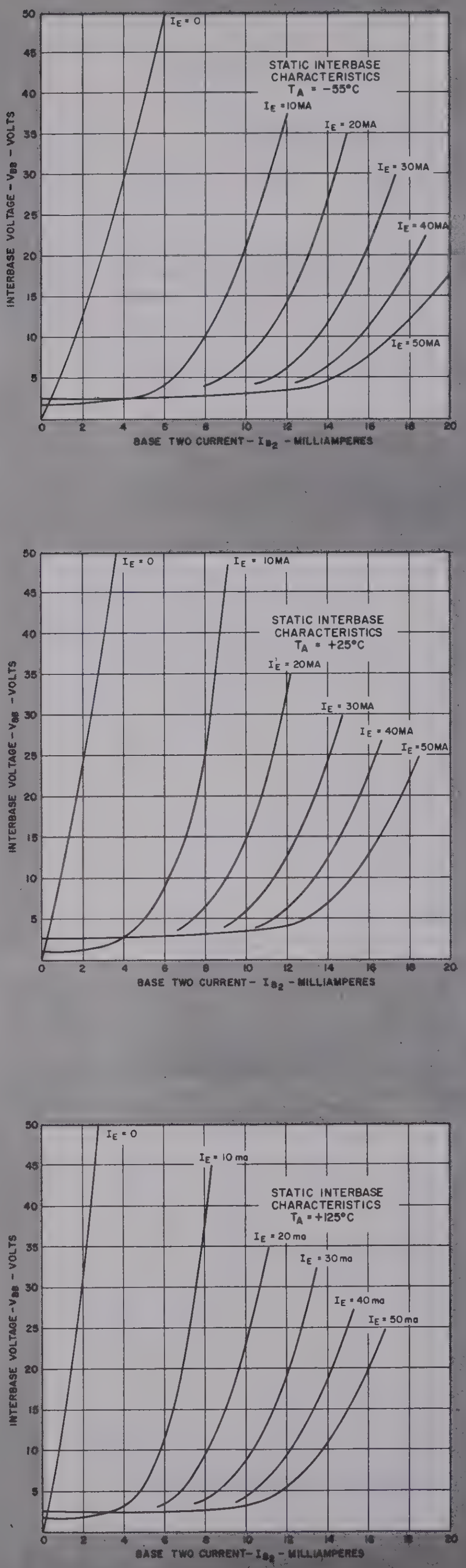


VARIATION OF R_{BB} WITH VOLTAGE

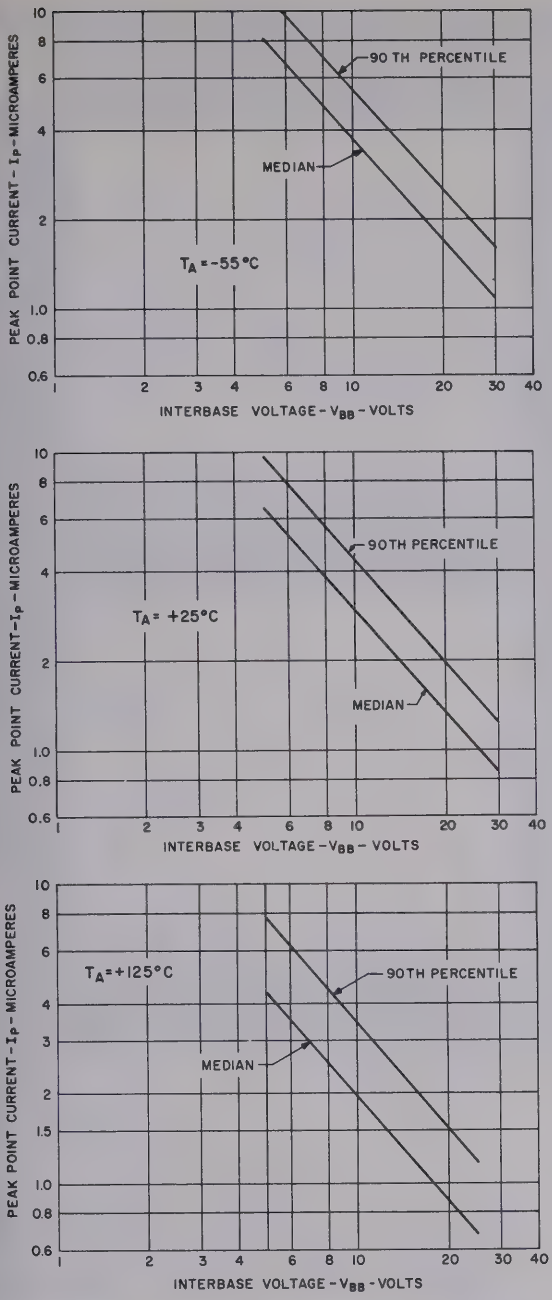


INTERBASE CHARACTERISTICS AT ANY AMBIENT TEMPERATURE MAY BE DETERMINED BY DIVIDING THE HORIZONTAL SCALE BY THE NORMALIZED INTERBASE RESISTANCE (K_R)

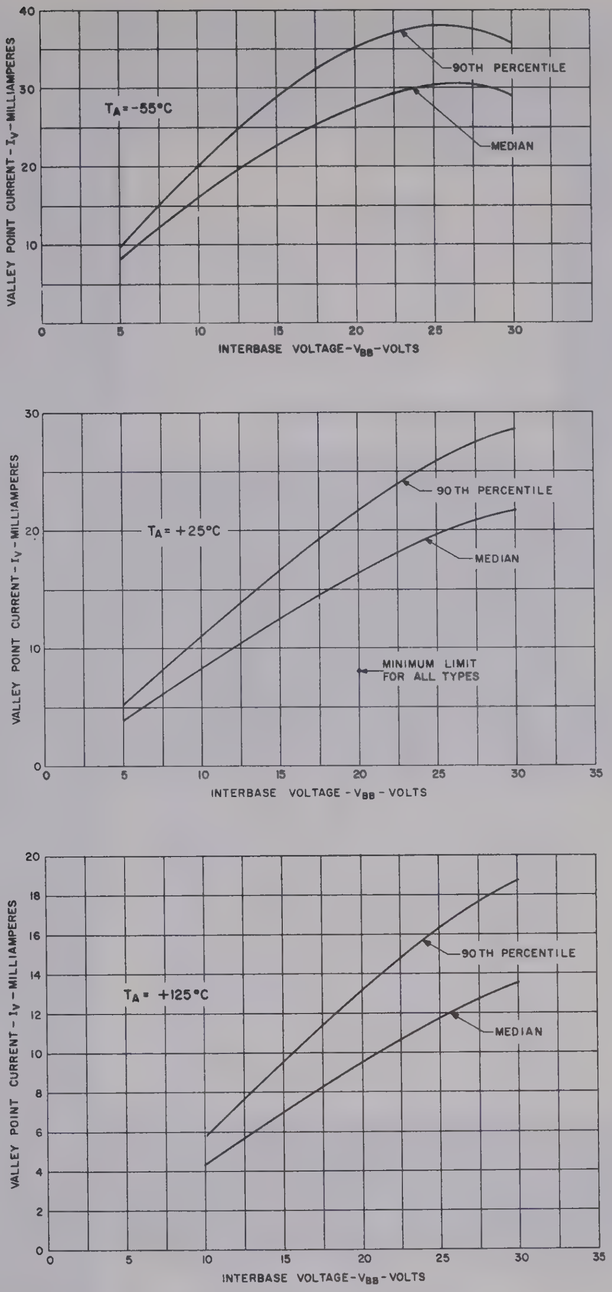
INTERBASE CHARACTERISTIC CURVES



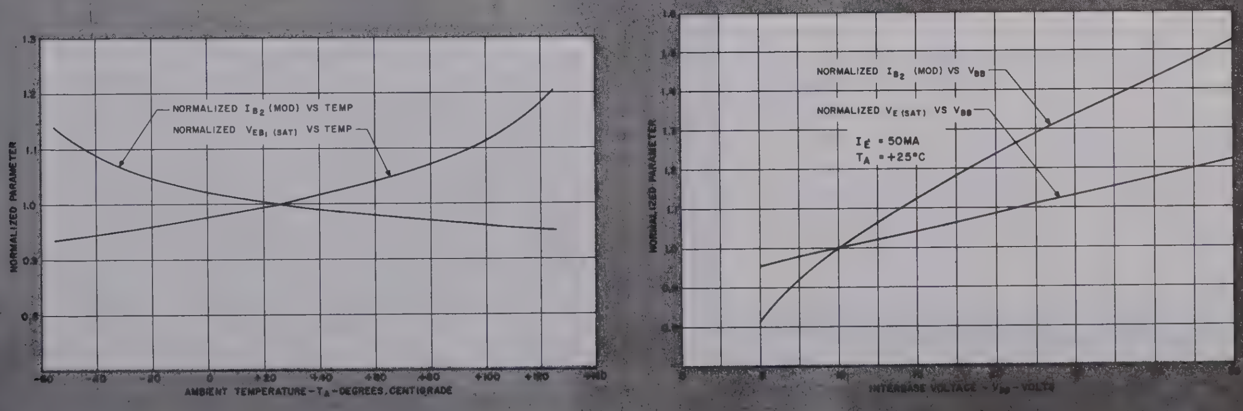
STATIC INTERBASE CHARACTERISTICS



VARIATION OF I_P WITH V_{BB}

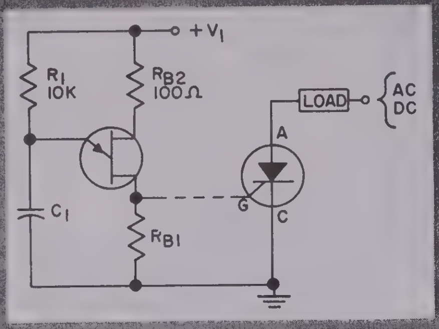


VARIATION OF I_V WITH V_{BB}



NORMALIZING CURVES FOR $I_{B2(MOD)}$ AND $V_{E(SAT)}$

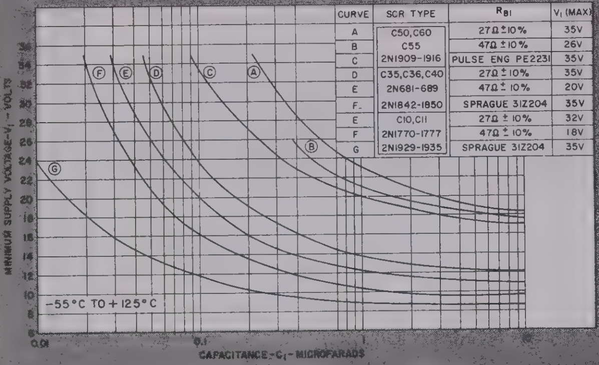
DESIGNING SCR FIRING CIRCUITS



Period of Relaxation Oscillator

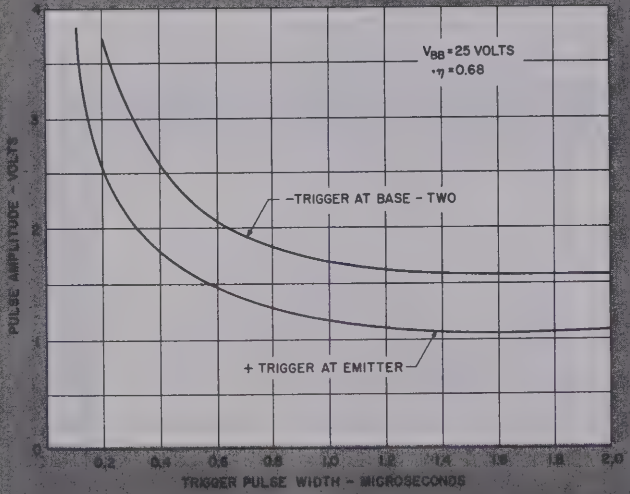
$\tau = R_1C_1 \ln\left(\frac{1}{1-\eta}\right)$

Maximum Value of R_1 for oscillation
(−55°C to +140°C)
R_1 (max) = 430 V_1^2 (except B versions)
R_1 (max) = 1800 V_1^2 (B versions only)
τ = Period in Seconds
C_1 = Capacitance in Farads
R_1 = Resistance in ohms
V_1 = Supply voltage in volts

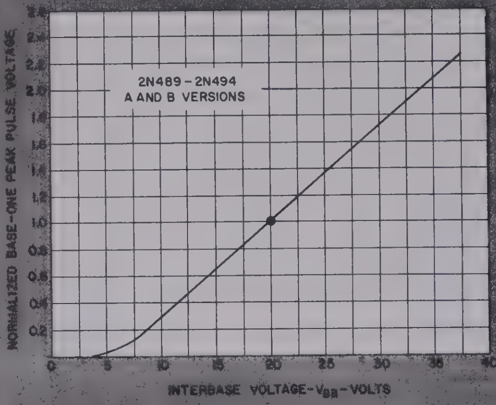


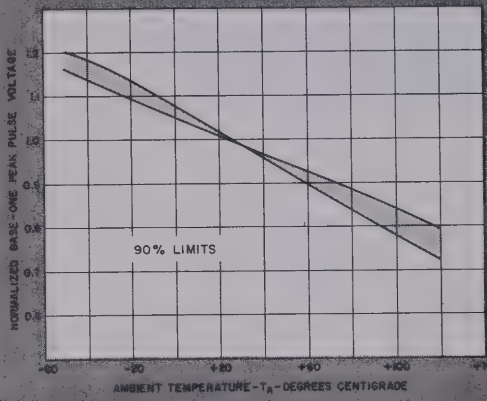
CURVE	SCR TYPE	R_{B1}	V_1 (MAX)
A	C50,C60	27Ω ± 10%	35V
B	C55	47Ω ± 10%	26V
C	2N1909-1916	PULSE ENG PE2231	35V
D	C35,C36,C40	27Ω ± 10%	35V
E	2N681-689	47Ω ± 10%	20V
F	2N1842-1850	SPRAGUE 31Z204	35V
E	C10,C11	27Ω ± 10%	32V
F	2N1770-1777	47Ω ± 10%	18V
G	2N1929-1935	SPRAGUE 31Z204	35V

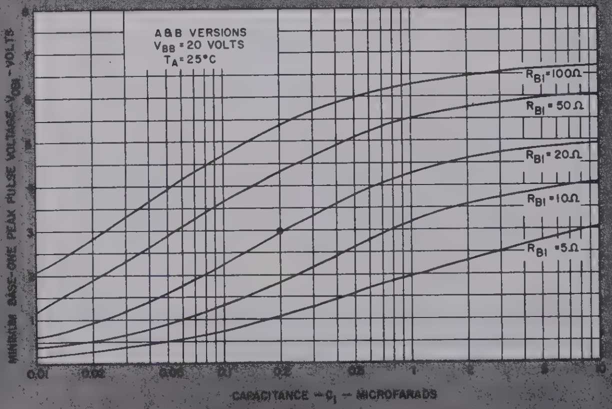
$V_{BB(MIN)}$ VS. C_1 FOR SCR FIRING



MINIMUM TRIGGER AMPLITUDE AS A FUNCTION OF TRIGGER PULSE WIDTH FOR TURN-ON OF UJT TRANSISTORS







V_{OB1} CHARACTERISTICS

references:

1. "Notes on the Application of the Silicon Unijunction Transistor," 90.10

2. "General Electric Transistor Manual—Sixth Edition" 450.19

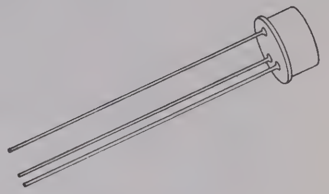
3. "General Electric Controlled Rectifier Manual," Third Edition 640.9

Silicon
Transistors

NPN

2N490C,2C,4C

The General Electric Silicon Unijunction Transistor is a three terminal device having a stable "N" type negative resistance characteristic over a wide temperature range. These devices have a stable peak point voltage, a low peak point current, and a low emitter reverse current making them useful in timing and sensing circuits. They are intended for applicatins where a low emitter leakage current (high input impedance) and a low peak point emitter current (sensitive trigger current) are required (i.e., level sensing and long time delay applications), and also for triggering Silicon Controlled Rectifiers or other pulse sensitive circuitry.



*Revisions included in this issue consist of adding the 2N490C and 2N492C. Secondly, the Emitter Reverse Current parameter, I_{EX}, is now shown for the first time.

See 2N489-94 specification sheet 60.10 for detailed curves.

absolute maximum ratings: (25°C)*

Voltages

Emitter Reverse	60	volts
Interbase	65	volts

Current

RMS Emitter	70	ma
Peak Emitter	2	amperes†

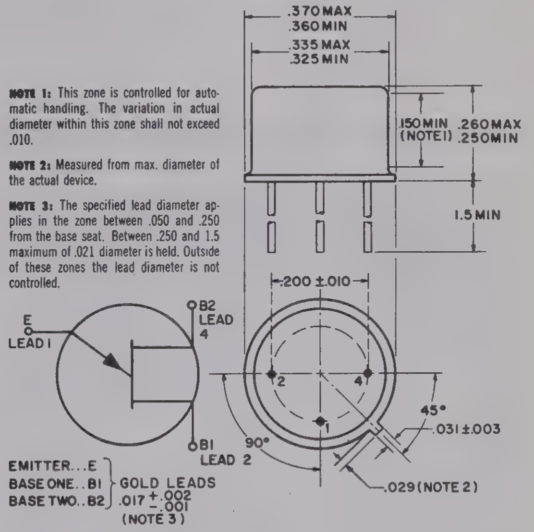
Power

Dissipation	600	mw**

Temperatures

Operating	−65 to +175	°C
Storage	−65 to +175	°C

†Capacitor discharge—10 μfd or less, 30 volts or less.
**Derate 3.9 mw/°C increase in ambient temperature. The total power dissipation (available power to Emitter and Base-Two) must be limited by the external circuitry.



NOTE 1: This zone is controlled for automatic handling. The variation in actual diameter within this zone shall not exceed .010.

NOTE 2: Measured from max. diameter of the actual device.

NOTE 3: The specified lead diameter applies in the zone between .050 and .250 from the base seat. Between .250 and 1.5 maximum of .021 diameter is held. Outside of these zones the lead diameter is not controlled.

electrical characteristics: (25°C)

		2N490C		2N492C		2N494C		
		MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
Intrinsic Standoff Ratio ($V_{BB} = 10V$)	η	.51	.62	.56	.68	.62	.75	
Interbase Resistance ($V_{BB} = 3V, I_E = 0$)	R_{BBO}	6.2	9.1	6.2	9.1	6.2	9.1	KΩ
Emitter Saturation Voltage ($V_{BB} = 10V, I_E = 50$ ma)	$V_{E(SAT)}$		4		4.3		4.6	volts
Modulated Interbase Current ($V_{BB} = 10V, I_E = 50$ ma)	$I_{B2(MOD)}$	6.8	22	6.8	22	6.8	22	ma
Emitter Reverse Current ($V_{B2E} = 30V, I_{B1} = 0$)	I_{EO}		0.02		0.02		0.02	μa
Emitter Reverse Current ($V_{BB} = 25V, V_{EB1} = V_P - .3V$) (Fig. 2)	I_{EX}		0.05		0.05		0.05	μa
Peak Point Emitter Current ($V_{BB} = 25V$)	I_P		2		2		2	μa
Valley Point Current ($V_{BB} = 20V, R_{B2} = 100\Omega$)	I_V	8.0		8.0		8.0		ma
Base-One Peak Pulse Voltage‡	V_{OB1}	3.0		3.0		3.0		volts

‡The base-one peak pulse voltage is measured in Figure 1 below. This specification is used to ensure a minimum pulse amplitude for applications in SCR firing circuits and other types of pulse circuits.

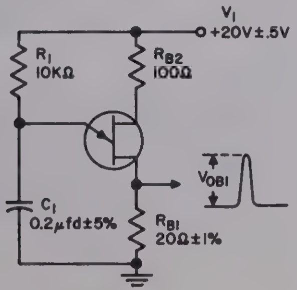


Figure 1

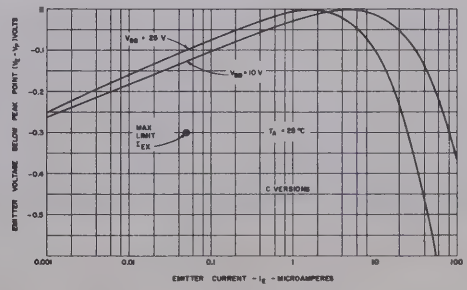
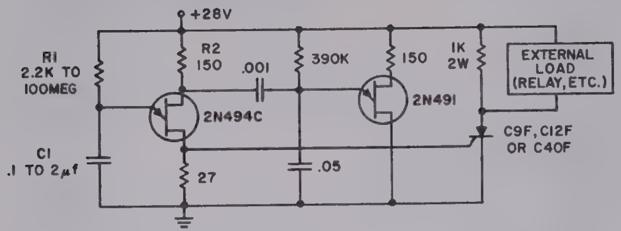
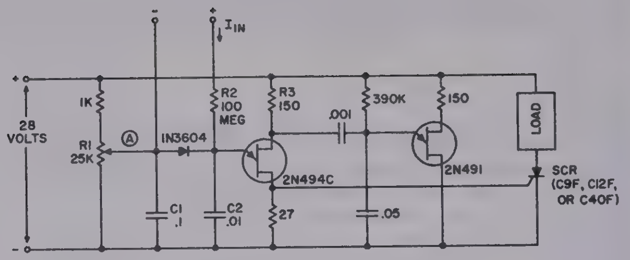


Figure 2



PRECISION SOLID STATE TIME DELAY CIRCUIT



NANOAMPERE SENSING CIRCUIT WITH
100 MEGOHM INPUT IMPEDANCE

PRECISION SOLID STATE TIME DELAY CIRCUIT

Time delays from 0.3 milliseconds to over three minutes is possible with this circuit without using a tantalum or electrolytic capacitor. The timing interval is initiated by applying power to the circuit. At the end of the timing interval, which is determined by the value of R1C1, the 2N494C fires the controlled rectifier. This places the supply voltage minus about one volt across the load. Load currents are limited only by the rating of the controlled rectifier which is from 1 ampere up to 25 amperes for the types specified in the circuit. A calibrated potentiometer could be used in place of R1 to permit setting a predetermined time delay after one initial calibration.

The charging resistor, R1, must be small enough to supply the minimum firing current (peak point current, I_P) of the 2N494C plus the leakage current of the capacitor when the emitter of the unijunction is biased at its peak point voltage. The 2N494C requires a minimum I_P of 2.0 microamperes. This would place a limit of 3 megohms for R1 and permit time delays of 6 seconds (C1 = 2 µf, without using the additional 2N491 relaxation oscillator.

The circuit as shown effectively reduces the minimum I_P requirement up to a 1000X by pulsing the upper base of the 2N494C with a ¾ volt negative pulse. This negative pulse rate is not critical but it should have a period that is less than .02 (R1 x C1). This negative pulse causes the peak point voltage (firing point voltage level required at the emitter of the 2N494C) to drop slightly and if the voltage level at C1 is greater than this, the unijunction will fire with the necessary I_P supplied from C1. By use of this technique, this circuit has given time delays of about one hour with 2000 megohms at R1 and 2 µf at C1. The low leakage requirement for C1 is easily obtained with a mylar capacitor. R2 can be adjusted or selected for best stabilization of the firing point over the required temperature range.

A pulse transformer can be used in place of the 27 ohm resistor if it is necessary to have the timing circuit isolated from the power switching (controlled rectifier) circuit which, for instance, might be connected to the AC line.

The input impedance of the 2N494C is greater than 1500 megohms before it is fired. The maximum time delay that can be achieved by this circuit is mainly dependent upon the maximum values that can be obtained for R1 and C1 consistent with the low leakage requirement.

NANOAMPERE SENSING CIRCUIT WITH 100 MEGOHM INPUT IMPEDANCE

The circuit shown may be used as a sensitive current detector or as a voltage detector having high input impedance. R1 is set so that the voltage at point (A) is ½ to ¾ volts below the level that fires the 2N494C. A small input current (I_{in}) of only 40 nanoamperes will charge C2 and raise the voltage at the emitter to the firing level. When the 2N494C fires, both capacitors, C1 and C2, are discharged through the 27 ohm resistor, which generates a positive pulse with sufficient amplitude to trigger a controlled rectifier (SCR), or other pulse sensitive circuitry.

C2 is kept small for faster firing response time and C1 is used to provide the pulse output energy. Rapid recovery is obtained after the 2N494C fires since both capacitors are charged through R1. This configuration has the advantage that the leakage current of the silicon diode effectively subtracts from the leakage current of the unijunction and thus providing some temperature compensation.

The input current available (I_{in}) through the 100 MΩ resistor will be much lower than the minimum firing current of the 2N494C (peak point current (I_P) = 2.0 µa). Use of a sampling technique described above, however, permits a reduction in the external firing current (I_{in}) by as much as 1000 times below I_P. By pulsing the upper base of the 2N494C with a 0.75 volt amplitude negative pulse the peak point voltage (firing point voltage level required at the emitter) will drop slightly and if the voltage level at C2 is greater than this, the unijunction will fire with the necessary I_P supplied from C2. By use of this technique, the 2N494C has been fired with external input currents (I_{in}) as low as 1 nanoampere with a 2000 megohm resistor for R2.

The period of the 2N491 relaxation oscillation is not critical, but it should have a time constant of .02 or less than that of the 2N494C.

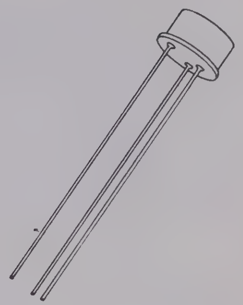
A floating power supply for this sensing circuit using a zener diode will permit grounding one of the sensing input terminals if this is desirable. R1 should be adjusted so the circuit will not fire at the maximum ambient temperature in the absence of the current or voltage sensing signal. R3 can be adjusted or selected for best stabilization of the firing point over the required temperature range.

Germanium Transistors

PNP

2N508,8A

The General Electric 2N508 and 2N508A transistors are PNP alloy junction devices intended specifically for low-noise application. The high gain at low current levels and low frequency noise characteristics make these transistors desirable for low noise circuitry. Stability of characteristics is assured by precise control of manufacturing technology developed since 1952. General Electric alloy transistors are radiflo leak tested to a 1×10^{-10} cc/sec criteria. Standard environmental and degradation tests to criteria equal to or more stringent than those of MIL-S-19500 are performed continuously.

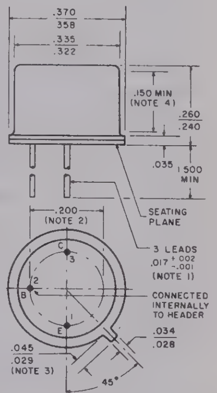


absolute maximum ratings: (25°C) (unless otherwise specified)

		2N508	2N508A	
Voltage				
Collector to Base	V_{CBO}	−18	−30	volts
Collector to Emitter ($R_{BE} \leq 10$ Kohms)	V_{CER}	−16	−25	volts
Collector to Emitter	V_{CES}		−30	volts
Emitter to Base	V_{EBO}	− 5	−10	volts
Current				
Collector	I_C	200	200	ma
Dissipation				
Total Transistor*	P_T	200	200	mw
Total Transistor @ 55°C	P_T	100	100	mw
Temperature				
Storage	T_{STG}	−65 to +100	−65 to +100	°C
Operating Junction	T_J	−65 to + 85	−65 to + 85	°C
Lead Temperature, 1/16" ± 1/32" from case for 10 seconds maximum	T_L	260	260	°C

*Derate 3.33 mw/°C increase in ambient temperature above 25°C.

DIMENSIONS WITHIN JEDEC OUTLINE TO-5



NOTE 1: Lead diameter is controlled in the zone between .050 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

NOTE 2: Leads having maximum diameter (.019) measured in gaging plane .054 + .001 − .000 below the seating plane of the device shall be within .007 of true position relative to a maximum width tab.

NOTE 3: Measured from max. diameter of the actual device.

NOTE 4: This zone is controlled for automatic handling. The variation in actual diameter within this zone shall not exceed .010.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

electrical characteristics: (25°C)

		2N508			2N508A			
DC CHARACTERISTICS		Min.	Typ.	Max.	Min.	Typ.	Max.	
Collector to Emitter Voltage ($R_{BE} \leq 10$ K, $I_C = -600$ μamps)	V_{CER}	−16			−25			volts
Collector Cutoff Current ($V_{CB} = 16V$)	I_{CBO}		−4	− 7				μa
($V_{CB} = -25V$)	I_{CBO}					−4	−7	μa
Emitter Cutoff Current ($V_{EB} = -5V$)	I_{EBO}		−3	−10				μa
($V_{EB} = -10V$)	I_{EBO}					−3	−7	μa
Forward Current Transfer Ratio** ($V_{CE} = -1.0V$, $I_C = -20$ ma)	h_{FE}	100(110)	120	200(180)	100(110)	120	200(180)	
($V_{CE} = 1.0V$, $I_C = -100$ ma)	h_{FE}				85			
Base to Emitter Voltage ($V_{CE} = -1.0V$, $I_C = -20$ ma)	V_{BE}	−0.18		−0.32	−0.18		−0.32	volts
SMALL SIGNAL CHARACTERISTICS ($V_{CB} = -5.0V$, $I_E = 1.0$ ma, f = 1.0 Kc, except as noted)								
AC Forward Current Transfer Ratio	h_{fe}		110		75	110	180	
Input Impedance	h_{ib}		28		26	28	31	ohms
Output Admittance	h_{ob}		0.4			0.4		μohms
Reverse Voltage Transfer Ratio	h_{rb}		7		1.0	7	17.0	$x10^{-4}$
Cutoff Frequency ($V_{CE} = 5.0V$, $I_E = 1.0$ ma)	f_{hfb}	2.5	4.5		2.5	4.5		mc
Output Capacity ($V_{CE} = 5.0V$, $I_E = 1.0$ ma)	C_{ob}		18	35		18	35	pf

**Note: Values within parentheses are test limits, ninety-five per cent or more of production will be contained between the test limits.

		2N508 Typ.	2N508A Typ.	Max.	
NOISE FIGURES					
(Measurement standard used—Quan-Tech model 310 noise analyser)					
Spot Noise					
($R_g = 500\ \Omega$, $V_{CB} = 1.0V$, $I_C = 1.0$ ma, f = 100~)	NF	6	5	8	db
($R_g = 500\ \Omega$, $V_{CB} = 1.0V$, $I_C = 1.0$ ma, f = 1000~)	NF	3	3	5	db
($R_g = 500\ \Omega$, $V_{CB} = 1.0V$, $I_C = 1.0$ ma, f = 10000~)	NF	3	2	4	db
Wide Band ($R_g = 1000\ \Omega$, $V_{CB} = 4.5V$, $I_C = 0.3$ ma)					
(15 to 1000~ Bandwidth)	NF	4.5	4.5		db
(15 to 10000~ Bandwidth)	NF	3	3		db

PREAMPLIFIERS

Preamplifiers have two major functions: (1) increasing the signal level from a pick-up device to about 1 volt rms, and (2) providing compensation if required to equalize the input signal for a constant output with frequency.

The circuit to the right meets these requirements when the pick-up device is a magnetic-microphone, phono cartridge (monaural or stereo), or a tape head. The total harmonic or I.M. (inter-modulation) distortion of the preamp is less than ½% at reference level output (1 volt).

This preamp will accommodate most magnetic pick-up impedances. The input impedance to the preamp increases with frequency because of the frequency selective negative feedback to the emitter of Q_1.

The first two stages of this circuit have a feedback bias arrangement with R3 feeding bias current to the base of Q_1 that is directly proportional to the emitter current of Q_2. The output stage is well stabilized with a 5K emitter resistance. The circuit will operate to 55°C (130°F) ambient and also with variations in h_{FE} for the transistors.

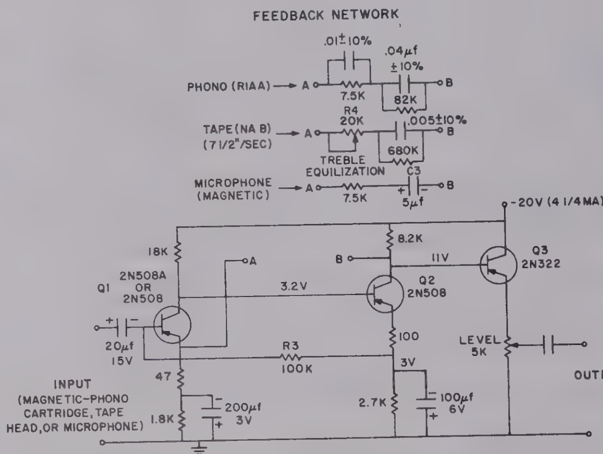
The AC negative feedback from the collector of Q_2 to the emitter of Q_1 is frequency selective to compensate for the standard NAB recording characteristic for tape or the standard RIAA for phonograph records. The flat response from a standard NAB recorded tape occurs with the Treble Control (R4) near mid-position. This treble equalization permits adjustment for variations in program material, pick-ups, and loudspeakers. A fixed resistor can be used at R4 is desired.

The RIAA feedback network has a 0.01 μf capacitor for decreasing the amplifier gain at the higher frequencies in accordance with RIAA requirements. This eliminates the need to load a reluctance pic-up with the proper resistance for high frequency compensation.

For microphone use, the capacitor C3 is large enough to make the voltage feedback, and thus the gain, constant across the audio spectrum. The input impedance for this connection is about 25K ohms, and 15 millivolts input level gives 1 volt output.

A good S/N can be realized with a tape head inductance between 0.2 and 1 henry; with 0.3 to 0.4 henry tape head, a S/N of 55 db can be attained. The preamp for tape use requires about 1.5 mv input signal at 1 KC for 1 volt output. Therefore a tape head with a 1 KC reference level output of 1.5 to 3 mv is desirable.

The emitter-follower output stage of the preamp gives a low impedance output for a cable run to a power amplifier (transistor or tube) and acts as a buffer so that any preamp loading will not affect the equalization characteristic.



PHONO, TAPE, OR MICROPHONE PREAMPLIFIER

APPLICATION OF TRANSISTOR NOISE CHARACTERISTICS

I. Definition of terms used:

e_N—Equivalent noise voltage at the transistor output with its input shorted.

i_N—Equivalent noise current at the transistor output with its input open.

$\sqrt{\text{cycle}}$—The rate at which noise varies with frequency. Example: If the noise bandwidth increases by a factor of 2, the noise increases by 1.4.

B—The effective noise bandwidth (Quantech 310, this is 1 cycle)

K—Boltzman's constant—1.38×10^{-23} joules/°K

T—Temperature in °K

II. Transistor Noise:

Transistor Noise can be considered as originating from a noise voltage generator (e_n) and a noise current generator (i_n). The curves show i_n and e_n versus collector current for three different frequencies. From these curves, the circuit designer can determine the optimum source impedance ($/Z_o/ \approx \frac{e_n}{i_n}$) for lowest noise at a given collector current. At this optimum source impedance, both noise generators contribute equally.

If the source impedance is fixed, then the circuit designer can choose the optimum collector current level to give lowest noise.

The value of minimum noise can be determined when using optimum source impedance for a given collector current and frequency.

III. Examples:

1. Calculate R optimum for 100 cycles with $I_c = 1$ ma and $V_c = 1$ volt.

$$R_{opt.} = \frac{e_n}{i_n} = \frac{1.8 \times 10^{-9}\text{ volts}}{7 \times 10^{-12}\text{ amps}} = 260\text{ ohms}$$

2. With the value of $R_{opt.}$ just obtained, what is the approximate optimum noise figure under these conditions?

$$\text{optimum NF} \approx 10 \log_{10} \left(1 + \frac{e_n\ i_n}{2\ k\ TB}\right)$$

$B = 1$ cycle

at room temperature $2\ kT = 8.28 \times 10^{-21}$

$$NF \approx 10 \log_{10} \left[1 + \frac{(1.8 \times 10^{-9})\ (7 \times 10^{-12})}{8.28 \times 10^{-21}}\right] = 4 \text{ db}$$

REFERENCE:

Sanderson and Fulks, "A Simplified Noise Theory and its Application to the Design of Low Noise Amplifiers," IRE Transactions on Audio, July-August, 1961.

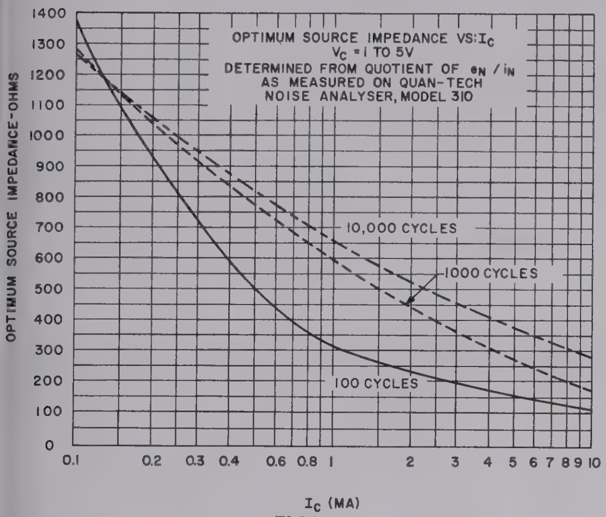


FIGURE 1

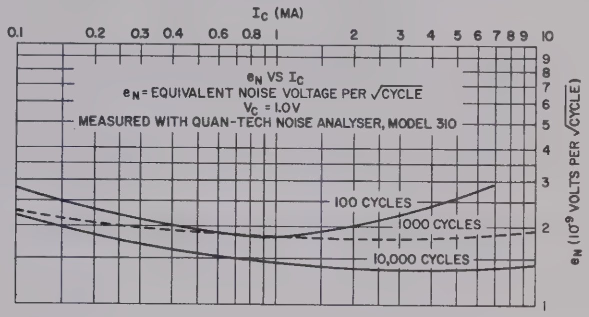


FIGURE 2

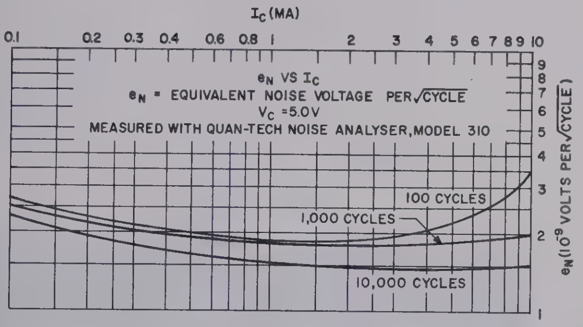


FIGURE 3

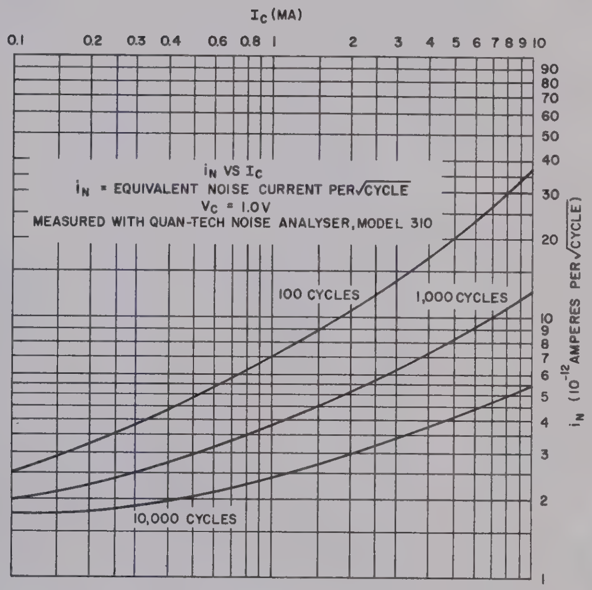


FIGURE 4

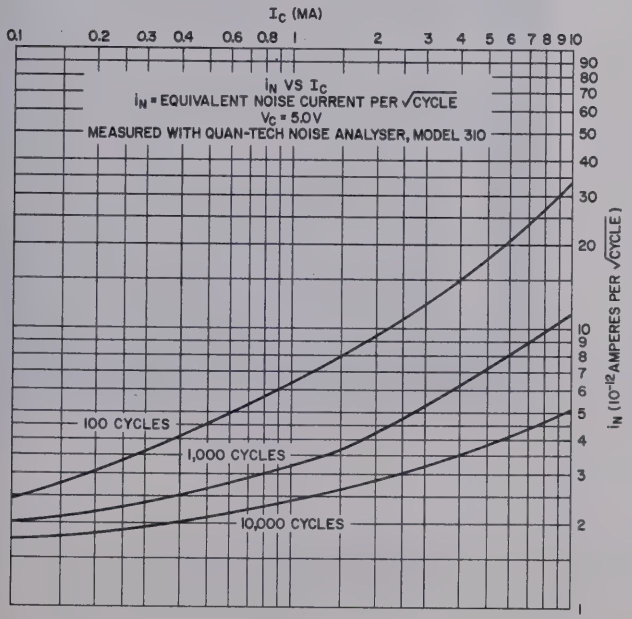


FIGURE 5

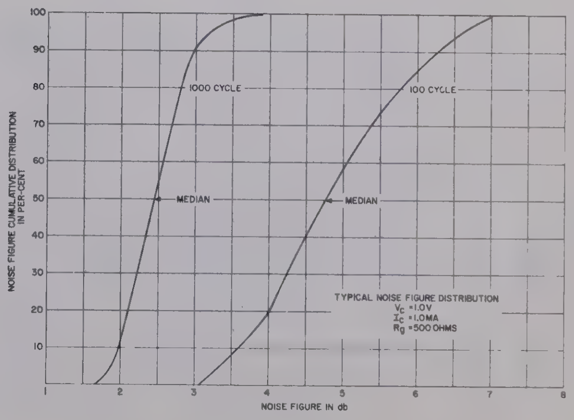


FIGURE 6

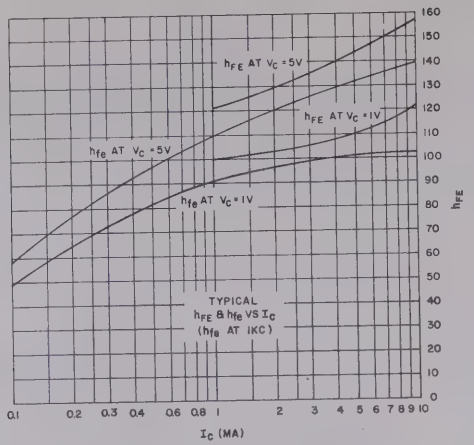


FIGURE 7

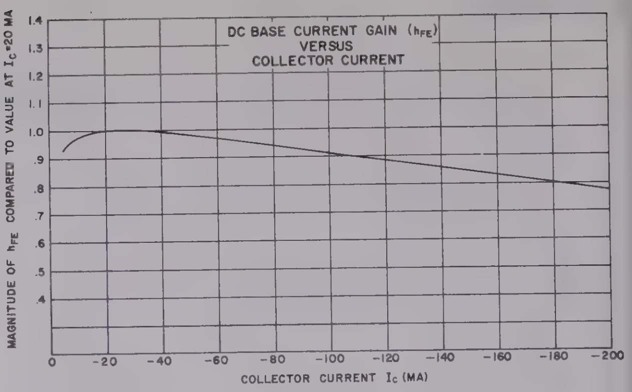


FIGURE 8

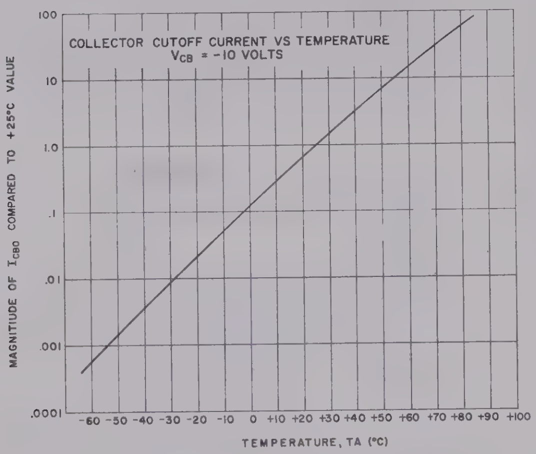


FIGURE 9

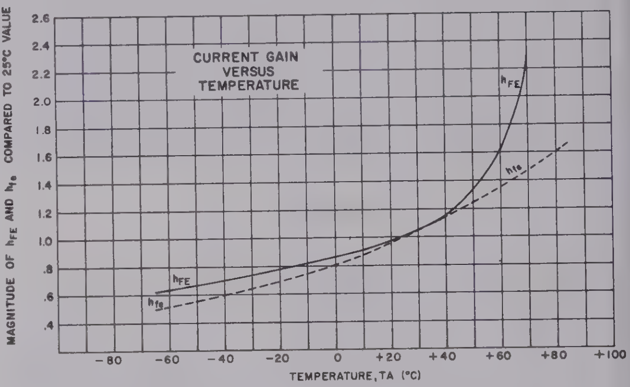


FIGURE 10

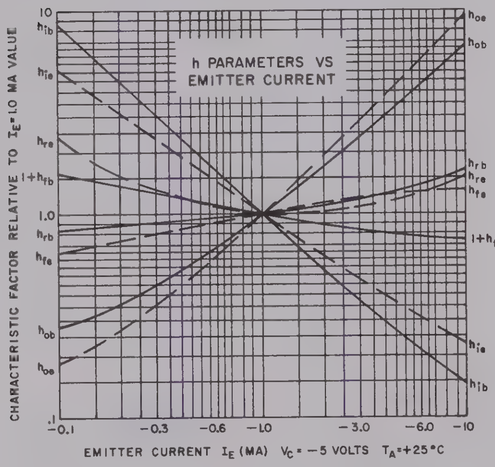


FIGURE 11

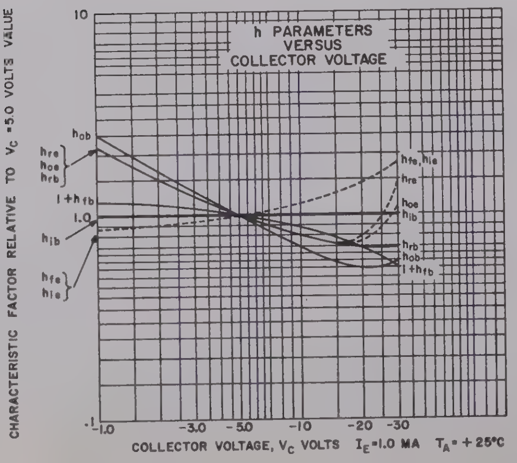


FIGURE 12

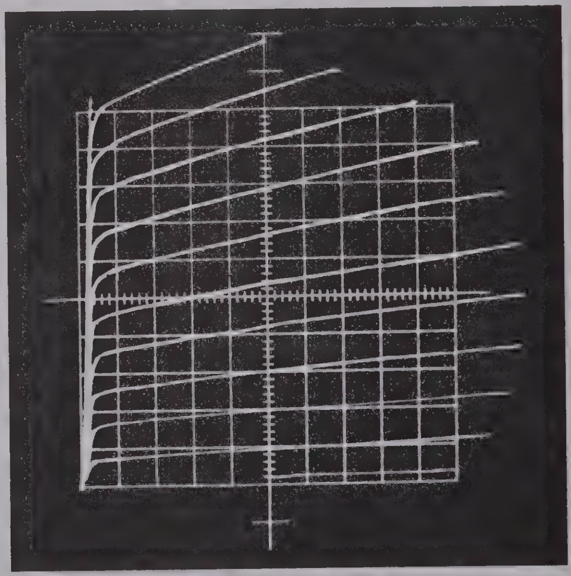


FIGURE 13

Collector Current vs V_{CE}
Vertical Scale = .5 MA/CM
Horizontal Scale = .5 V/CM
I_B = .005 MA/STEP

Germanium
Transistors

PNP

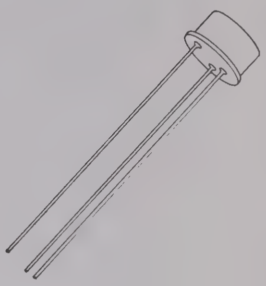
2N524,5,6,7

The General Electric types 2N524, 2N525, 2N526, and 2N527 are PNP germanium alloy transistors recommended for extremely reliable medium power amplification and switching in low frequency military and industrial applications.

Maximum operational reliability is assured by inclusion of military environmental testing. Each transistor is stabilized for at least 100 hours at 100°C minimum and is subjected to a hermetic seal test insuring a maximum leak rate of 10^{-10} cc/sec.

Reliable circuit design is assured by a unique Reliability-Index, and high temperature I_{CBO} and low temperature forward current gain 1000 hour life end points.

The high value of Reliability-Index is achieved by exacting control of parts, processes, and getter encapsulation to prevent junction contamination.



absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages		
Collector to Base	V_{CBO}	— 45 volts
Collector to Emitter ($R_{BE} \leqq 10K$)	V_{CER}	— 30 volts
Emitter to Base	V_{EBO}	— 15 volts
Collector Current	I_C	— 500 ma
Temperatures		
Storage	T_{STG}	— 65 to + 100°C
Operating	T_J	— 65 to + 85°C
Lead Temperature, 1/16″ ± 1/32″ from case for 10 seconds maximum	T_L	260°C
Total Transistor Dissipation		
Free Air (Derate 3.75 mw/°C increase in ambient above 25°C)	P_T	225 mw
Clip-on Heat Sink in Free Air (Derate 5.0 mw/°C)	P_T	300 mw
Infinite Heat Sink (Derate 9.15 mw/°C)	P_T	550 mw

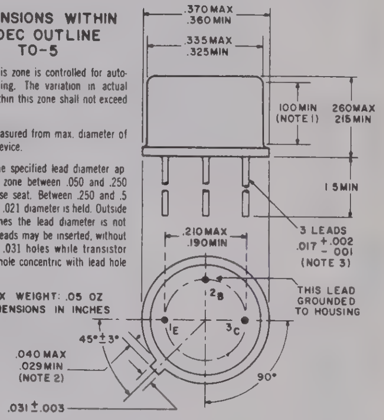
DIMENSIONS WITHIN
JEDEC OUTLINE
TO-5

NOTE 1: This zone is controlled for automatic handling. The variation in actual diameter within this zone shall not exceed .010.

NOTE 2: Measured from max. diameter of the actual device.

NOTE 3: The specified lead diameter applies in the zone between .050 and .250 from the base seat. Between .250 and .5 maximum of .021 diameter is held. Outside of these zones the lead diameter is not controlled. Leads may be inserted, without damage, in .031 holes while transistor enters .371 hole concentric with lead hole circle.

APPROX WEIGHT: .05 OZ
ALL DIMENSIONS IN INCHES

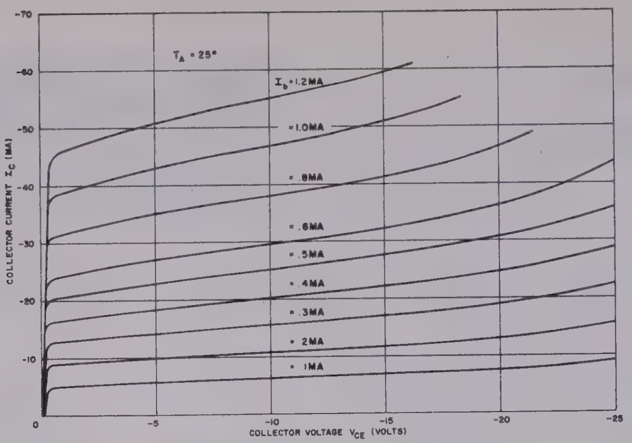


electrical characteristics: (25°C) (unless otherwise specified)

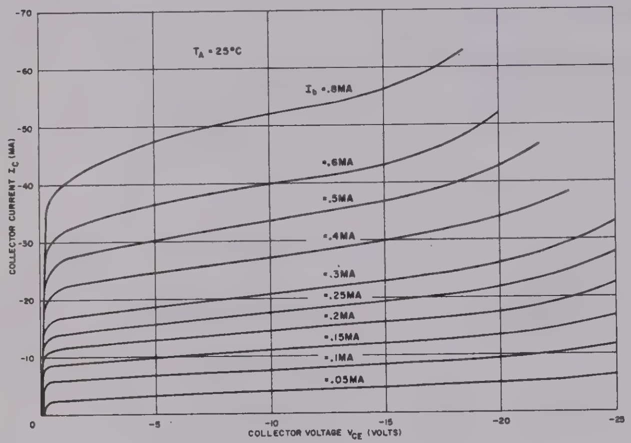
TEST	CONDITIONS	SYMBOL	UNITS	2N524 MIN.	2N524 TYP.	2N524 MAX.	2N525 MIN.	2N525 TYP.	2N525 MAX.	2N526 MIN.	2N526 TYP.	2N526 MAX.	2N527 MIN.	2N527 TYP.	2N527 MAX.
DC Characteristics															
Subgroup I															
Collector to Base Voltage	$I_C = -200\ \mu a$	V_{CBO}	volts	− 45			− 45			− 45			− 45		
Collector to Emitter Voltage	R_{BE} = 10K ohms, $I_C = -600\ \mu a$	V_{CER}	volts	− 30			− 30			− 30			− 30		
Reach-through Voltage		V_{RT}	volts	− 30			− 30			− 30			− 30		
Emitter Cutoff Current	$V_{EB} = -15v$	I_{EBO}	μa		− 3	− 10		− 3	− 10		− 3	− 10		− 3	− 10
Subgroup II															
Collector-Cutoff Current	$V_{CB} = -30v$	I_{CBO}	μa		− 3	− 10		− 3	− 10		− 3	− 10		− 3	− 10
Forward Current Transfer Ratio	$I_C = -20$ ma, $V_{CE} = -1v$ (Note 1)	h_{FE}		25(28)	35	(38)42	34(38)	50	(59)65	53(59)	70	(80)90	72(80)	95	(110)121
Forward Current Transfer Ratio	$I_C = -100$ ma, $V_{CE} = -1v$	h_{FE}		23	30		30	45		47	60		65	80	
Subgroup III															
Base Input Voltage, Common Emitter	$I_C = -20$ ma, $V_{CE} = -1v$	V_{BE}	volts	−.220	−.250	−.320	−.200	−.235	−.300	−.190	−.230	−.280	−.180	−.225	−.260
Collector Saturation Voltage	$I_C = -20$ ma, I_B as shown	V_{CE}(SAT)	volts		−.075	−.130		−.080	−.130		−.085	−.130		−.090	−.130
		@I_B	ma		−2.00			−1.33			−1.00			−0.67	
Small Signal Characteristics															
Subgroup I															
AC Forward Current Transfer Ratio	I_E = 1 ma, $V_{CE} = -5v$, f = 1kc	h_{fe}		18	30	41	30	44	64	44	64	88	60	80	120
Input Impedance	I_E = 1 ma, $V_{CB} = -5v$, f = 1kc	h_{ib}	ohms	26	30	34	26	29	33	26	28	32	26	28	31
Output Admittance	I_E = 1 ma, $V_{CB} = -5v$, f = 1kc	h_{ob}	μmhos	0.1	0.7	1.3	0.1	0.6	1.2	0.1	0.5	1.0	0.1	0.4	0.9
Reverse Voltage Transfer Ratio	I_E = 1 ma, $V_{CB} = -5v$, f = 1kc	h_{rb}	$x10^{-4}$	1	4	10	1	5	11	1	6	12	1	7	14
Subgroup II															
Cutoff Frequency	I_E = 1 ma, $V_{CB} = -5v$	f_{hfb}	mc	0.8	2.5	5.0	1.0	3.0	5.5	1.3	3.5	6.5	1.5	4.0	7.0
Output Capacity	I_E = 1 ma, $V_{CB} = -5v$, f = 1mc (Note 1)	C_{ob}	pf	5	18	(30)40	5	18	(30)40	5	18	(30)40	5	18	(30)40
Noise Figure	I_E = 1 ma, $V_{CB} = -5v$, f = 1kc, BW = 1 cps, Rg = 1000 ohms (Note 1)	NF	db	(1)	5	(8)15	(1)	4	(7)15	(1)	3	(6)15	(1)	2	(5)15

Note 1: A minimum of 95% of the distribution is normally contained between values in parenthesis.

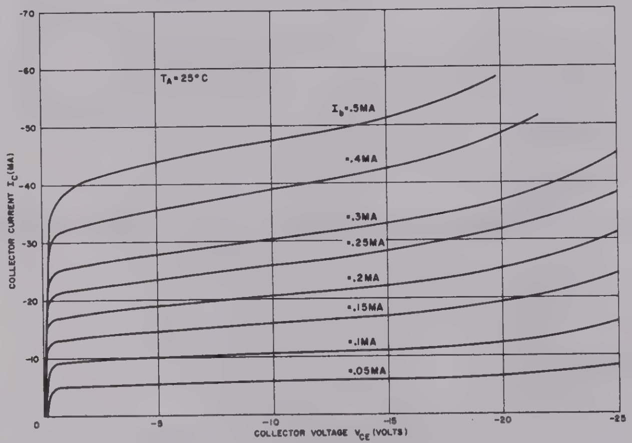
COMMON EMITTER COLLECTOR TYPICAL CHARACTERISTICS
TYPES 2N524 2N525 2N526 2N527 $T_A = 25°C$



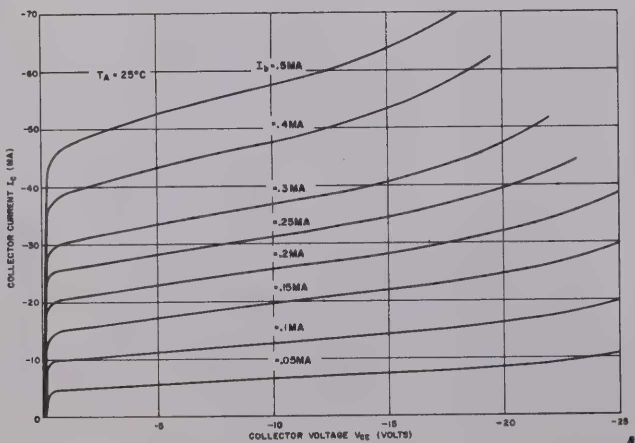
COMMON EMITTER COLLECTOR CHARACTERISTICS TYPE 2N524



COMMON EMITTER COLLECTOR CHARACTERISTICS TYPE 2N525

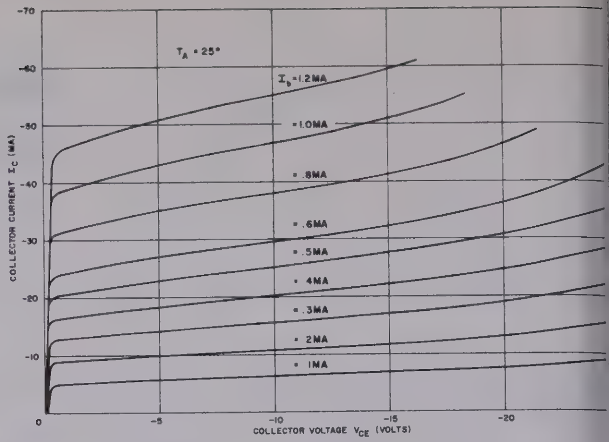


COMMON EMITTER COLLECTOR CHARACTERISTICS TYPE 2N526

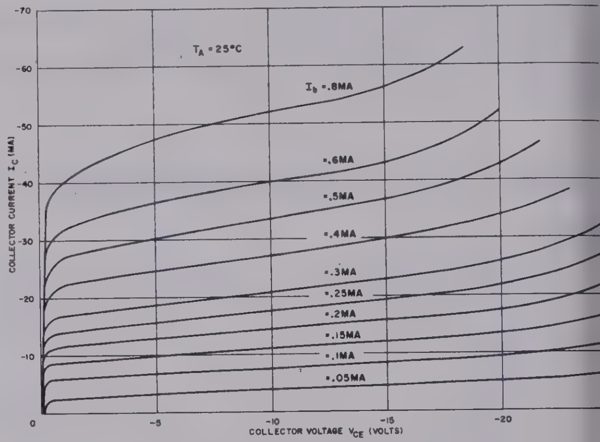


COMMON EMITTER COLLECTOR CHARACTERISTICS TYPE 2N527

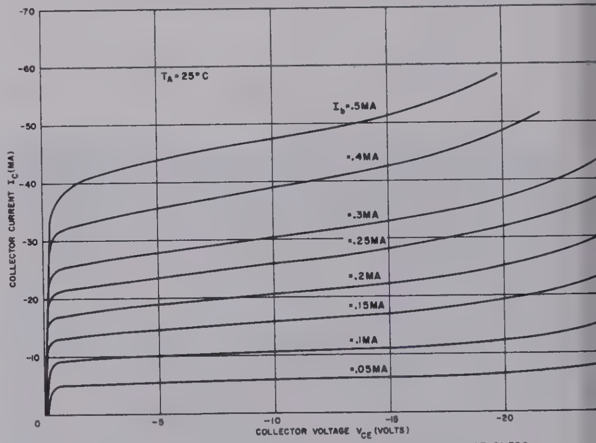
COMMON EMITTER COLLECTOR TYPICAL CHARACTERISTICS
TYPES 2N524 2N525 2N526 2N527 $T_A = 25°C$



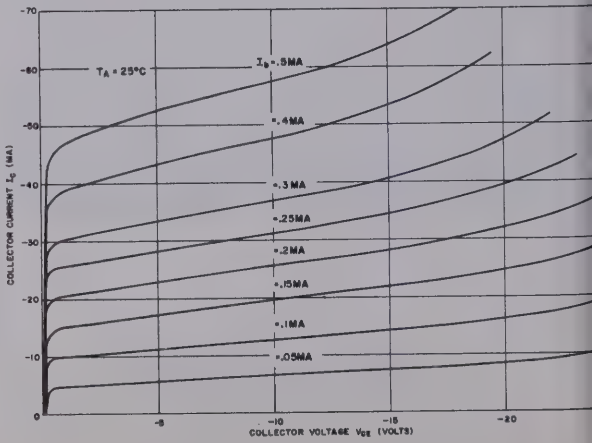
COMMON EMITTER COLLECTOR CHARACTERISTICS TYPE 2N524



COMMON EMITTER COLLECTOR CHARACTERISTICS TYPE 2N525

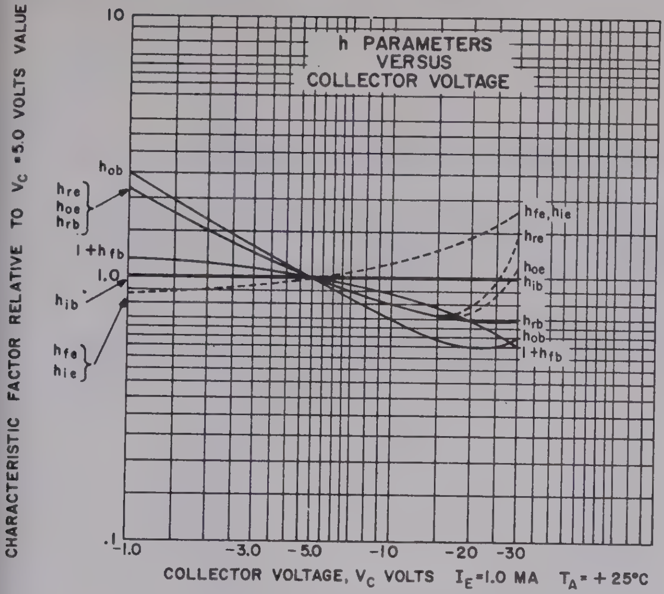


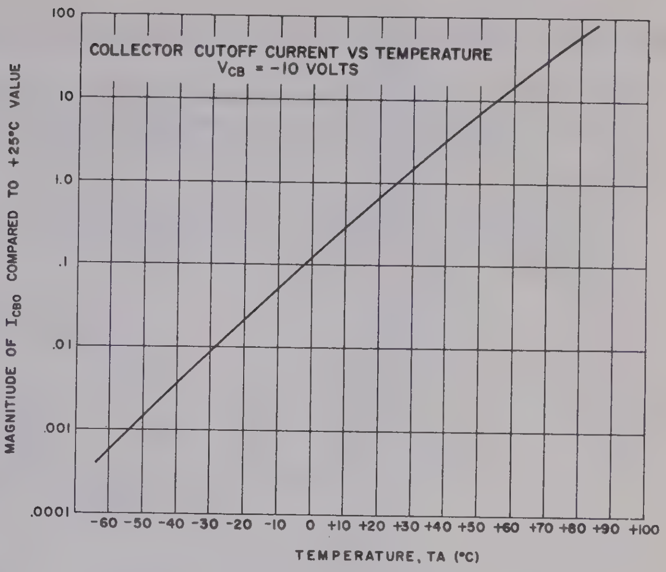
COMMON EMITTER COLLECTOR CHARACTERISTICS TYPE 2N526

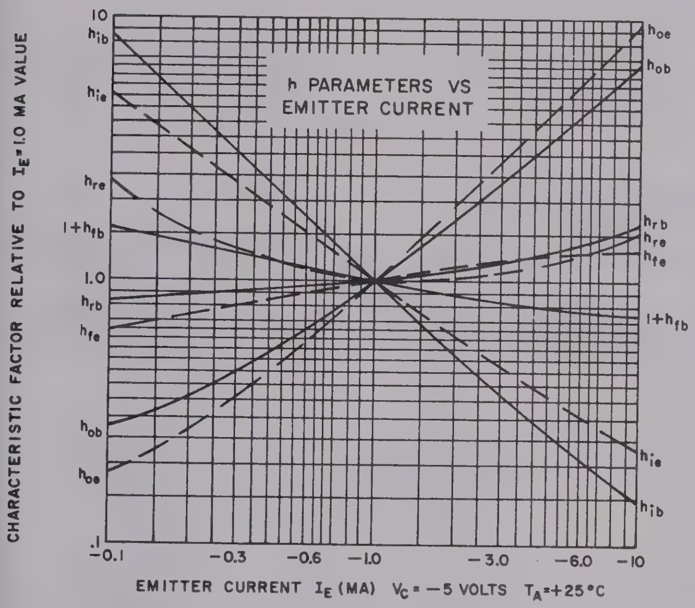


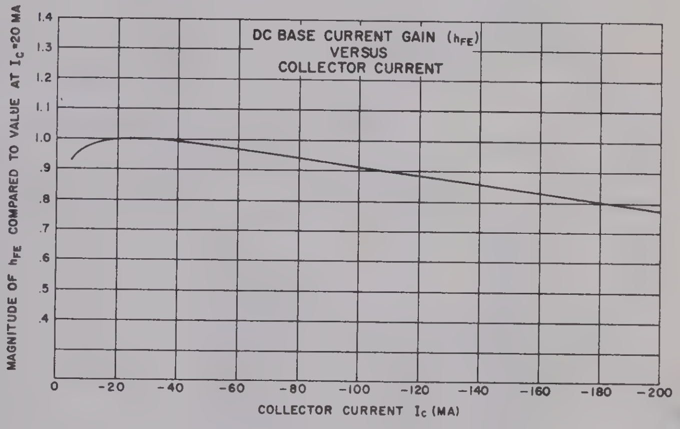
COMMON EMITTER COLLECTOR CHARACTERISTICS TYPE 2N527

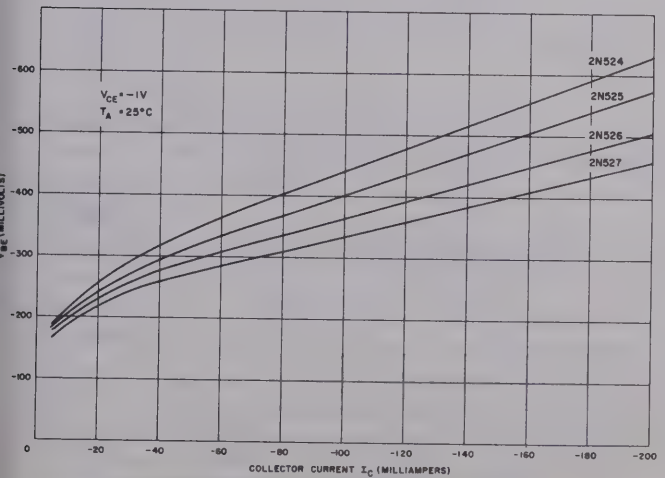
TYPICAL CHARACTERISTICS



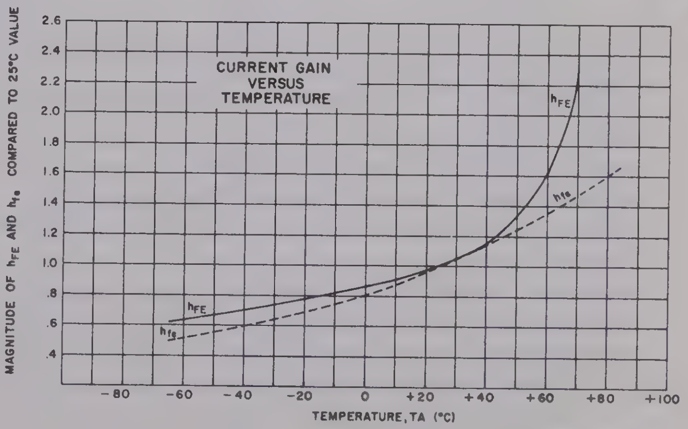








COMMON EMITTER INPUT VOLTAGE VS COLLECTOR CURRENT



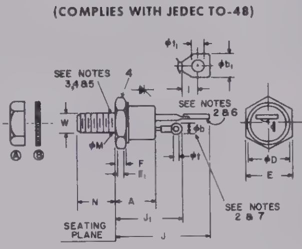
2N681-92

The 2N681 through 2N692 Series of Silicon Controlled Rectifiers are reverse blocking triode thyristor semiconductor devices for use in medium power switching and phase control applications requiring blocking voltages up to 800 volts, and average load currents (single-phase, 180° conduction angle) up to 16 amperes.

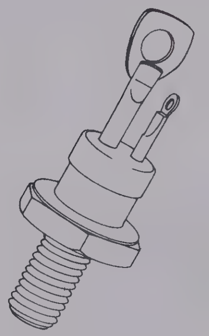
General Electric's C35 SCR (Publication No. 160.20), and C137 SCR (Publication No. 160.45) are recommended where a higher level of performance is required for a device of this size.

OUTLINE DRAWING
(COMPLIES WITH JEDEC TO-48)

NOTES:
1 Complete threads to extend to within 2½ threads of seating plane. Diameter of unthreaded portion .249" (6.32MM) Maximum, 220" (5.59MM) Minimum.
2. Angular orientation of these terminals is undefined.
3 ¼-28 UNF-2A Maximum pitch diameter of plated threads shall be basic pitch diameter .2268" (5.76MM), minimum pitch diameter .2225" (5.66MM), reference: screw thread standards for Federal Service 1957, Handbook H28, 1957, P1.
4 A chamfer (or undercut) on one or both ends of hexagonal portions is optional
5 Case is anode connection.
6 Large terminal is cathode connection.
7. Small terminal is gate connection
8 Insulating kit available upon request.
A ¼-28 steel nut, Ni plated, 178 min thk.
B Ext. tooth lockwasher, steel, Ni plated, .023 min. thk.



SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	330	505	8 38	12 83	
φb	115	140	2 92	3 56	2
φb₁	.210	300	5 33	7 62	2
φD		544		13 82	
E	.544	.562	13.82	14.27	
F	.113	.200	2.87	5.08	4
F₁	.060		1.52		
J		1.193		30 30	
J₁		.875		22.23	
l	120		3.05		
φM					1
N	.422	.453	10.72	11 51	
φt	.060	.075	1.52	1 91	
φt₁	.125	165	3.18	4.19	
W					3



MAXIMUM ALLOWABLE RATINGS

TYPE	PEAK FORWARD BLOCKING VOLTAGE, V_{FOM} $T_C = -65°C +125°C$	PEAK FORWARD VOLTAGE, PFV[2] $T_C = -65°C +125°C$	REPETITIVE PEAK REVERSE VOLTAGE, V_{ROM} (rep)[1] $T_C = -65°C +125°C$	NON-REPETITIVE PEAK REVERSE VOLTAGE (<5 MILLISEC.), V_{ROM} (non-rep)[1] $T_C = -65°C +125°C$
2N681	25 Volts*	35 Volts	25 Volts*	35 Volts*
2N682	50 Volts*	75 Volts	50 Volts*	75 Volts*
2N683	100 Volts*	150 Volts	100 Volts*	150 Volts*
2N684	150 Volts*	225 Volts	150 Volts*	225 Volts*
2N685	200 Volts*	300 Volts	200 Volts*	300 Volts*
2N686	250 Volts*	350 Volts	250 Volts*	350 Volts*
2N687	300 Volts*	400 Volts	300 Volts*	400 Volts*
2N688	400 Volts*	500 Volts	400 Volts*	500 Volts*
2N689	500 Volts*	600 Volts	500 Volts*	600 Volts*
2N690	600 Volts*	720 Volts	600 Volts*	720 Volts*
2N691	700 Volts*	840 Volts	700 Volts*	840 Volts*
2N692	800 Volts*	960 Volts	800 Volts*	960 Volts*

(1)Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for which maximum V_{FOM} and V_{ROM} ratings apply equals 11°C per watt.

(2)Cells with higher PFV ratings are available upon request.

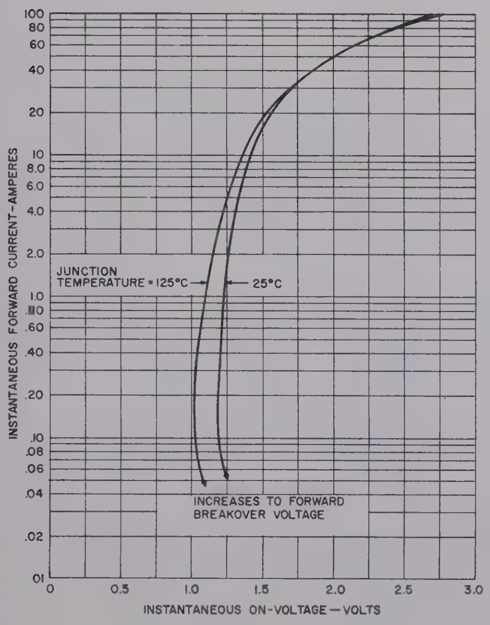
RMS Forward Current, On-State	25 amperes (all conduction angles)
Average Forward Current, On-State	Depends on conduction angle (see Charts 3, 5 and 7)
Rate of Rise of Forward Current, On-State, di/dt	10 amperes per microsecond
Peak One-cycle Surge Forward Current, I_{FM} (surge)	150 amperes*
I^2t (for fusing)	75 ampere² seconds (for times ≧1.5 milliseconds)
Peak Gate Power Dissipation, P_{GM}	5 watts*
Average Gate Power Dissipation, $P_{G\ (AV)}$	0.5 watt*
Peak Forward Gate Current, I_{GFM}	2 amperes*
Peak Forward Gate Voltage, V_{GFM}	10 volts*
Peak Reverse Gate Voltage, V_{GRM}	5 volts*
Storage Temperature, T_{stg}	−65°C to +150°C*
Operating Temperature, T_J	−65°C to +125°C*
Stud Torque	30 lb-in (35 kg-cm)

***Indicates Data included on JEDEC type number registration.**

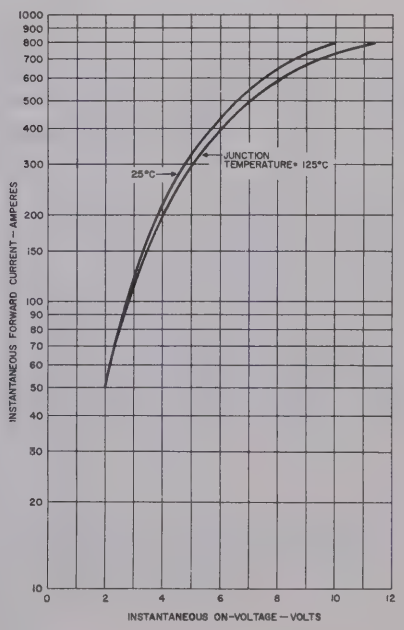
CHARACTERISTICS

TEST	SYMBOL	MIN.	MAX.	UNITS	TEST CONDITIONS
PEAK REVERSE OR FORWARD BLOCKING CURRENT†	I_{ROM} or I_{FOM}			mA	$T_C = -65°C$ to $+125°C$
2N681		—	13.0		$V_{ROM} = V_{FOM} =$ 25V Peak
2N682		—	13.0		= 50V
2N683		—	13.0		= 100V
2N684		—	13.0		= 150V
2N685		—	12.0		= 200V
2N686		—	11.0		= 250V
2N687		—	10.0		= 300V
2N688		—	8.0		= 400V
2N689		—	6.0		= 500V
2N690		—	5.0		= 600V
2N691		—	4.5		= 700V
2N692		—	4.0		= 800V
FULL CYCLE AVG. REVERSE OR FORWARD BLOCKING CURRENT†	$I_{RX(AV)}$ or $I_{FX(AV)}$			mA	$T_C = +65°C$, $I_o = 16A$ 180° Conduction Angle
2N681		—	6.5*		$V_{RXM} = V_{FXM} =$ 25V Peak
2N682		—	6.5*		= 50V
2N683		—	6.5*		= 100V
2N684		—	6.5*		= 150V
2N685		—	6.0*		= 200V
2N686		—	5.5*		= 250V
2N687		—	5.0*		= 300V
2N688		—	4.0*		= 400V
2N689		—	3.0*		= 500V
2N690		—	2.5*		= 600V
2N691		—	2.25*		= 700V
2N692		—	2.0*		= 800V
GATE TRIGGER CURRENT	I_{GT}	—	40	mAdc	$T_C = +25°C$, $V_{FX} = 12Vdc$, $R_L = 50$ ohms
		—	80*	mAdc	$T_C = -65°C$, $V_{FX} = 12Vdc$, $R_L = 50$ ohms
GATE TRIGGER VOLTAGE	V_{GT}	—	3.0*	Vdc	$T_C = -65°C$ to $+125°C$, $V_{FX} = 12Vdc$, $R_L = 50$ ohms
		0.25*	—	Vdc	$T_C = +125°C$, V_{FXM} = Rated V_{FOM}, $R_L = 1000$ ohms
PEAK ON-VOLTAGE	V_{FM}	—	2.0	V	$T_C = +25°C$, $I_{FM} = 50A$ Peak, 1 mlilisecond wide pulse
EFFECTIVE THERMAL RESISTANCE (DC)	θ_{J-C}	—	1.7	°C/watt	

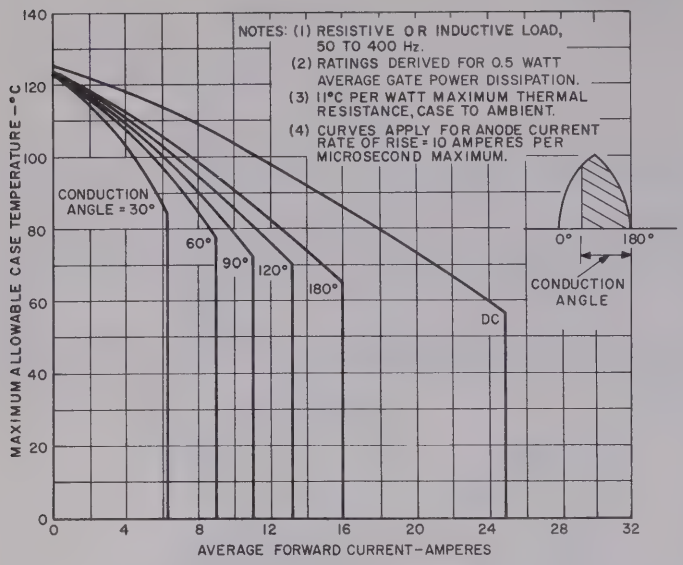
†Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for which maximum V_{FOM} and V_{ROM} ratings apply equals 11°C/watt.
*Indicates data included on JEDEC type number registration.



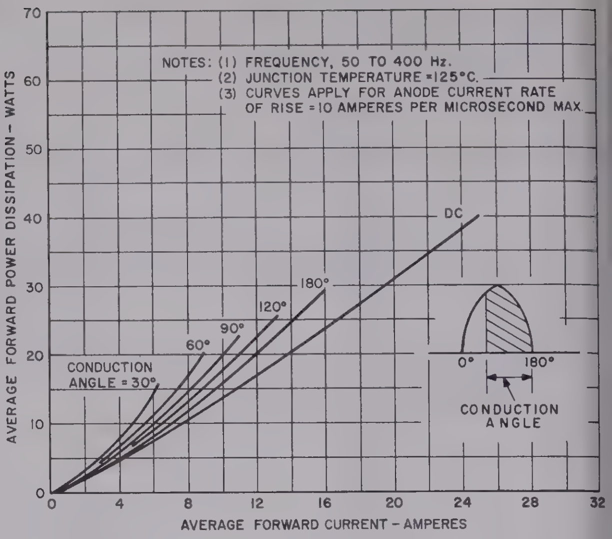
1. MAXIMUM FORWARD CHARACTERISTICS—ON-STATE



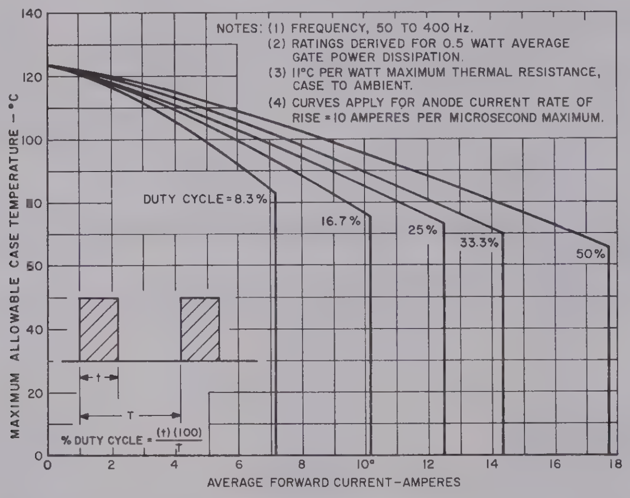
2. MAXIMUM FORWARD CHARACTERISTICS—HIGH CURRENT LEVEL—ON-STATE



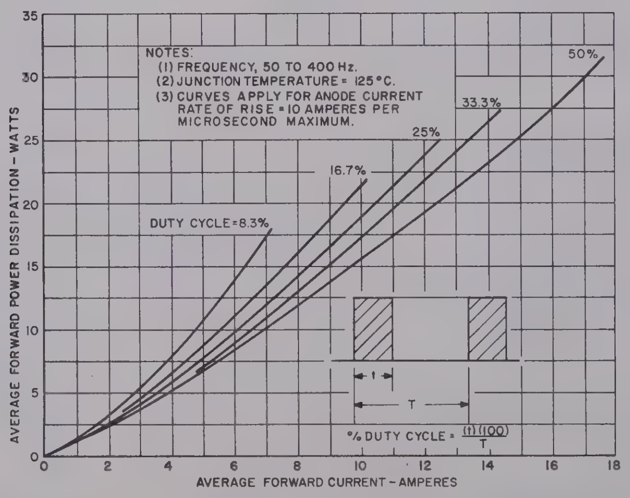
3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



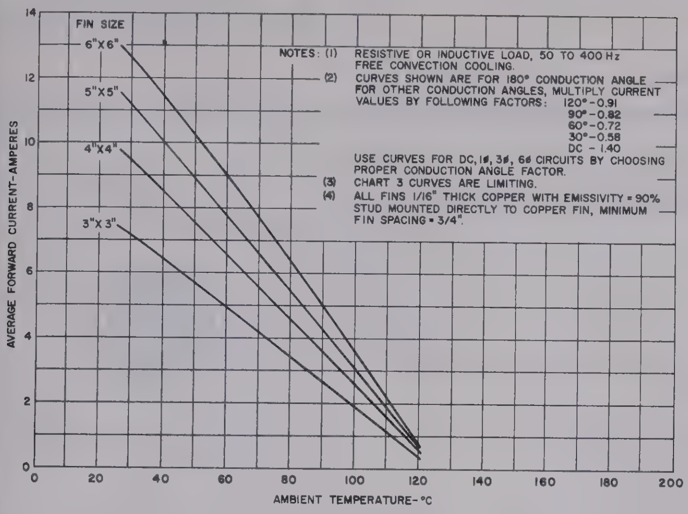
4. FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



5. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM

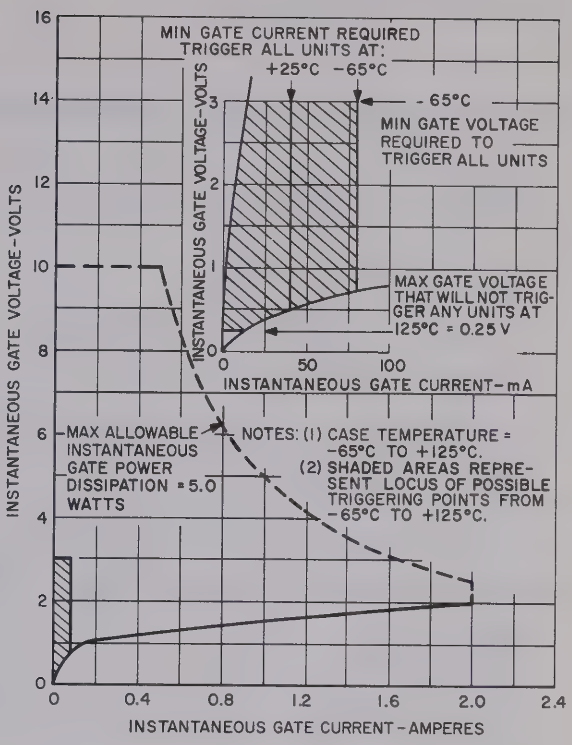


6. FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



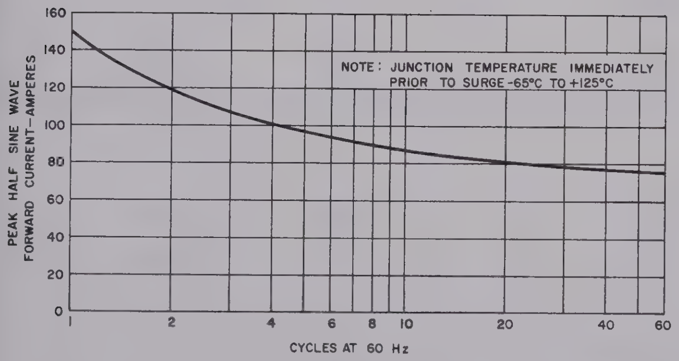
NOTES: (1) RESISTIVE OR INDUCTIVE LOAD, 50 TO 400 Hz FREE CONVECTION COOLING.
(2) CURVES SHOWN ARE FOR 180° CONDUCTION ANGLE FOR OTHER CONDUCTION ANGLES, MULTIPLY CURRENT VALUES BY FOLLOWING FACTORS: 120°-0.91
90°-0.82
60°-0.72
30°-0.58
DC - 1.40
USE CURVES FOR DC, 1ø, 3ø, 6ø CIRCUITS BY CHOOSING PROPER CONDUCTION ANGLE FACTOR.
(3) CHART 3 CURVES ARE LIMITING.
(4) ALL FINS 1/16" THICK COPPER WITH EMISSIVITY = 90% STUD MOUNTED DIRECTLY TO COPPER FIN, MINIMUM FIN SPACING = 3/4".

7. MAXIMUM FORWARD CURRENT VS. AMBIENT TEMPERATURE FOR VARIOUS FIN SIZES



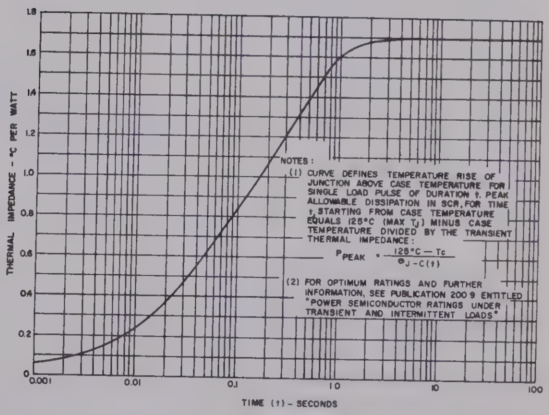
NOTES: (1) CASE TEMPERATURE = -65°C TO +125°C.
(2) SHADED AREAS REPRESENT LOCUS OF POSSIBLE TRIGGERING POINTS FROM -65°C TO +125°C.

8. GATE TRIGGERING CHARACTERISTICS



NOTE: JUNCTION TEMPERATURE IMMEDIATELY PRIOR TO SURGE -65°C TO +125°C

9. MAXIMUM ALLOWABLE NON-RECURRENT PEAK SURGE FORWARD CURRENT AT RATED LOAD CONDITIONS



NOTES:
(1) CURVE DEFINES TEMPERATURE RISE OF JUNCTION ABOVE CASE TEMPERATURE FOR SINGLE LOAD PULSE OF DURATION t. PEAK ALLOWABLE DISSIPATION IN SCR, FOR TIME t, STARTING FROM CASE TEMPERATURE EQUALS 125°C (MAX T_J) MINUS CASE TEMPERATURE DIVIDED BY THE TRANSIENT THERMAL IMPEDANCE:

$$P_{PEAK} = \frac{125°C - T_C}{\theta_{J-C(t)}}$$

(2) FOR OPTIMUM RATINGS AND FURTHER INFORMATION, SEE PUBLICATION 200.9 ENTITLED "POWER SEMICONDUCTOR RATINGS UNDER TRANSIENT AND INTERMITTENT LOADS"

10. MAXIMUM TRANSIENT THERMAL IMPEDANCE—JUNCTION TO CASE

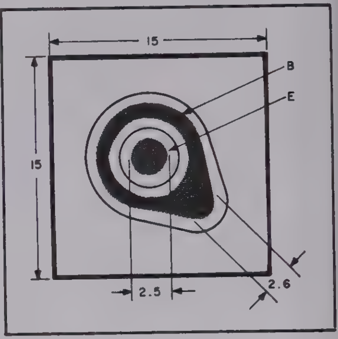
Silicon
Transistor Chips

NPN

2N708 (Chip)

(M82P-X500)

The General Electric NPN silicon planar passivated epitaxial transistor chip is designed primarily for high-speed switching applications. The chip is also suitable as a small signal device.



General specifications:
- Gold collector contact backing, minimum thickness—3000Å
- Aluminum base and emitter contact metalization
- Maximum conditions for mounting chips—425°C for 5 minutes (Max.) in an inert atmosphere
- Shipping containers: Glass vials sealed with a nitrogen back-fill
  Maximum of 10k chips per vial
  Egg crate containers available at extra cost
- Chip drawing dimensions are in mils
- Chip thickness = 5.0 $^{+0.5}_{-1.0}$ mils

absolute maximum ratings: ($T_A = 25°C$)

	Symbol		
Voltages			
Collector to Base	V_{CBO}	40	V
Collector to Emitter	V_{CEO}	15	V
Emitter to Base	V_{EBO}	5	V
Collector to Emitter ($R_{BE} = 10\ \Omega$)	V_{CER}	20	V
Current			
Collector	I_C	200	mA
Temperature			
Storage	T_{STG}	−65°C to +200°C	
Operating	T_J	−65°C to +200°C	

electrical characteristics: 100% Probe ($T_A = 25°C$)

Tested at outgoing acceptance to a 10% LTPD with a maximum accept number of 3.

	Symbol	Min.	Max.	
Collector Base Breakdown Voltage ($I_C = 1\ \mu A$)	BV_{CBO}	40	—	V
Collector Emitter Breakdown Voltage ($I_C = 10$ mA)	BV_{CEO}	15	—	V
Emitter Base Breakdown Voltage ($I_E = 10\ \mu A$)	BV_{EBO}	5	—	V
Collector Cutoff Current ($V_{CB} = 20V$)	I_{CBO}	—	0.5	μA
Forward Current Transfer Ratio ($I_C = 10$ mA, $V_{CE} = 2V$)	h_{FE}	30	120	

specifications: ($T_A = 25°C$)

Product yield is at least 93% to each of the following parameters:

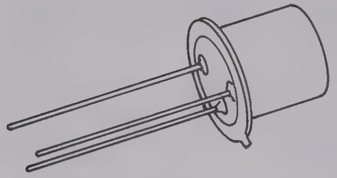
	Symbol	Min.	Max.	
Forward Current Transfer Ratio ($I_C = 10$ mA, $V_{CE} = 1.0V$)	h_{FE}	30	120	
Collector Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)	$V_{CE(SAT)}$	—	0.4	V
Base Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)	$V_{BE(SAT)}$	0.72	0.80	V
Forward Current Transfer Ratio ($I_C = 10$ mA, $V_{CE} = 10V$, f = 100 MHz)	h_{fe}	3	—	
Collector Base Capacitance ($V_{CB} = 10V$, f = 1 MHz)	C_{cb}	—	6	pF

SCR

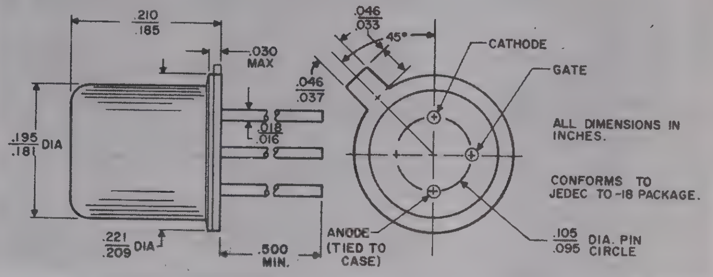
2N877-81
2N885-89

FEATURES:

- All-diffused for Proved Reliability
- Miniature Package TO-18
- Two Ranges of Gate Sensitivity:
  2N877-881 — 200 ua max.
  2N885-889 — 20ua max.
- Low Holding Current:
  2N877-881 — 5 ma. max.
  2N885-889 — 3 ma. mas.
- Voltage Ratings up to 200 volts
- Designed for Military Applications



OUTLINE DRAWING


.210
.185
.030 MAX
.046
.033
45°
CATHODE
GATE
.046
.037
.018
.016
.195
.181 DIA
ALL DIMENSIONS IN INCHES.
CONFORMS TO JEDEC TO-18 PACKAGE.
.221
.209 DIA
.500 MIN.
ANODE (TIED TO CASE)
.105
.095 DIA. PIN CIRCLE

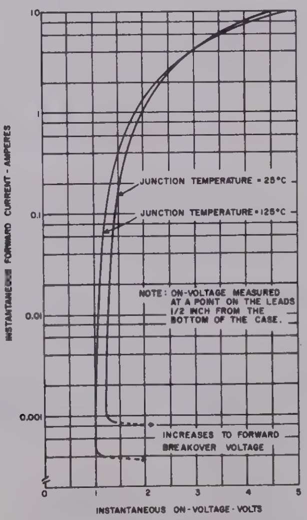
MAXIMUM ALLOWABLE RATINGS

TYPES	PEAK FORWARD BLOCKING VOLTAGE, V_{FXM}, $T_J = -65°C$ to $+125°C$. $R_{GK} = 1000$ OHMS MAXIMUM.	WORKING AND REPETITIVE PEAK REVERSE VOLTAGE, V_{ROM} (wkg) and V_{ROM} (rep). $T_J = -65°C$ to $+150°C$	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{ROM} (non-rep) $<$ 5 Milliseconds. $T_J = -65°C$ to $+125°C$
2N877, 2N885	30 volts	30 volts	45 volts
2N878, 2N886	60 volts	60 volts	90 volts
2N879, 2N887	100 volts	100 volts	130 volts
2N880, 2N888	150 volts	150 volts	200 volts
2N881, 2N889	200 volts	200 volts	275 volts

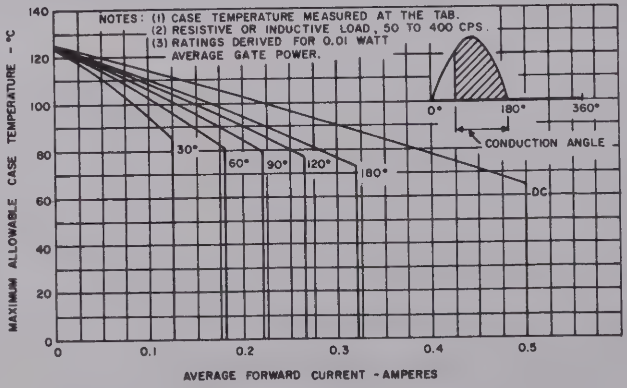
Peak Forward Voltage, PFV	300 Volts
RMS Forward Current, On-state	0.5 Ampere
Average Forward Current, On-state	Depends on conduction angle (see charts 2, 3, 11 & 12)
Peak One Cycle Surge Forward Current (Non-repetitive), I_{FM} (surge)	7 Amperes
Peak Forward Gate Power Dissipation, P_{GM}	0.1 Watt
Average Forward Gate Power Dissipation, $P_{G(AV)}$	0.01 Watt
Peak Gate Voltage, Forward and Reverse, V_{GFM} and V_{GRM}	6 Volts
Storage Temperature, T_{stg}	−65°C to +150°C
Operating Temperature	−65°C to +150°C

CHARACTERISTICS

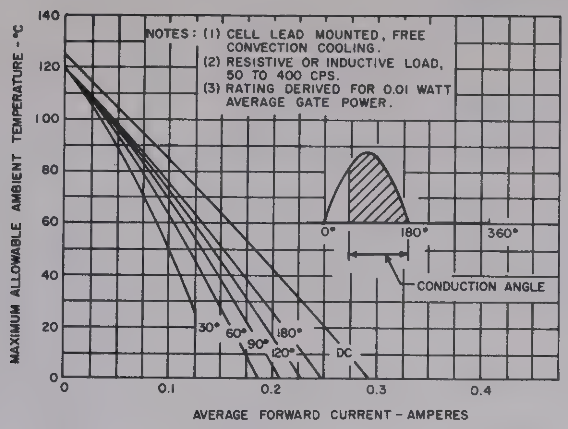
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
FORWARD BLOCKING CURRENT	I_{FX}				μAdc	V_{FX} = Rated V_{FXM}, R_{GK} = 1000 ohms
2N877-2N881		—	0.03	10		$T_J = +25°C$
		—	10	100		$T_J = +125°C$
2N885-2N889		—	0.03	1		$T_J = +25°C$
		—	10	20		$T_J = +125°C$
REVERSE BLOCKING CURRENT	I_{RX}				μAdc	V_{RX} = Rated V_{ROM} (rep)
2N877-2N881		—	0.1	10		$T_J = +25°C$
		—	10	100		$T_J = +125°C$
2N885-2N889		—	0.1	1		$T_J = +25°C$
		—	10	20		$T_J = +125°C$
REVERSE GATE CURRENT	I_{GRM}	—	1	10	μAdc	V_{GRM} = 2 Volts, $T_J = +25°C$.
PEAK ON-VOLTAGE	V_{FM}	—	1.3	1.9	volts	$T_J = +25°C$, I_{FM} = 1 Ampere, single half sine wave pulse, 2.0 milliseconds wide max.
HOLDING CURRENT	I_{HX}				mAdc	$T_J = +25°C$, R_{GK} = 1000 ohms, V_{FX} = 24 Volts dc.
2N877-2N881		0.4	1.7	5.0		
2N885-2N889		0.4	1.1	3.0		
RATE OF RISE OF APPLIED FORWARD VOLTAGE	dv/dt	—	40	—	volts/ μsec	$T_J = +125°C$, R_{GK} = 1000 ohms, V_{FXM} = Rated V_{FXM}
TURN-ON TIME (Delay Time + Rise Time)	t_d+t_r	—	1.0	—	μsec	$T_J = +25°C$, V_{FX} = Rated V_{FXM}, I_{FM} = 1 Ampere, Gate Supply: 6 Volts, 300 ohms
CIRCUIT COMMUTATED TURN-OFF TIME All Types	t_{off}	—	15	—	μsec	$T_J = +125°C$, R_{GK} = 1000 ohms, I_{FM} = 1 Ampere, I_R (recovery) = 1 Ampere Reapplied V_{FXM} = Rated, Rate of Rise of Reapplied Forward Blocking Voltage = 20 V/μsec
GATE TRIGGER CURRENT	I_{GT}				μAdc	V_{FX} = 6 Vdc, R_{GK} = 1000 ohms, R_L = 100 ohms maximum.
2N877-2N881		—	40	200		$T_J = +25°C$
2N885-2N889		—	10	20		$T_J = +25°C$
GATE TRIGGER VOLTAGE	V_{GT}				Vdc	V_{FX} = 6 Vdc, R_{GK} = 1000 ohms, R_L = 100 ohms maximum.
2N877-2N881		0.4	0.5	0.8		$T_J = +25°C$
2N885-2N889		0.44	0.5	0.6		$T_J = +25°C$
All Types		0.05	—	—		V_{FX} = Rated V_{FXM}, R_{GK} = 1000 ohms, $T_J = +125°C$



1. MAXIMUM FORWARD CHARACTERISTICS, ON-STATE

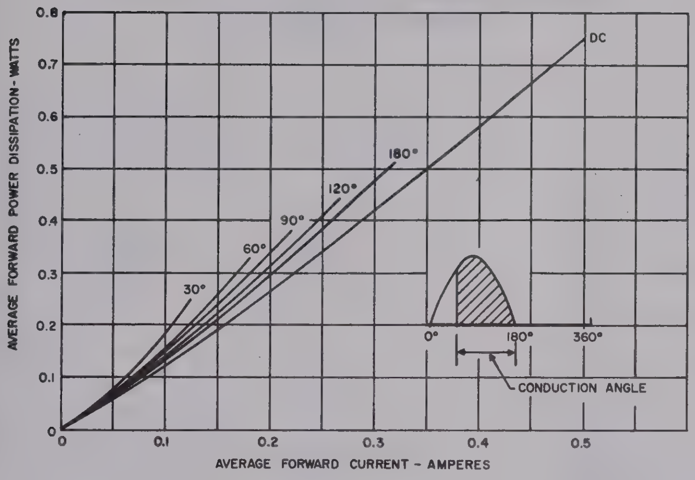


2. MAXIMUM ALLOWABLE CASE TEMPERATURE (125°C JUNCTION TEMP.)

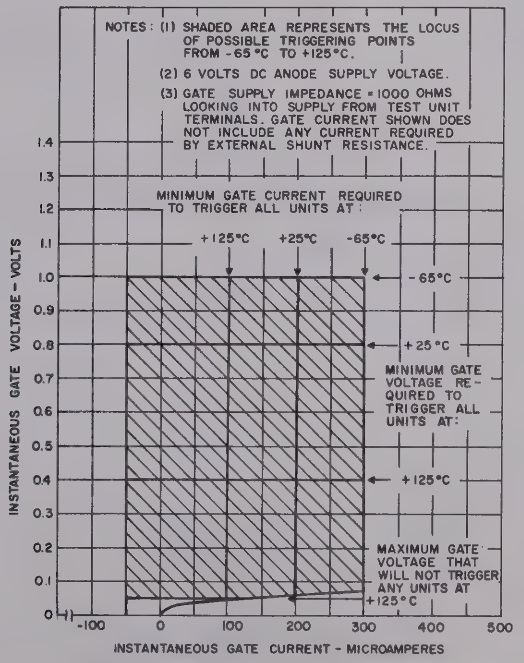


NOTES: (1) CELL LEAD MOUNTED, FREE CONVECTION COOLING.
(2) RESISTIVE OR INDUCTIVE LOAD, 50 TO 400 CPS.
(3) RATING DERIVED FOR 0.01 WATT AVERAGE GATE POWER.

3. MAXIMUM ALLOWABLE AMBIENT TEMPERATURE (125°C JUNCTION TEMP.)



4. FORWARD POWER DISSIPATION



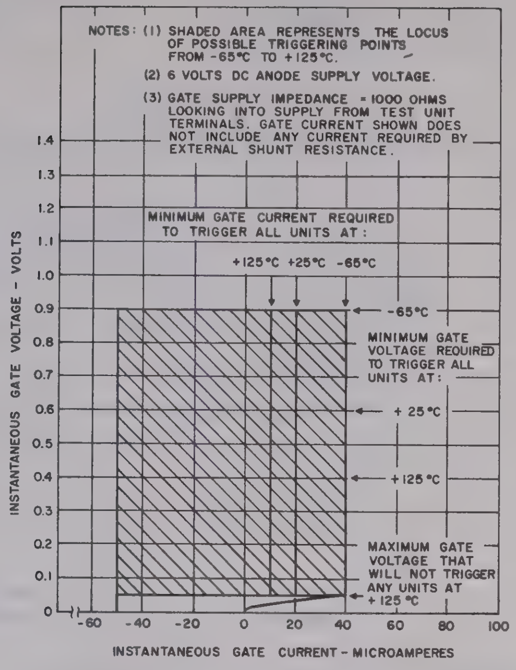
NOTES: (1) SHADED AREA REPRESENTS THE LOCUS OF POSSIBLE TRIGGERING POINTS FROM -65°C TO +125°C.
(2) 6 VOLTS DC ANODE SUPPLY VOLTAGE.
(3) GATE SUPPLY IMPEDANCE = 1000 OHMS LOOKING INTO SUPPLY FROM TEST UNIT TERMINALS. GATE CURRENT SHOWN DOES NOT INCLUDE ANY CURRENT REQUIRED BY EXTERNAL SHUNT RESISTANCE.

MINIMUM GATE CURRENT REQUIRED TO TRIGGER ALL UNITS AT: +125°C +25°C -65°C

MINIMUM GATE VOLTAGE REQUIRED TO TRIGGER ALL UNITS AT: -65°C +25°C +125°C

MAXIMUM GATE VOLTAGE THAT WILL NOT TRIGGER ANY UNITS AT +125°C

5. GATE TRIGGERING CHARACTERISTICS (2N877-2N881)



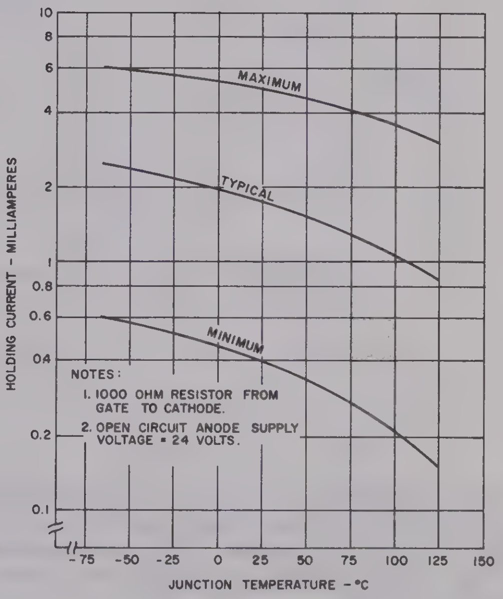
NOTES: (1) SHADED AREA REPRESENTS THE LOCUS OF POSSIBLE TRIGGERING POINTS FROM -65°C TO +125°C.
(2) 6 VOLTS DC ANODE SUPPLY VOLTAGE.
(3) GATE SUPPLY IMPEDANCE = 1000 OHMS LOOKING INTO SUPPLY FROM TEST UNIT TERMINALS. GATE CURRENT SHOWN DOES NOT INCLUDE ANY CURRENT REQUIRED BY EXTERNAL SHUNT RESISTANCE.

MINIMUM GATE CURRENT REQUIRED TO TRIGGER ALL UNITS AT: +125°C +25°C -65°C

MINIMUM GATE VOLTAGE REQUIRED TO TRIGGER ALL UNITS AT: -65°C +25°C +125°C

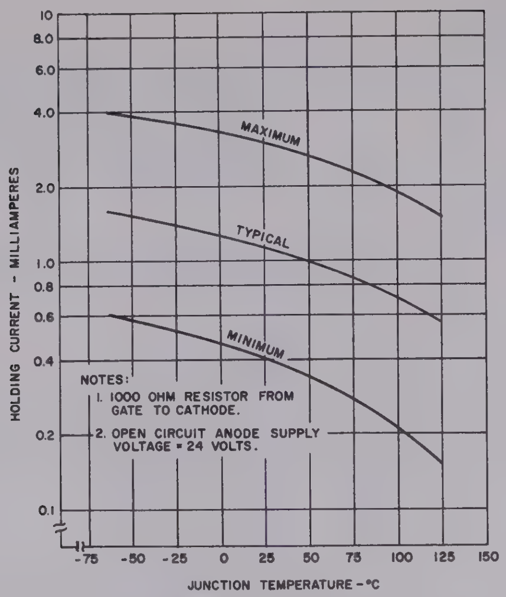
MAXIMUM GATE VOLTAGE THAT WILL NOT TRIGGER ANY UNITS AT +125°C

6. GATE TRIGGERING CHARACTERISTICS (2N885-2N889)

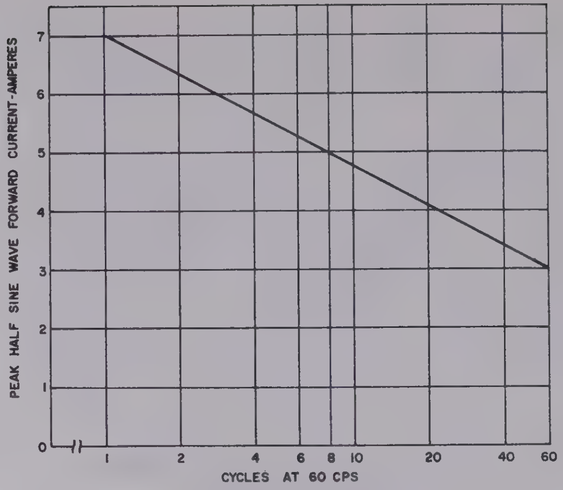


NOTES:
1. 1000 OHM RESISTOR FROM GATE TO CATHODE.
2. OPEN CIRCUIT ANODE SUPPLY VOLTAGE = 24 VOLTS.

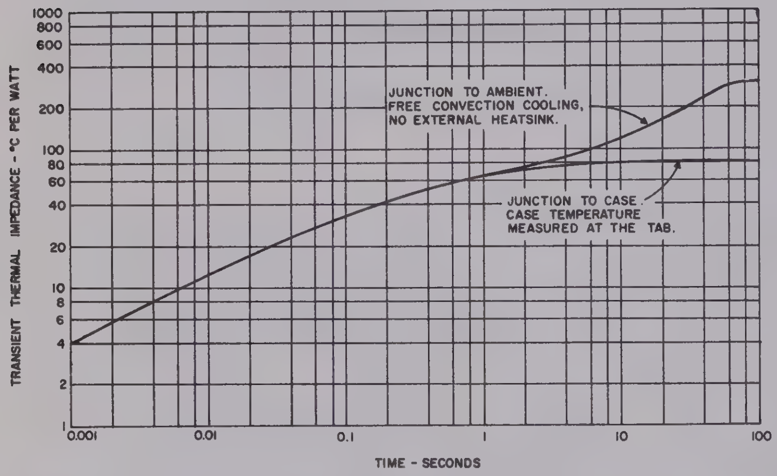
7. HOLDING CURRENT AS A FUNCTION OF JUNCTION TEMPERATURE (2N877-2N881)



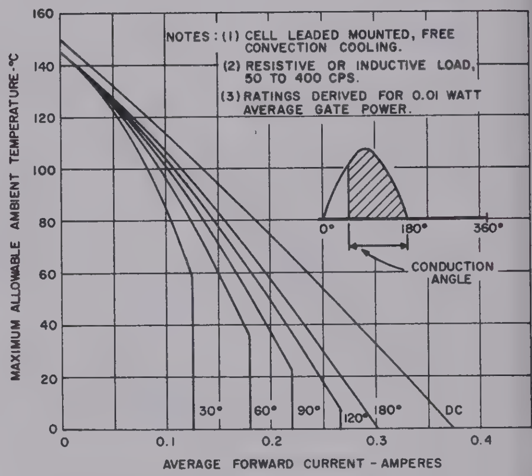
8. HOLDING CURRENT AS A FUNCTION OF JUNCTION TEMPERATURE (2N885-2N889)



9. MAXIMUM ALLOWABLE NON-RECURRENT SURGE CURRENT AT RATED LOAD CONDITIONS

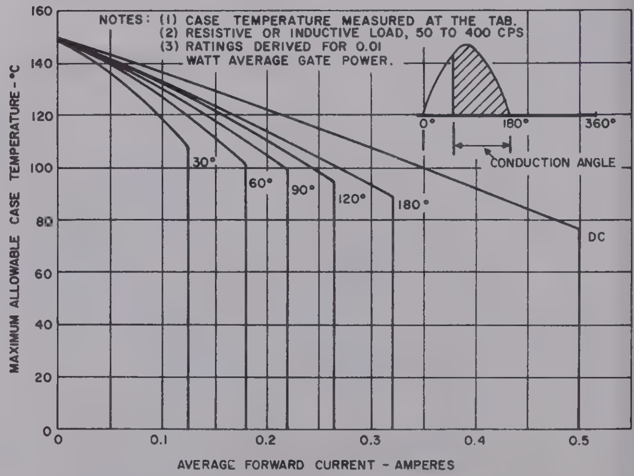


10. MAXIMUM TRANSIENT THERMAL IMPEDANCE



11. MAXIMUM ALLOWABLE AMBIENT TEMPERATURE (150°C JUNCTION TEMP.)

Charts 11 and 12 apply to latching applications where SCR need not block forward voltage after being turned on, since the V_{FXM} rating does not apply above 125°C junction temperature. SCR will again block rated forward voltage after junction temperature drops below 125°C.



12. MAXIMUM ALLOWABLE CASE TEMPERATURE (150°C JUNCTION TEMP.)

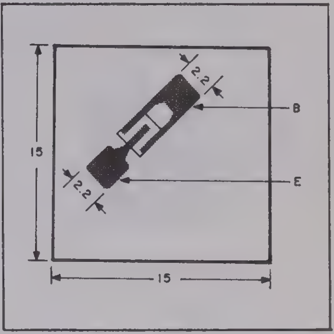
Silicon
Transistor Chips

NPN

2N918 (Chip)

(M63P-X503)

This General Electric NPN silicon planar passivated epitaxial transistor chip is designed specifically for high frequency applications. The chip is suitable for use as an oscillator in UHF television tuners, and features a typical circuit power gain of 19 decibels at 200 MHz.



General specifications:

- Gold collector contact backing, minimum thickness—3000Å
- Aluminum base and emitter contact metalization
- Maximum conditions for mounting chips—425°C for 5 minutes (Max.) in an inert atmosphere
- Shipping containers: Glass vials sealed with a nitrogen back-fill
  Maximum of 10k chips per vial
  Egg crate containers available at extra cost
- Chip drawing dimensions are in mils
- Chip thickness = 5.9 $^{+0.8}_{-0.9}$ mils

absolute maximum ratings: (T$_A$ = 25°C)

	Symbol		
Voltages			
Collector to Base	V_{CBO}	30	V
Collector to Emitter	V_{CEO}	15	V
Emitter to Base	V_{EBO}	3	V
Current			
Collector	I_C	50	mA
Temperature			
Storage	T_{STG}	−65°C to +200°C	
Operating	T_J	−65°C to +200°C	

electrical characteristics: 100% Probe (T$_A$ = 25°C)

Tested at outgoing acceptance to a 10% LTPD with a maximum accept number of 3.

	Symbol	Min.	Max.	
Collector Base Breakdown Voltage ($I_C = 10\ \mu A$)	BV_{CBO}	30	—	V
Collector Emitter Breakdown Voltage ($I_C = 3$ mA)	BV_{CEO}	15	—	V
Emitter Base Breakdown Voltage ($I_E = 0.5\ \mu A$)	BV_{EBO}	3	—	V
Collector Cutoff Current ($V_{CB} = 20V$)	I_{CBO}	—	50	nA
Forward Current Transfer Ratio ($I_C = 3$ mA, $V_{CE} = 2V$)	h_{FE}	20	—	
Collector Emitter Breakdown Voltage ($I_C = 0.5\ \mu A$)	BV_{CES}	18	—	V

specifications: (T$_A$ = 25°C)

Product yield is at least 93% to each of the following parameters:

	Symbol	Min.	Max.	
Collector Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)	$V_{CE(SAT)}$	—	0.4	V
Base Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)	$V_{BE(SAT)}$	—	1	V
Forward Current Transfer Ratio ($I_C = 4$ mA, $V_{CE} = 10V$, f = 100 MHz)	h_{fe}	6	—	
Collector Base Capacitance ($V_{CB} = 10V$, f = 1 MHz)	C_{cb}	—	1.7	pF
Available Power Gain (Neutralized) ($I_C = 6$ mA, $V_{CE} = 12V$, f = 200 MHz)	A_p	15	—	db
Power Output ($I_C = 8$ mA, $V_{CB} = 15V$, f = 500 MHz)	P_o	30	—	mW
Noise Figure ($I_C = 1$ mA, $V_{CE} = 6V$, f = 60 MHz, $R_G = 400\ \Omega$)	NF	—	6	db

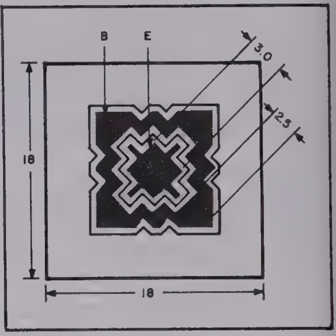
Silicon
Transistor Chips

NPN

2N929 (Chip)

(M26P-X531)

This General Electric NPN silicon planar passivated epitaxial transistor chip is designed primarily for low-level amplifier applications. The chip features high gain at low collector currents, low leakage currents and low noise.



General specifications:

- Gold collector contact backing, minimum thickness—3000Å
- Aluminum base and emitter contact metalization
- Maximum conditions for mounting chips—425°C for 5 minutes (Max.) in an inert atmosphere
- Shipping containers: Glass vials sealed with a nitrogen back-fill
  Maximum of 10k chips per vial
  Egg crate containers available at extra cost
- Chip drawing dimensions are in mils
- Chip thickness = $5.4^{+0.8}_{-0.9}$ mils

absolute maximum ratings: ($T_A = 25°C$)

	Symbol		
Voltages			
Collector to Base	V_{CBO}	60	V
Collector to Emitter	V_{CEO}	45	V
Emitter to Base	V_{EBO}	5	V
Current			
Collector	I_C	30	mA
Temperature			
Storage	T_{STG}	−65°C to +200°C	
Operating	T_J	−65°C to +200°C	

electrical characteristics: 100% Probe ($T_A = 25°C$)

Tested at outgoing acceptance to a 10% LTPD with a maximum accept number of 3.

	Symbol	Min.	Max.	
Collector Base Breakdown Voltage ($I_C = 10\ \mu A$)	BV_{CBO}	60	—	V
Collector Emitter Breakdown Voltage ($I_C = 10$ mA)	BV_{CEO}	45	—	V
Emitter Base Breakdown Voltage ($I_E = 10\ \mu A$)	BV_{EBO}	5	—	V
Collector Cutoff Current ($V_{CB} = 50V$)	I_{CBO}	—	50	nA
Forward Current Transfer Ratio ($I_C = 100\ \mu A$, $V_{CE} = 5V$)	h_{FE}	60	180	

specifications: ($T_A = 25°C$)

Product yield is at least 93% to each of the following parameters:

	Symbol	Min.	Max.	
***Forward Current Transfer Ratio**	h_{FE}			
($I_C = 50$ mA, $V_{CE} = 5V$, Pulsed)		—	350	
($I_C = 500\ \mu A$, $V_{CE} = 5V$)		60	—	
***Collector Saturation Voltage**	$V_{CE(SAT)}$			
($I_C = 10$ mA, $I_B = 0.5$ mA, Pulsed)		—	1	V
***Base Saturation Voltage**	$V_{BE(SAT)}$			
($I_C = 10$ mA, $I_B = 0.5$ mA, Pulsed)		0.6	1	V
Noise Figure	NF			
($I_C = 10\ \mu A$, $V_{CE} = 5V$, $R_g = 10\ K\Omega$, f = 10 CPS to 10 KC, BW = 15.7 KC)		—	4	db
Emitter Cutoff Current	I_{EBO}			
($V_{EB} = 5V$)		—	10	nA
Collector Cutoff Current	I_{CBO}			
($V_{CB} = 45V$)		—	2	nA
Collector Base Capacitance	C_{cb}			
($V_{CB} = 10V$, f = 1 MHz)		—	4	pF

*Pulse conditions: pulse width ≤300 μsec, duty cycle ≤2%.

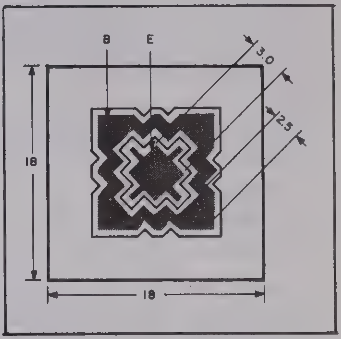
Silicon
Transistor Chips

NPN

2N930 (Chip)

(M26P-X505)

This General Electric NPN silicon planar passivated transistor chip is designed primarily for low-level amplifier applications. The chip features high gain at extremely low collector currents, low leakage currents and low noise.



General specifications:

- Gold collector contact backing, minimum thickness—3000Å
- Aluminum base and emitter contact metalization
- Maximum conditions for mounting chips—425°C for 5 minutes (Max.) in an inert atmosphere
- Shipping containers: Glass vials sealed with a nitrogen back-fill
  Maximum of 10k chips per vial
  Egg crate containers available at extra cost
- Chip drawing dimensions are in mils
- Chip thickness = 5.4 $^{+0.8}_{-0.9}$ mils

absolute maximum ratings: ($T_A = 25°C$)

	Symbol		
Voltages			
Collector to Base	V_{CBO}	60	V
Collector to Emitter	V_{CEO}	45	V
Emitter to Base	V_{EBO}	6	V
Current			
Collector	I_C	30	mA
Temperature			
Storage	T_{STG}	−65°C to +200°C	
Operating	T_J	−65°C to +200°C	

electrical characteristics: ($T_A = 25°C$)

Tested at outgoing acceptance to a 10% LTPD with a maximum accept number of 3.

	Symbol	Min.	Max.	
Collector Base Breakdown Voltage ($I_C = 100\ \mu A$)	BV_{CBO}	65	—	V
Collector Emitter Breakdown Voltage ($I_C = 10$ mA)	BV_{CEO}	45	—	V
Emitter Base Breakdown Voltage ($I_E = 100\ \mu A$)	BV_{EBO}	6	—	V
Collector Cutoff Current ($V_{CB} = 55V$)	I_{CBO}	—	50	nA
Forward Current Transfer Ratio ($I_C = 100\ \mu A$, $V_{CE} = 5V$)	h_{FE}	175	—	

specifications: ($T_A = 25°C$)

Product yield is at least 93% to each of the following parameters:

	Symbol	Min.	Max.	
Forward Current Transfer Ratio ($I_C = 10$ mA, $V_{CE} = 5V$)	h_{FE}	—	600	
Collector Saturation Voltage ($I_C = 10$ mA, $I_B = 0.5$ mA)	$V_{CE(SAT)}$	—	1.0	V
Base Saturation Voltage ($I_C = 10$ mA, $I_B = 0.5$ mA)	$V_{BE(SAT)}$	0.6	1.0	V
Emitter Cutoff Current ($V_{EB} = 5V$, $I_C = 0$)	I_{EBO}	—	10	nA
Collector Cutoff Current ($V_{CB} = 45V$, $I_E = 0$)	I_{CBO}	—	2	nA
Noise Figure ($I_C = 10\ \mu A$, $V_{CE} = 5V$, $R_g = 10\ k\Omega$, f = 10 Hz —10 kHz, BW = 2 kHz)	N_F	—	3	db
High Frequency Current Gain ($I_C = 500\ \mu A$, $V_{CE} = 5V$, f = 30 MHz)	h_{fe}	1	—	
Collector Base Capacitance ($V_{CB} = 5V$, f = 140 kHz)	C_{cb}	—	8	pF

Silicon
Darlington Amplifiers

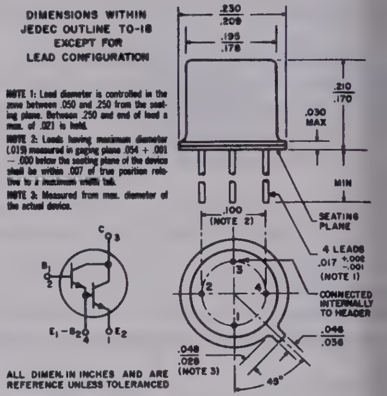
NPN

2N997, 2N999

The General Electric type 2N997 and 2N999 transistors are hermetically sealed 4 terminal devices containing two high gain passivated planar transistors connected in the Darlington Configuration. These devices are particularly advantageous when used in circuits requiring very high gain at low collector currents, high input impedance, and low noise.

ABSOLUTE MAXIMUM RATINGS (25°C)

		2N997	2N999	
Voltage				
Collector to base	V_{CBO}	75	60	volts
Collector to emitter	V_{CEO}	40	60	volts
Emitter to base	V_{EBO}	7	15	volts
Power Dissipation				
Total Power (Free Air 25°C) Note 1		.5	.5	watts
Total Power (Case temperature 25°C) Note 2		1.5	1.8	watts
Total Power (Case temperature 100°C) Note 2			1.0	watts
Temperature				
Storage		-65 to +300		°C
Operating Junction		175	200	°C max.


DIMENSIONS WITHIN JEDEC OUTLINE TO-18 EXCEPT FOR LEAD CONFIGURATION

NOTE 1: Lead diameter is controlled in the zone between .050 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

NOTE 2: Leads having maximum diameter (.019) measured in gaging plane .054 + .001 − .000 below the seating plane of the device shall be within .007 of true position relative to a maximum width tab.

NOTE 3: Measured from max. diameter of the actual device.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

Note 1: 2N997 - Derate 3.33 mw/°C for increase in ambient temperature above 25°C
2N999 - Derate 2.85 mw/°C for increase in ambient temperature above 25°C

Note 2: Derate 10 mw/°C for increase in case temperature above 25°C

ELECTRICAL CHARACTERISTICS (25°C unless otherwise specified)

		2N997		2N999		
DC Characteristics		Min.	Max.	Min.	Max.	
Current transfer ratio						
(I_C=100μa, V_{CE}=10V)	h_{FE}	1000		1000		
(I_C=10ma, V_{CE}=10V)	h_{FE}*	4000		4000		
(I_C=100ma, V_{CE}=10V)	h_{FE}*	7000	70000	7000	70000	
Current transfer ratio						
(I_C=100ma, V_{CE}=10V, T_A=-55°C)	h_{FE}*	1000		1000		
Collector Cutoff Current						
(60V, I_E=0)	I_{CBO}		10		10	na
(60V, I_E=0, 150°C)	I_{CBO}		10		10	μa
Emitter Cutoff Current						
(V_{EB}=10V, I_C=0)	I_{EBO}				10	na
(V_{EB}=5V, I_C=0)	I_{EBO}		10			na
Collector Saturation Voltage						
(I_C=100ma, I_B=1ma)	$V_{CE(SAT)}$ *		1.6		1.6	volts
Emitter Saturation Voltage						
(I_C=100ma, I_B=1ma)	$V_{BE(SAT)}$ *				1.8	volts
Base Emitter Voltage						
(I_C=100ma, V_{CE}=10V)	V_{BE}	.9	1.8			volts
Collector base breakdown voltage						
(I_C=100μa, I_E=0)	BV_{CBO}	75		60		volts
Collector emitter breakdown voltage						
(I_C=30ma, I_B=0)	BV_{CEO}*	40		60		volts
Emitter base breakdown voltage						
(I_E=100μa, I_C=0)	BV_{EBO}	7		15		volts
Output capacitance						
(V_{CB}=10V, f=1mc)	C_{ob}		35		20	pf
Emitter Transition capacitance						
(V_{EB}=.5V, I_C=0)	C_{TE}				10	pf

*Pulse width ≦ 300 μsec., duty cycle ≦ 1%

Silicon
Monolithic Darlington
Amplifiers

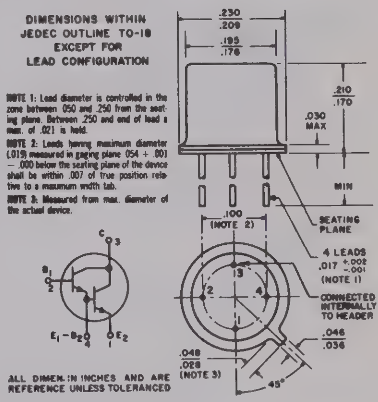
NPN

2N998

The General Electric type 2N998 transistor is a hermetically sealed 4 terminal device containing two high gain passivated planar transistors connected in the Darlington Configuration. The 2N998 is particularly advantageous when used in circuits requiring very high gain, high input impedance, and low noise.

electrical characteristics: (25°C) (unless otherwise specified)

Voltage		
Collector to Base	V_{CBO}	100 volts
Collector to Emitter	V_{CEO}	60 volts
Emitter to Base	V_{EBO}	15 volts
Power Dissipation		
Total power (Free Air 25°C) Note 1	P_T	.5 watts
Total power (case temperature 25°C) Note 2	P_T	1.8 watts
Total power (case temperature 100°C) Note 2	P_T	1.0 watts
Temperature		
Storage	T_{STG}	-65°C to +300 °C
Operating Junction	T_J	200 °C max.
Lead temperature (soldering-no time limit)		+300 °C max.



DIMENSIONS WITHIN JEDEC OUTLINE TO-18 EXCEPT FOR LEAD CONFIGURATION

NOTE 1: Lead diameter is controlled in the zone between .050 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

NOTE 2: Leads having maximum diameter (.019) measured in gaging plane .054 + .001 − .000 below the seating plane of the device shall be within .007 of true position relative to a maximum width tab.

NOTE 3: Measured from max. diameter of the actual device.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

Note 1: Derate 2.85 mw/°C increase in ambient temperatures above 25°C.

Note 2: Derate 10.3 mw/°C increase in case temperature above 25°C.

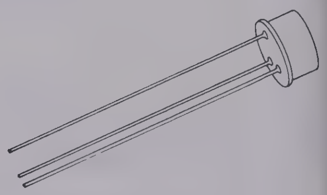
electrical characteristics: (25°C) (unless otherwise specified)

		Min.	Max.	
Collector to base voltage (I_C=100μa, I_E=0)	BV_{CBO}	100		volts
Collector to Emitter voltage (I_C=30ma, I_B=0)	V_{CEO}*	60		volts
Emitter to base voltage (I_E=100μa, I_C=0)	V_{EBO}	15		volts
Forward Current Transfer ratio (V_{CE}= 5V, I_C=1ma)	h_{FE}	800		
Forward Current Transfer ratio (V_{CE}= 5V, I_C=10ma)	h_{FE}*	1600	8000	
Forward Current Transfer ratio (V_{CE}= 5V, I_C=100ma)	h_{FE}*	2000		
Base Saturation Voltage (I_C=50ma, I_B=0.5ma)	$V_{BE(SAT)}$		1.8	volts
Collector Saturation Voltage (I_C=50ma, I_B=0.5ma)	$V_{CE(SAT)}$		1.2	volts
Collector Cutoff Current (V_{CE}=90V, I_E=0)	I_{CBO}		10	mμa
Collector Cutoff Current (V_{CE}=90V, I_E=0, 150°C)	I_{CBO}		15	μa
Emitter Cutoff Current (V_{EB}=10V, I_C=0)	I_{EBO}		10	mμa
Output Capacitance (V_{CB}=10V, I_E=0)	C_{ob}		30	pt
Emitter Transition Capacitance (V_{EB}=0.5V, I_C=0)	C_{TE}		50	pt
Noise Figure (V_{CE}=10V, I_C=0.1ma, f=1kc, Rg=5KΩ, Bandwidth=200cps)	NF		6	db

*Pulse width = 300μsec., Duty Cycle = 1%

Germanium Transistors

PNP 2N1175,A



The General Electric type 2N1175 is a PNP germanium alloy transistor intended for industrial general purpose applications where cost is of prime importance.

For extremely low noise applications, type 2N1175A is recommended. The 2N1175A is a 2N1175 selected for a maximum noise figure of 6 db.

Both types are similar to the 2N1415 but have a higher forward current transfer ratio.

All units are hermetically sealed and are subjected to 100 hours of high temperature bake as well as a detergent pressure test, thus assuring reliable performance under adverse environmental conditions. Efficient thermal characteristics are assured by welding the transistor base to the case.

absolute maximum ratings: (25°C)

Voltage		
Collector to Base	V_{CBO}	−35 volts
Collector to Emitter	V_{CER} ($R_{BE} \leqq 10K$)	−25 volts
Emitter to Base	V_{EBO}	−10 volts
Current		
Collector	I_{CM}	−200 ma
Power		
Collector Dissipation*	P_C	200 mw
Temperature		
Storage	T_{STG}	−65 to +85 °C
Operating	T_J	+85 °C

*Derate 3.33 mw/°C increase in ambient temperature above 25°C.

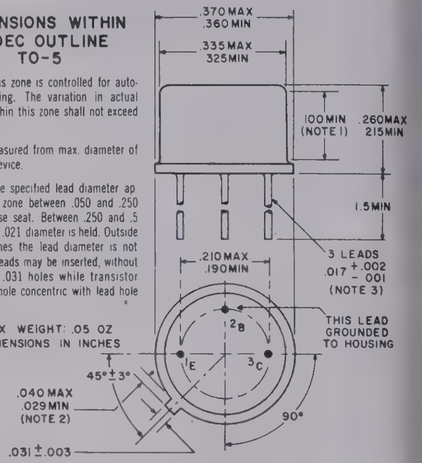
DIMENSIONS WITHIN
JEDEC OUTLINE
TO-5

NOTE 1: This zone is controlled for automatic handling. The variation in actual diameter within this zone shall not exceed .010

NOTE 2: Measured from max. diameter of the actual device.

NOTE 3: The specified lead diameter applies in the zone between .050 and .250 from the base seat. Between .250 and .5 maximum of .021 diameter is held. Outside of these zones the lead diameter is not controlled. Leads may be inserted, without damage, in .031 holes while transistor enters .371 hole concentric with lead hole circle.

APPROX WEIGHT: .05 OZ
ALL DIMENSIONS IN INCHES

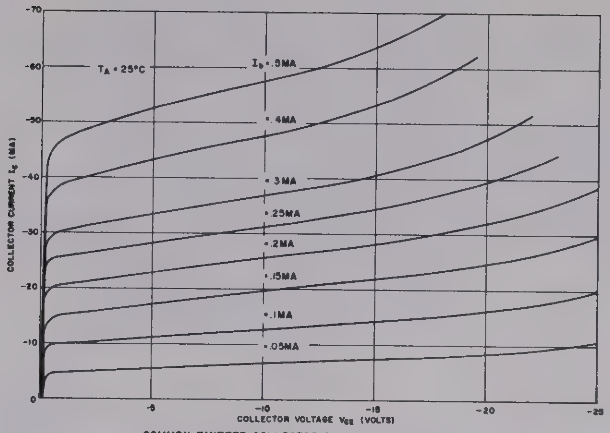


electrical characteristics: (25°C)

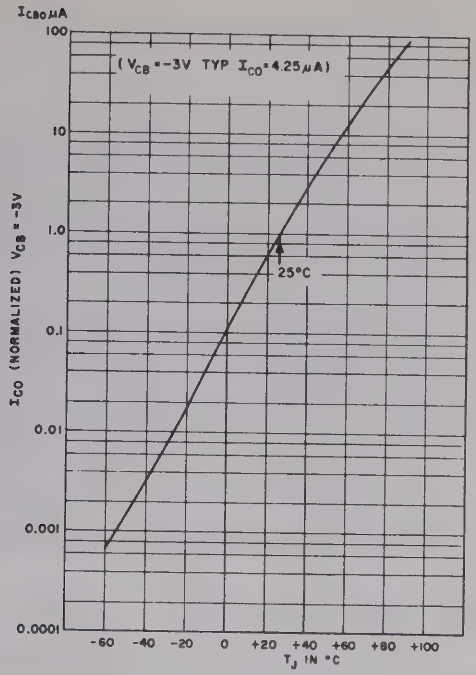
		Min.	Typ.	Max.	
SMALL SIGNAL CHARACTERISTICS					
(Unless otherwise specified $V_C = -5V$ common base; $I_E = -1ma$; f = 1000 cps)					
Output Admittance (Input AC Open Circuited)	h_{ob}	.1	.45	.9	µmhos
Input Admittance (Output AC Short Circuited)	h_{ib}	26	28	31	ohms
Reverse Voltage Transfer Ratio (Input AC Open Circuited)	h_{rb}	1	5.9	14	$x10^{-4}$
Forward Current Transfer Ratio (Common Emitter; Output AC Short Circuited)	h_{fe}	60	80	120	
Frequency Cutoff	f_{hfb}	1.5	4.2		mc
Output Capacity (f = 1mc; Input AC Open Circuited)	C_{ob}		26	40	µµf
Noise Figure (f = 1kc; BW = 1 cycle)	NF		6	6*	db
D-C CHARACTERISTICS					
Forward Current Gain (Common Emitter, I_C/I_B)					
($V_{CE} = -1V$; $I_C = -20ma$)	h_{FE}	70	90	140	
($V_{CE} = -1V$; $I_C = -100ma$)	h_{FE}	62			
Collector Saturation Voltage ($I_C = -20ma$; I_B as indicated)	$V_{CE(SAT)}$		−90		mv
	@ I_B =		−.67		ma
Base Input Voltage, Common Emitter ($V_{CE} = -1V$; $I_C = -20ma$)	V_{BE}		−.220	−.260	volts
Collector Cutoff Current ($V_{CBO} = -30V$)	I_{CO}		−6	−12	µa
Emitter Cutoff Current ($V_{EBO} = -10V$)	I_{EO}		−4	−10	µa
Collector to Emitter Voltage (R_{BE} = 10K ohms; $I_C = -.6ma$)	V_{CER}	−25			volts

*Type 2N1175A only.

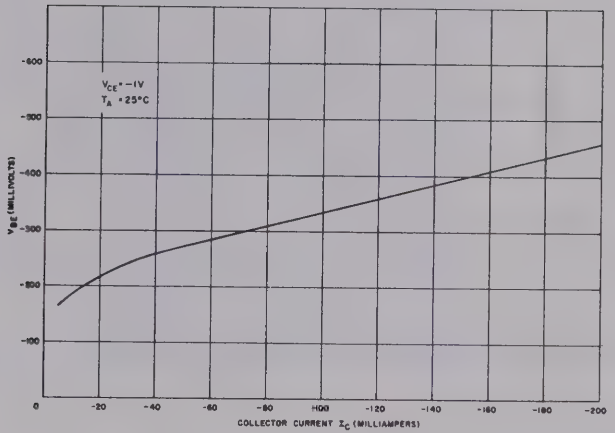
2N1175,A



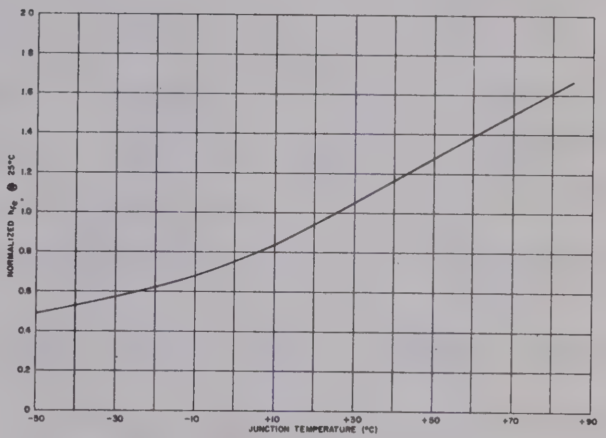
COMMON EMITTER COLLECTOR CHARACTERISTICS



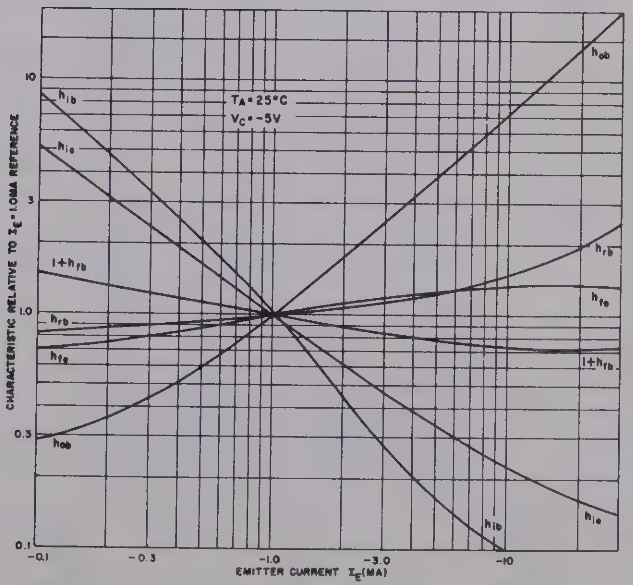
NORMALIZED COLLECTOR CURRENT
VS. TEMPERATURE



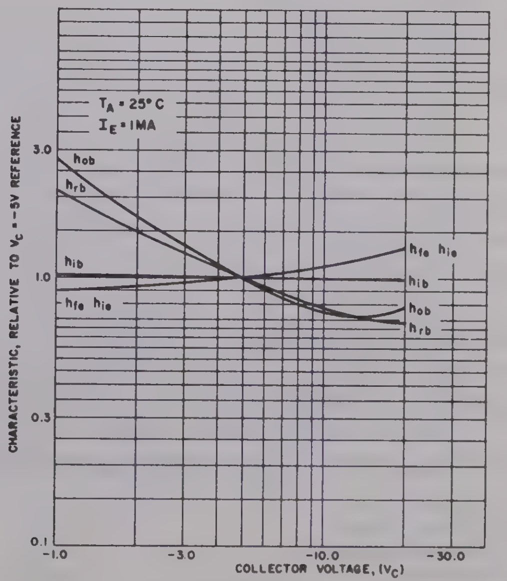
COMMON EMITTER INPUT VOLTAGE VS COLLECTOR CURRENT



NORMALIZED CURRENT GAIN (h_fe) VS TEMPERATURE



A.C. CHARACTERISTICS VS EMITTER CURRENT



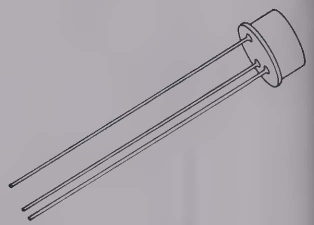
A.C. CHARACTERISTICS VS COLLECTOR VOLTAGE

Germanium
Transistors

PNP

2N1303,5,7

The General Electric types 2N1303, 2N1305, and 2N1307 are PNP germanium alloy transistors intended primarily for medium speed switching applications for military and industrial use where reliability is of prime importance. All transistors are aged for at least 100 hours at 100°C, and are subjected to 100% hermetic seal test to ensure stability of parameters. All transistors are "gettered" to provide assurance against residual contaminants and as a protection against further "outgassing" with use under severe environmental conditions.



absolute maximum ratings: (25°C)

		2N1303	2N1305	2N1307	
Voltage					
Collector to Base	V_{CBO}	−30	−30	−30	volts
Emitter to Base	V_{EBO}	−25	−25	−25	volts
Collector to Emitter	V_{CE}†	−25	−20	−15	volts
Current					
Collector	I_C	−300	−300	−300	ma
Dissipation*					
Power	P_T	150	150	150	mw
Temperature					
Storage	T_{STG}	−65 + 100	−65 + 100	−65 + 100	°C

*Derate 2.5 mw/°C for increase in ambient temperature above 25°C.

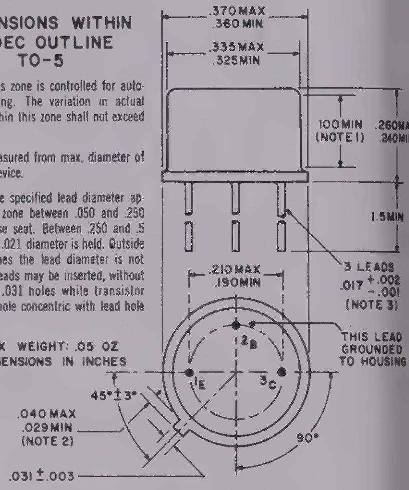
DIMENSIONS WITHIN
JEDEC OUTLINE
TO-5

NOTE 1: This zone is controlled for automatic handling. The variation in actual diameter within this zone shall not exceed .010.

NOTE 2: Measured from max. diameter of the actual device.

NOTE 3: The specified lead diameter applies in the zone between .050 and .250 from the base seat. Between .250 and .5 maximum of .021 diameter is held. Outside of these zones the lead diameter is not controlled. Leads may be inserted, without damage, in .031 holes while transistor enters .371 hole concentric with lead hole circle.

APPROX WEIGHT: .05 OZ
ALL DIMENSIONS IN INCHES



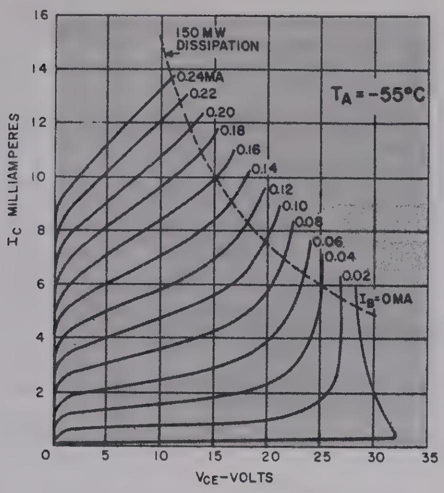
electrical characteristics: (25°C)

		2N1303		2N1305		2N1307		
D. C. CHARACTERISTICS		Min.	Max.	Min.	Max.	Min.	Max.	
Forward Current Transfer Ratio								
(V_{CE} = −1.0 Vdc, I_C = −10 ma)	h_{FE}	20		40	200	60	300	
(V_{CE} = −.35 Vdc, I_C = −200 ma)	h_{FE}	10		15		20		
Collector to Emitter Saturation Voltage								
(I_C = −10 ma, I_B = −.5 ma)	$V_{CE(SAT)}$		−.2					volts
(I_C = −10 ma, I_B = −.25 ma)	$V_{CE(SAT)}$				−.2			volts
(I_C = −10 ma, I_B = −.17 ma)	$V_{CE(SAT)}$						−.2	volts
Base Emitter Voltage								
(I_C = −10 ma, I_B = −.5 ma)	V_{BE}	−.15	−.4	−.15	−.35	−.15	−.35	volts
†Reach through Voltage	V_{RT}	−25		−20		−15		
Collector Cutoff Current								
(V_{CB} = −25v)	I_{CBO}		−6		−6		−6	μa
Emitter Cutoff Current								
(V_{EB} = −25v)	I_{EBO}		−6		−6		−6	μa
HIGH FREQUENCY CHARACTERISTICS								
Alpha Cutoff Frequency								
(V_{CB} = −5v, I_E = 1 ma)	f_{hfb}	3		5		10		mcs
Collector Capacity								
(V_{CB} = −5v, I_E = 0 ma, f = 1 mcs)	C_{ob}		20		20		20	pf

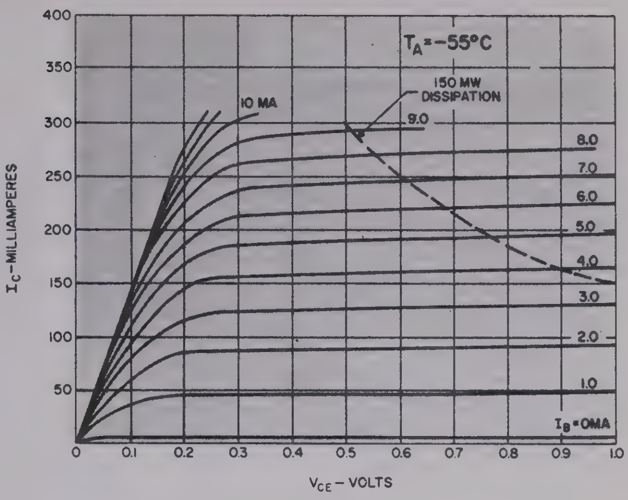
LOW FREQUENCY CHARACTERISTICS (COMMON EMITTER)

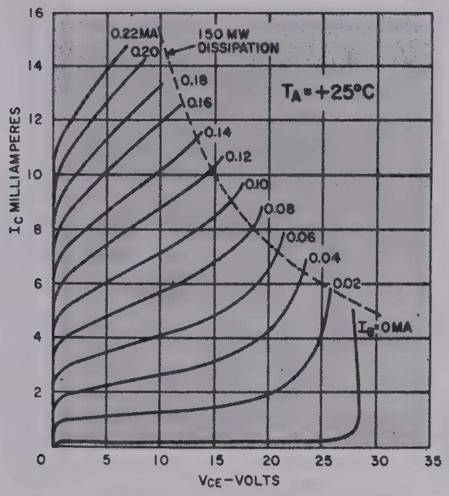
		Typical			
		2N1303	2N1305	2N1307	
Output admittance	h_{oe}	350	400	420	μmhos
Voltage feedback ratio	h_{re}	6.3	8.4	8.8	$X10^{-4}$
Forward current transfer ratio	h_{fe}	60	86	95	
Input impedance	h_{ie}	320	450	480	ohms

2N1303

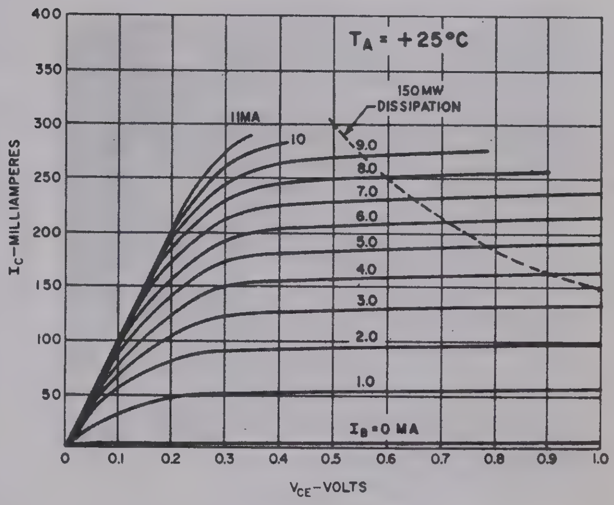


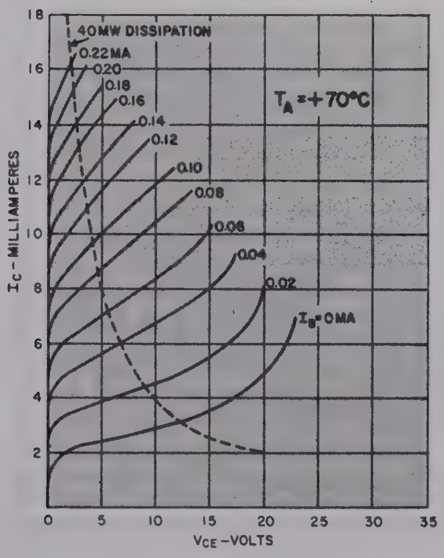
T_A = −55°C



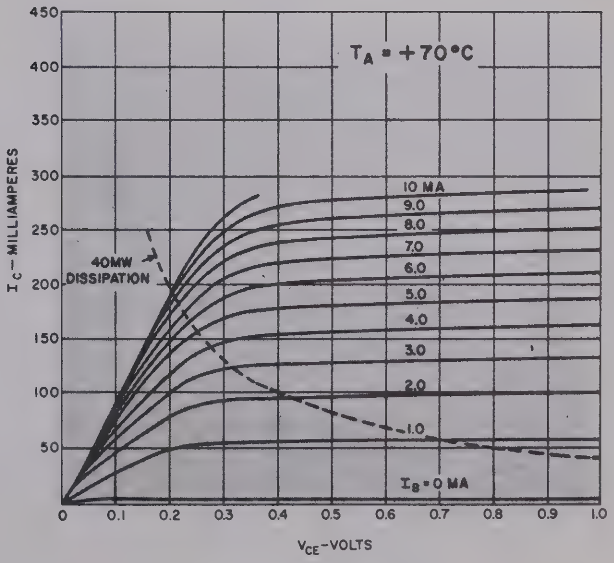


T_A = +25°C



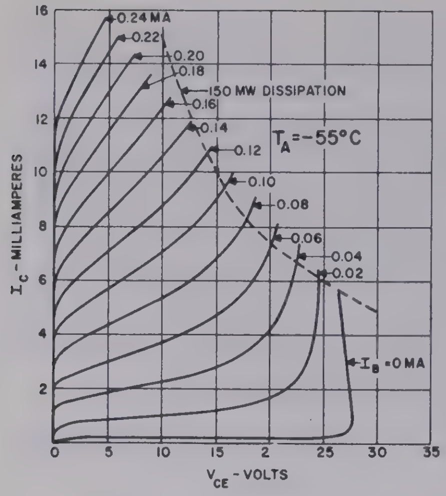


T_A = +70°C

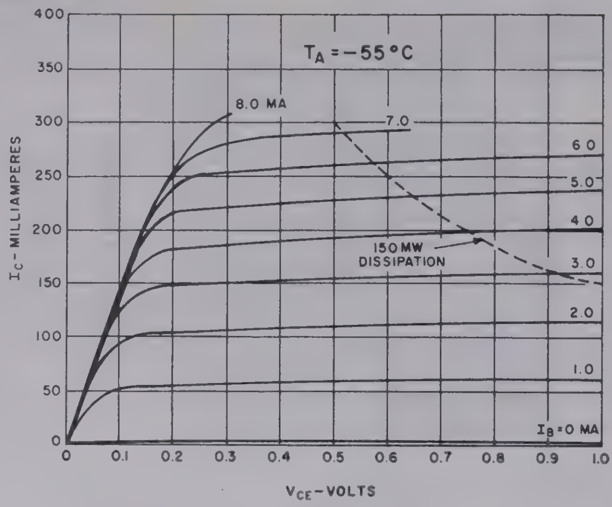


TYPICAL COLLECTOR – EMITTER CHARACTERISTICS

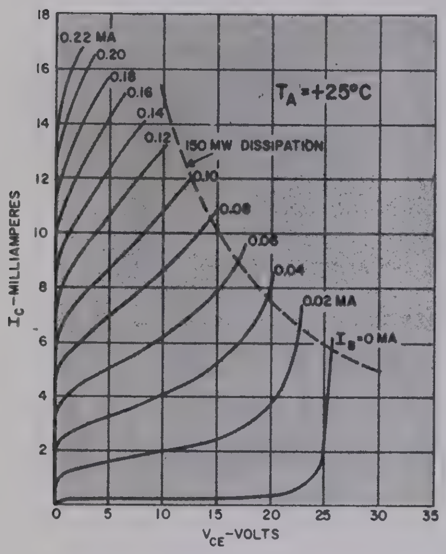
2N1305

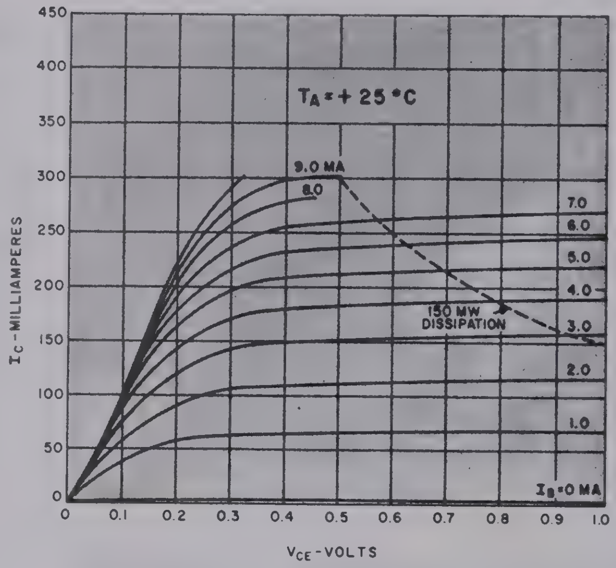


T_A = −55°C

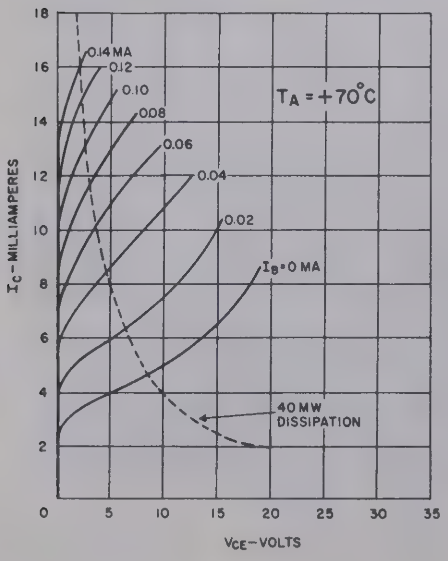


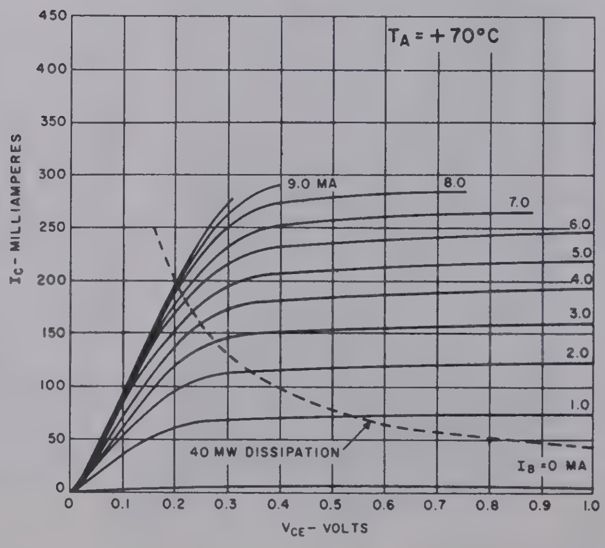
T_A = +25°C



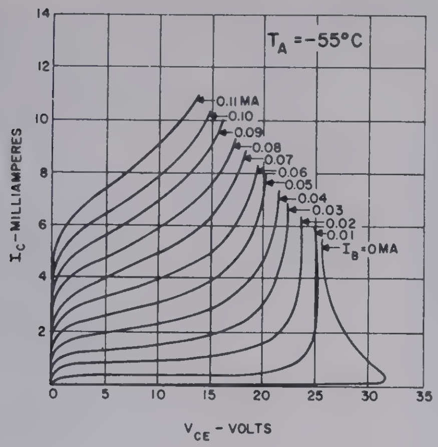


T_A = +70°C

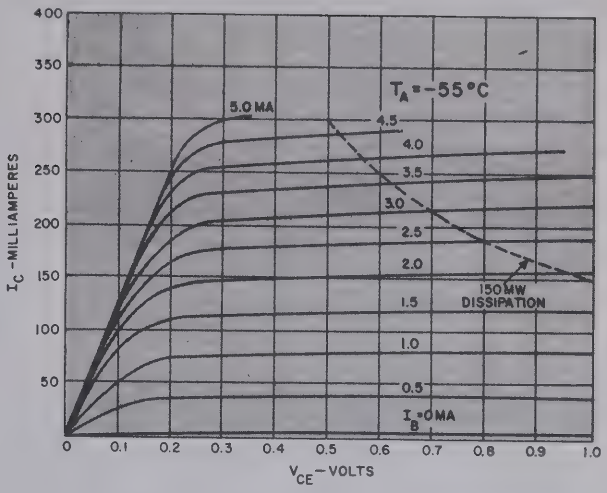


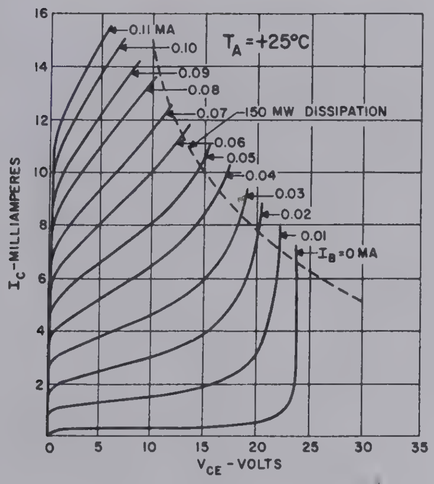


2N1307

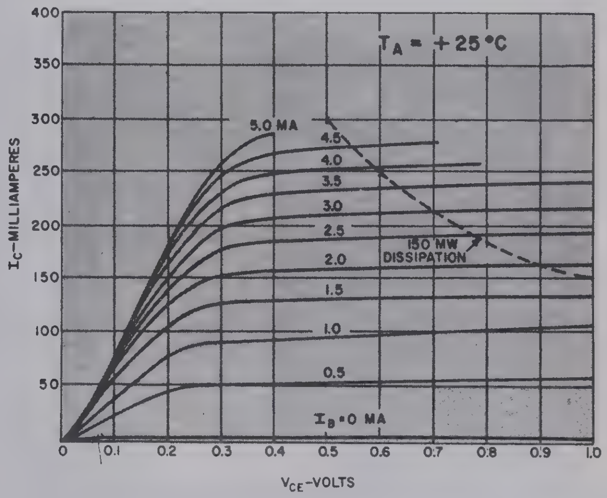


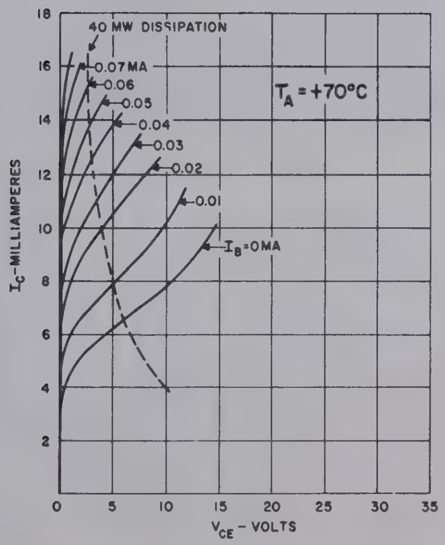
$T_A = -55°C$



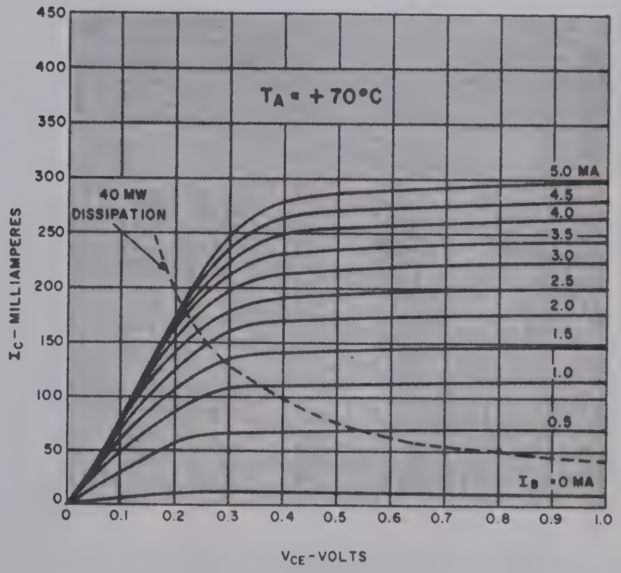


$T_A = +25°C$



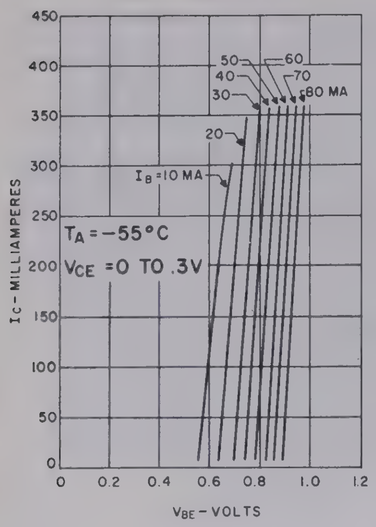


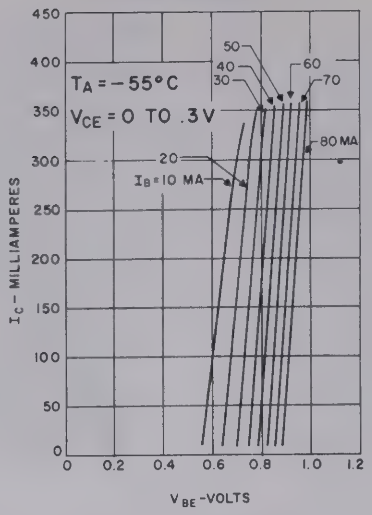
$T_A = +70°C$

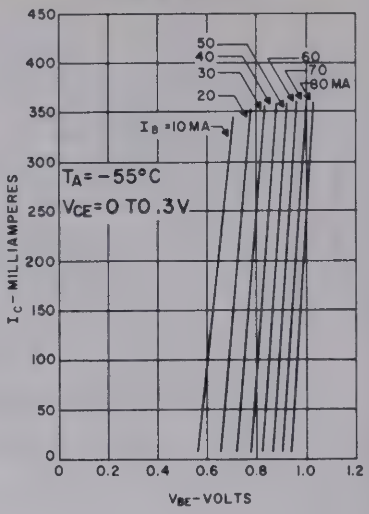


TYPICAL BASE – EMITTER CHARACTERISTICS

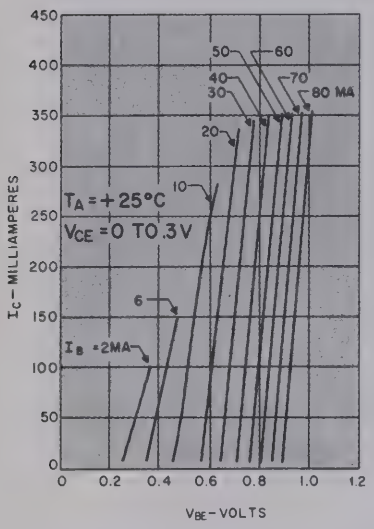
2N1303 2N1305 2N1307

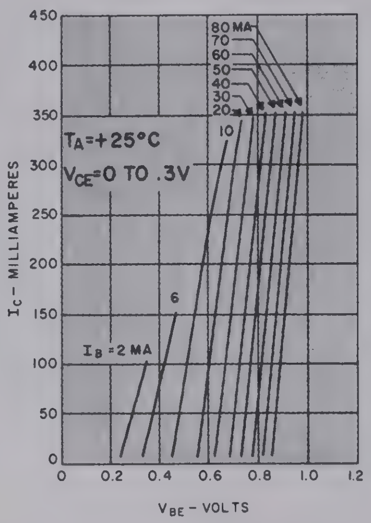


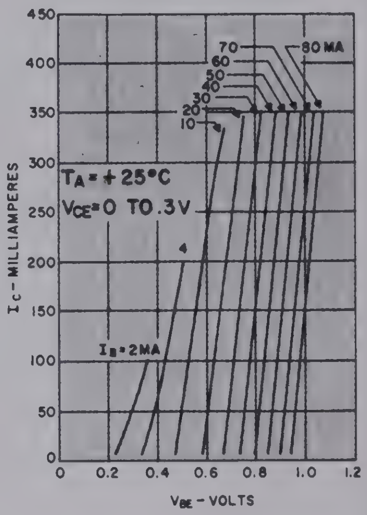




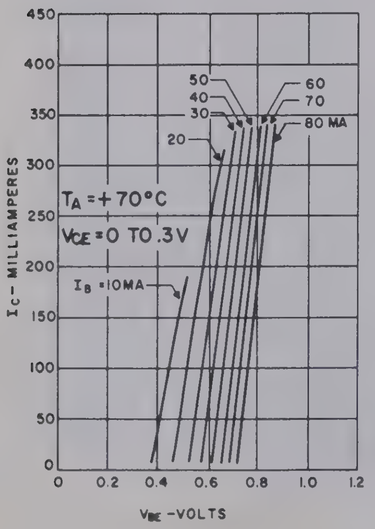
TA = −55°C

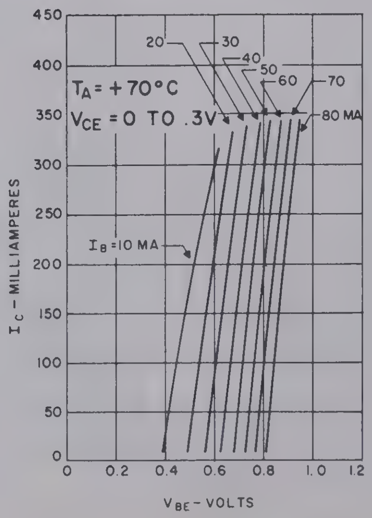


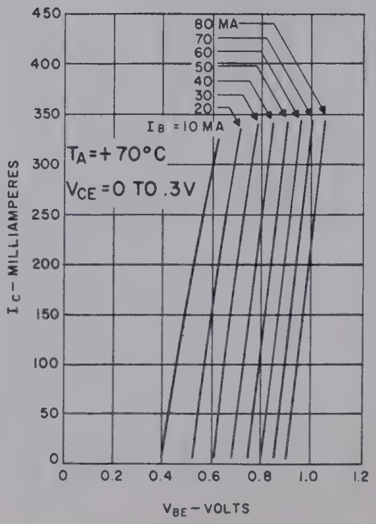




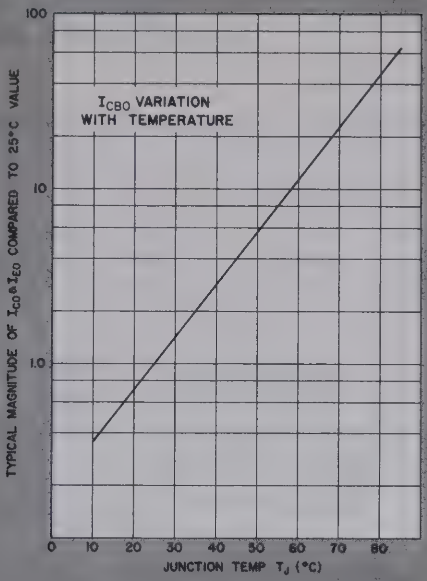
TA = +25°C

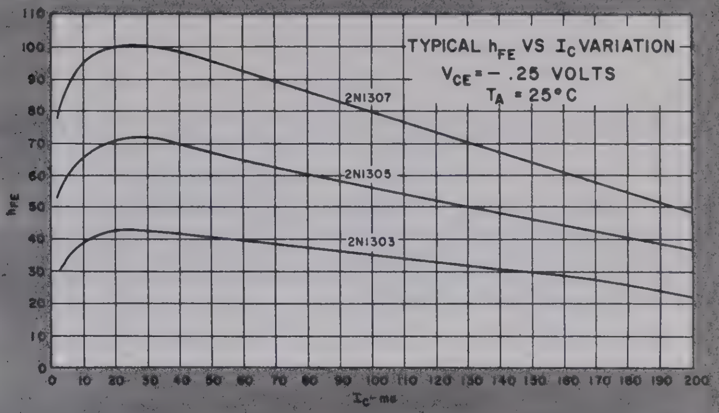






TA = +70°C

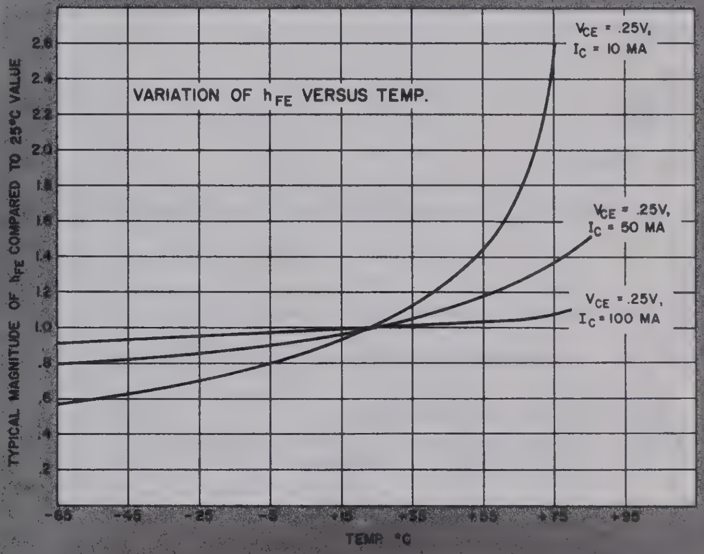


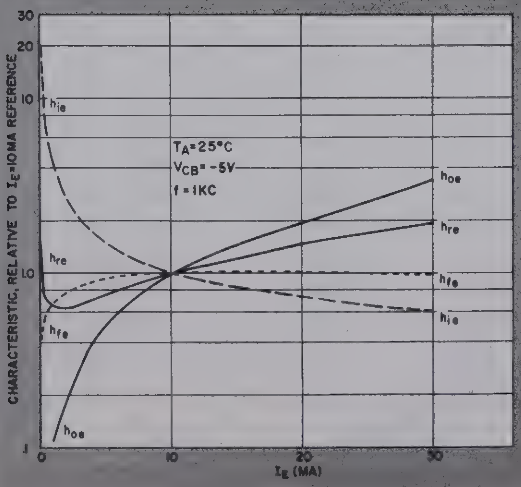


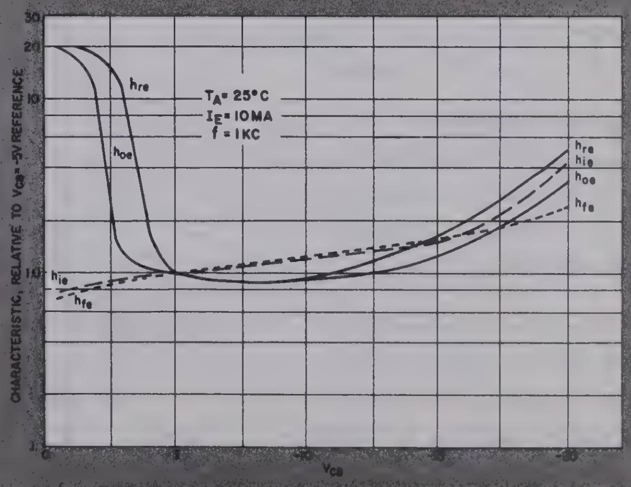
2N1303

2N1305

2N1307







Germanium
Transistors

PNP

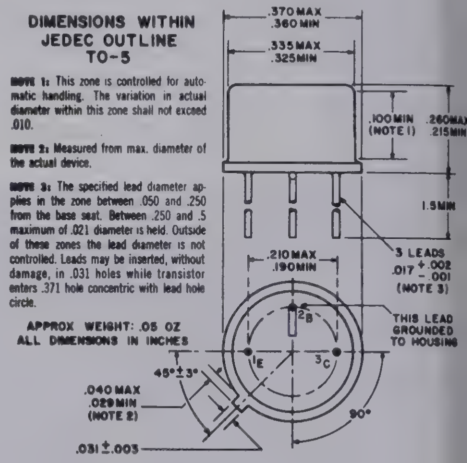
2N1413,4,5

The General Electric types 2N1413, 2N1414 and 2N1415 are intended for those industrial audio amplifiers and low frequency switching applications where cost is of prime importance. All units are hermetically sealed and are subjected to 100 hours of high temperature bake as well as a hermeticity test, thus assuring reliable performance under adverse environmental conditions. Efficient thermal characteristics are assured by welding the transistor base to the case.

absolute maximum ratings: (25°C)

Voltages		
Collector to Base	V_{CBO}	−35 volts
Collector to Emitter	V_{CER} ($R_{BE} \leqq 10K$)	−25 volts
Emitter to Base	V_{EBO}	−10 volts
Collector Current	I_{CM}	−200 ma
Temperatures		
Storage	T_{STG}	−65°C to +85 °C
Operating	T_J	+85 °C
Total Transistor Dissipation*	P_T	200 mw

*Derate 3.33 mw/°C increase in ambient temperature above 25°C.



DIMENSIONS WITHIN JEDEC OUTLINE TO-5

NOTE 1: This zone is controlled for automatic handling. The variation in actual diameter within this zone shall not exceed .010.

NOTE 2: Measured from max. diameter of the actual device.

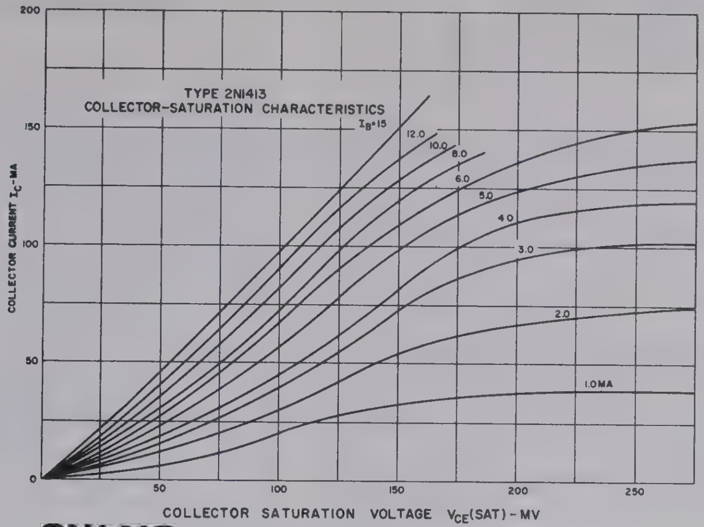
NOTE 3: The specified lead diameter applies in the zone between .050 and .250 from the base seat. Between .250 and .5 maximum of .021 diameter is held. Outside of these zones the lead diameter is not controlled. Leads may be inserted, without damage, in .031 holes while transistor enters .371 hole concentric with lead hole circle.

APPROX WEIGHT: .05 OZ
ALL DIMENSIONS IN INCHES

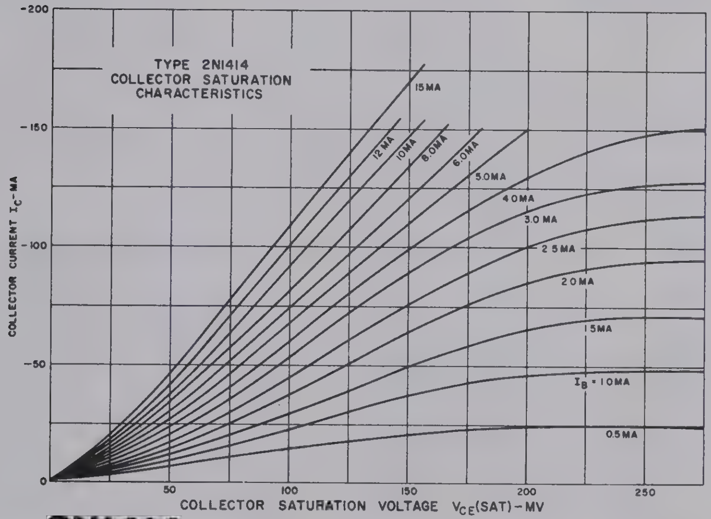
electrical characteristics: (25°C)

		2N1413			2N1414			2N1415			
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
SMALL SIGNAL CHARACTERISTICS (Unless otherwise specified $V_C = -5V$ common base; $I_E = +1ma$; $f = 1000$ cps)											
Output Admittance (Input AC Open Circuited)	h_{ob}	.1	.65	1.3	.1	.62	1.2	.1	.55	1.0	μmhos
Input Impedance (Output AC Short Circuited)	h_{ib}	26	29	36	26	29	35	26	29	33	ohms
Reverse Voltage Transfer Ratio (Input AC Open Circuited)	h_{rb}	1	4.8	10	1	5.2	11	1	5.7	12	x10^{-4}
Forward Current Transfer Ratio (Common Emitter; Output AC Short Circuited)	h_{fe}	20	30	41	30	44	64	44	64	88	
Frequency Cutoff	f_{hfb}	0.8	3.2		1.0	3.6		1.3	4.0		mc
Output Capacity (f = 1mc; Input AC Open Circuited)	C_{ob}		26	40		26	40		26	40	μμf
Noise Figure (f = 1 kc; BW = 1 cycle)	NF		6			6			6		db
D-C CHARACTERISTICS											
Forward Current Gain (Common Emitter, I_C/I_B)											
($V_{CE} = -1v$; $I_C = -20ma$)	h_{FE}	25	36	42	34	52	65	53	73	90	
($V_{CE} = -1v$; $I_C = -100ma$)	h_{FE}	23			30			47			
Collector Saturation Voltage ($I_C = -20ma$; I_B as indicated)	$V_{CE\ (SAT)}$ @ $I_B =$		−.070 −2.0			−.075 −1.33			−.080 −1.0		volts ma
Base Input Voltage, Common Emitter ($V_{CE} = -1v$; $I_C = -20ma$)	V_{BE}		−.255			−.243			−.230		volts
Collector Cutoff Current ($V_{CBO} = -30v$)	I_{CO}		−6	−12		−6	−12		−6	−12	μa
Emitter Cutoff Current ($V_{EBO} = -10v$)	I_{EO}		−4	−10		−4	−10		−4	−10	μa
Collector to Emitter Voltage ($R_{BE} \leqq 10K$ ohms; $I_C = -.6ma$)	V_{CER}	−25			−25			−25			volts
Reach-Through Voltage	V_{RT}	−25			−25			−25			volts

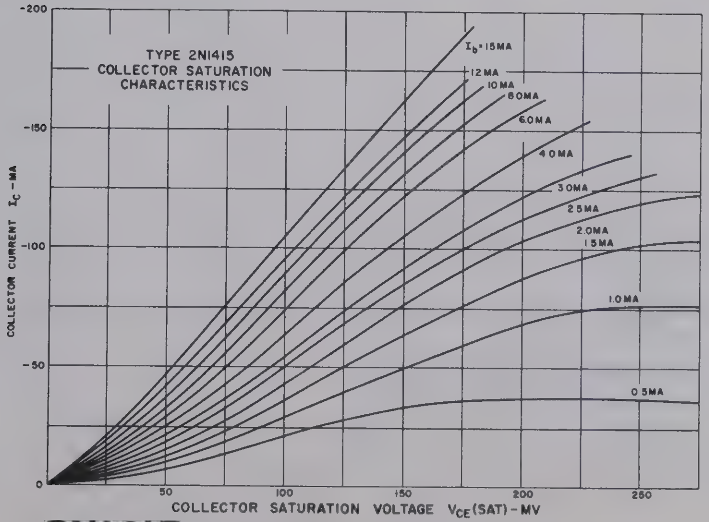
COLLECTOR SATURATION CHARACTERISTICS



2N1413

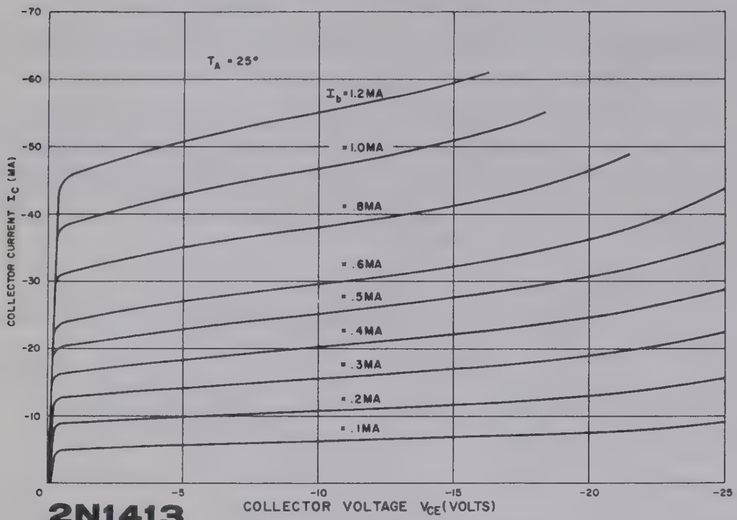


2N1414

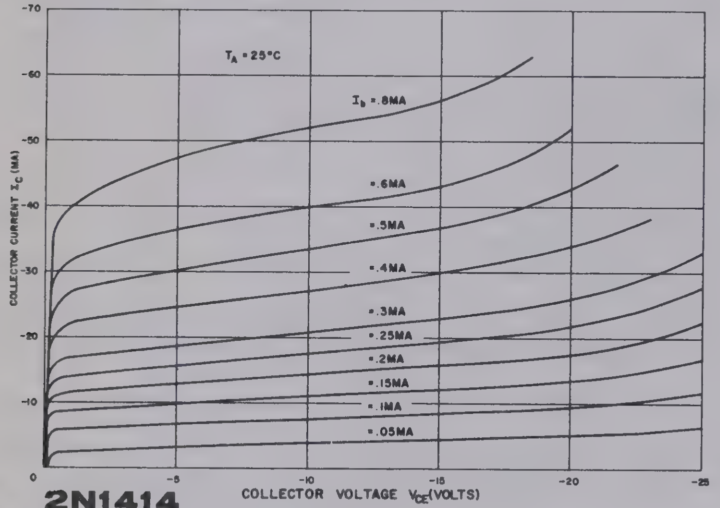


2N1415

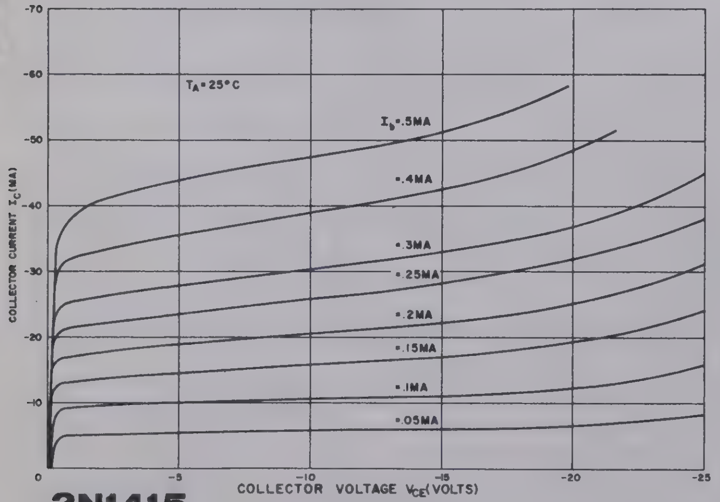
COMMON EMITTER COLLECTOR CHARACTERISTICS



2N1413

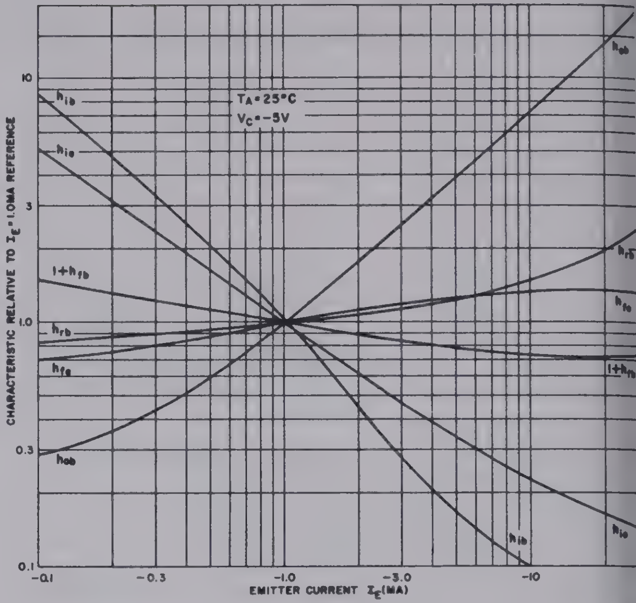


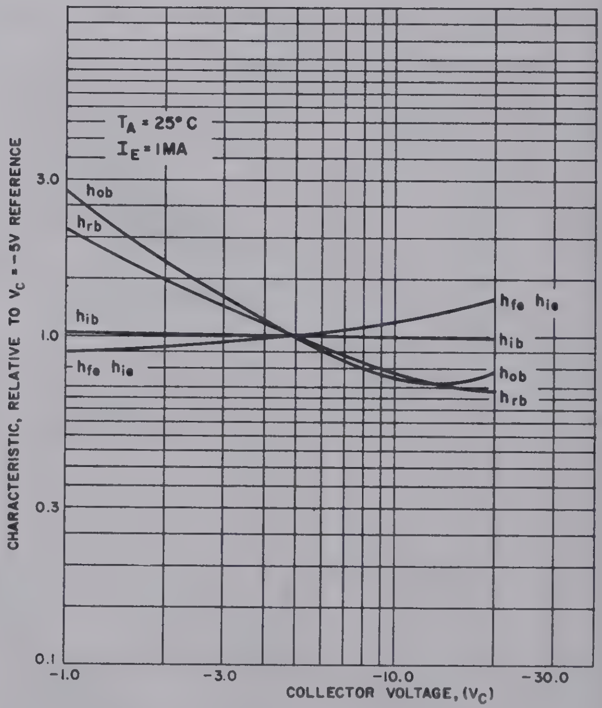
2N1414



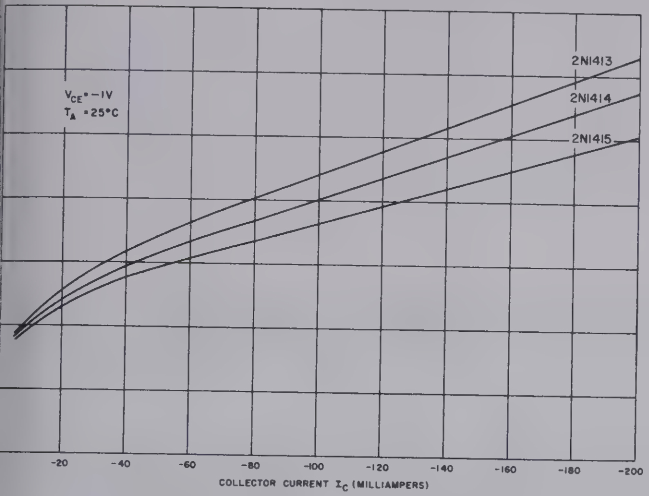
2N1415

SMALL SIGNAL CHARACTERISTICS

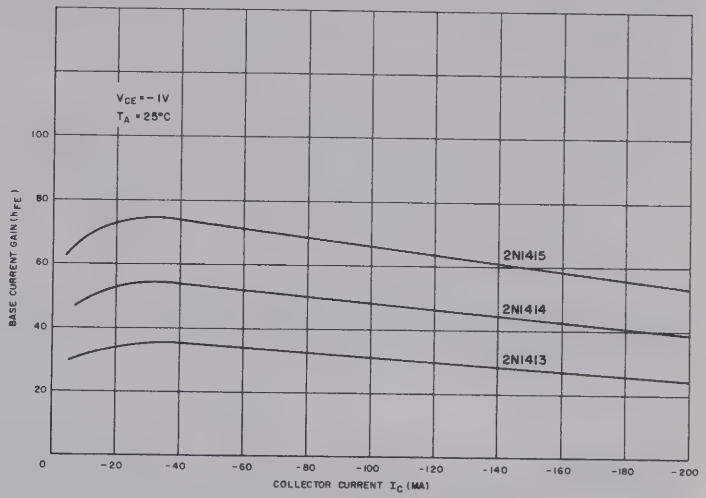




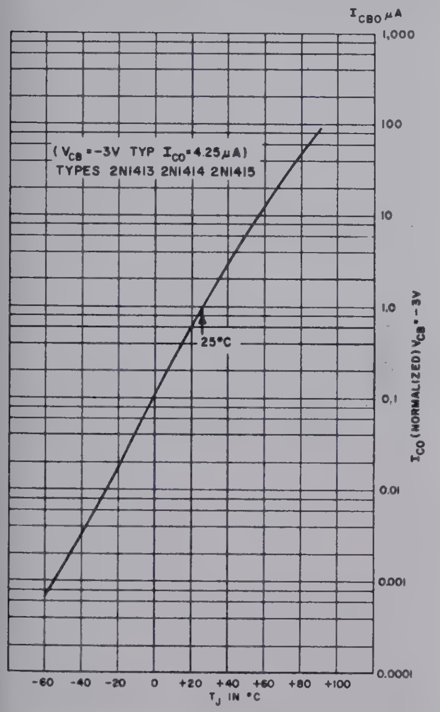
TYPES 2N1413, 2N1414, 2N1415



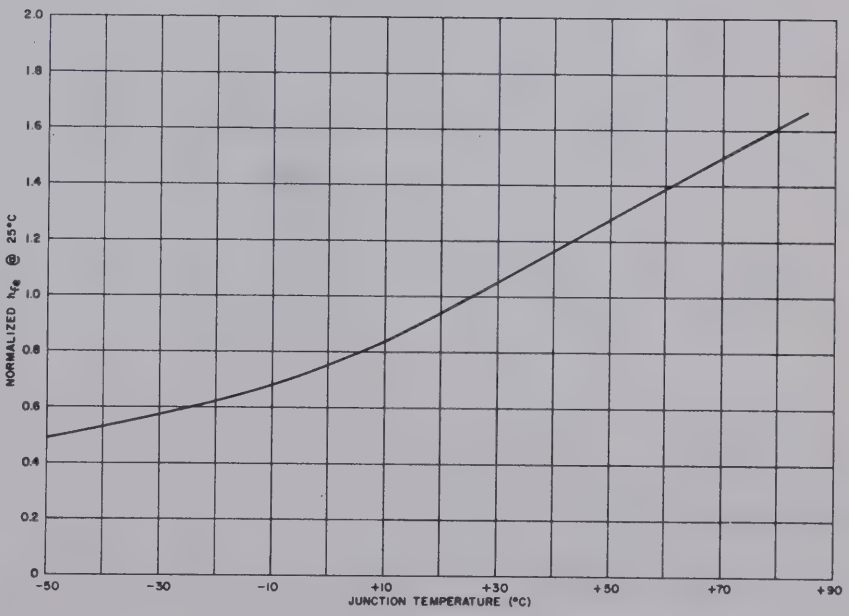
Common Emitter Input Voltage vs. Collector Current



DC Current Gain (h_{FE}) vs. Collector Current



Normalized Collector Current vs. Temperature

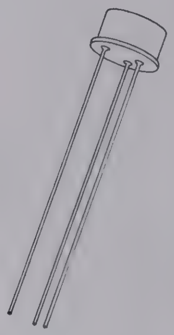


Normalized AC Current Gain (h_{fe}) vs. Temperature

SCR

2N1595-99

The 2N1595 series of Silicon Controlled Rectifiers are planar-passivated, all-diffused, three junction, reverse blocking triode thyristors for low power switching and control applications. The 2N2322 series, which is also available, offers additional maximum specified electrical parameters.



- Painted external surface for maximum heat dissipation
- Single-ended package, ideal for printed circuit applications
- All-welded construction
- All-diffused, planar passivated
- Glass-to-metal seals

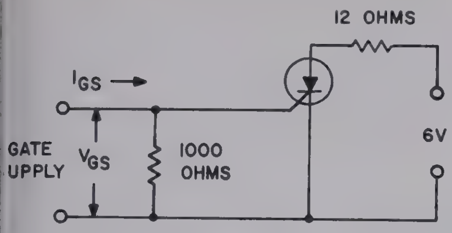
MAXIMUM ALLOWABLE RATINGS

TYPE	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM}(1)	PEAK POSITIVE ANODE VOLTAGE PFV	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM}
	$T_C = -65°C$ to $+125°C$		
2N1595	50 Volts*	500 Volts	50 Volts*
2N1596	100 Volts*	500 Volts	100 Volts*
2N1597	200 Volts*	500 Volts	200 Volts*
2N1598	300 Volts*	500 Volts	300 Volts*
2N1599	400 Volts*	500 Volts	400 Volts*

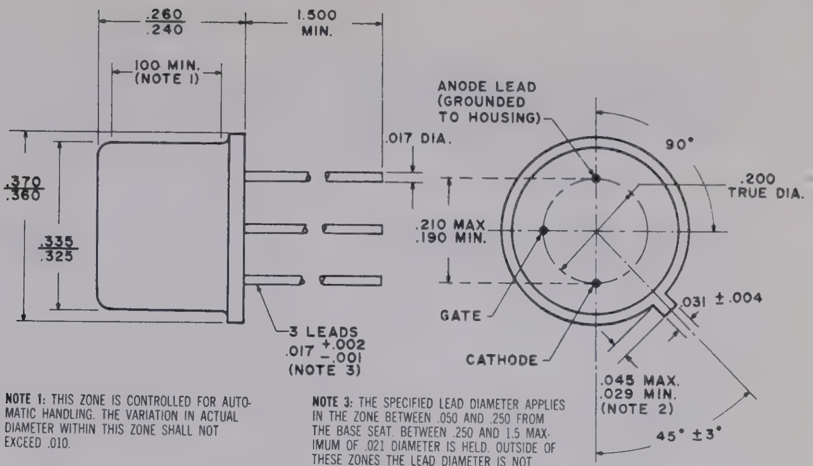
(1) Applies for 1000 ohms maximum, connected gate-to-cathode.

RMS On-State Current, $I_{T(RMS)}$	1.6 Amperes (all conduction angles)
Average On-State Current, $I_{T(AV)}$	Depends on conduction angle (see Charts 3, 4, 5 and 6)
Peak One-Cycle Surge (Non-rep) On-State Current, I_{TSM}	15 Amperes*
Peak Gate Power Dissipation, P_{GM}	0.1 Watts
Average Gate Power Dissipation, $P_{G(AV)}$	0.01 Watts
Peak Positive Gate Current, I_{GM}	0.1 Amperes
Peak Positive Gate Voltage, V_{GM}	6 Volts
Peak Negative Gate Voltage, V_{GM}	−6 Volts
Storage Temperature, T_{STG}	−65°C to +150°C*
Operating Temperature, T_J	−65°C to +150°C

* Indicates data included in JEDEC type number registration.


12 OHMS
I_{GS}
GATE
UPPLY
V_{GS}
1000
OHMS
6V

OUTLINE DRAWING
(Conforms to JEDEC TO-5 Package Outline)


.260
.240
1.500
MIN.
.100 MIN.
(NOTE 1)
ANODE LEAD
(GROUNDED
TO HOUSING)
.017 DIA.
90°
.200
TRUE DIA.
.370
.360
.335
.325
.210 MAX
.190 MIN.
GATE
.031 ± .004
3 LEADS
.017 +.002 −.001
(NOTE 3)
CATHODE
.045 MAX.
.029 MIN.
(NOTE 2)
45° ±3°

NOTE 1: THIS ZONE IS CONTROLLED FOR AUTOMATIC HANDLING. THE VARIATION IN ACTUAL DIAMETER WITHIN THIS ZONE SHALL NOT EXCEED .010.

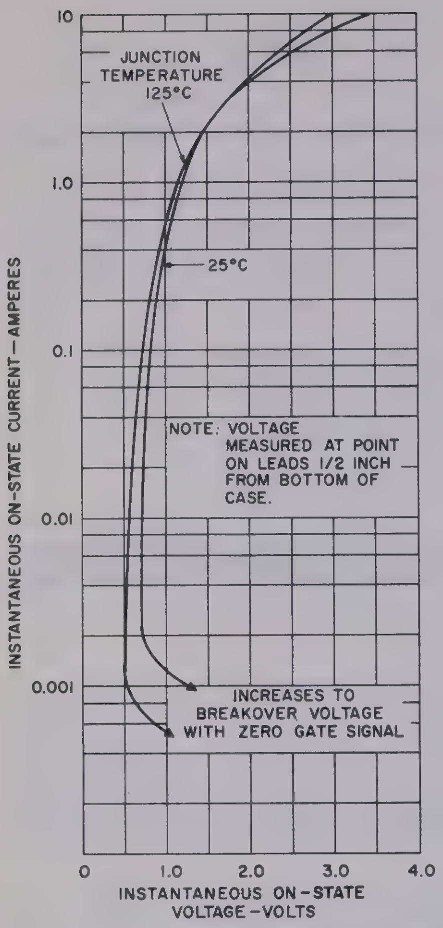
NOTE 2: MEASURED FROM MAX. DIAMETER OF THE ACTUAL DEVICE.

NOTE 3: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN .050 AND .250 FROM THE BASE SEAT. BETWEEN .250 AND 1.5 MAXIMUM OF .021 DIAMETER IS HELD. OUTSIDE OF THESE ZONES THE LEAD DIAMETER IS NOT CONTROLLED. LEADS MAY BE INSERTED, WITHOUT DAMAGE, IN .031 HOLES WHILE DEVICE ENTERS .371 HOLE CONCENTRIC WITH LEAD HOLE CIRCLE

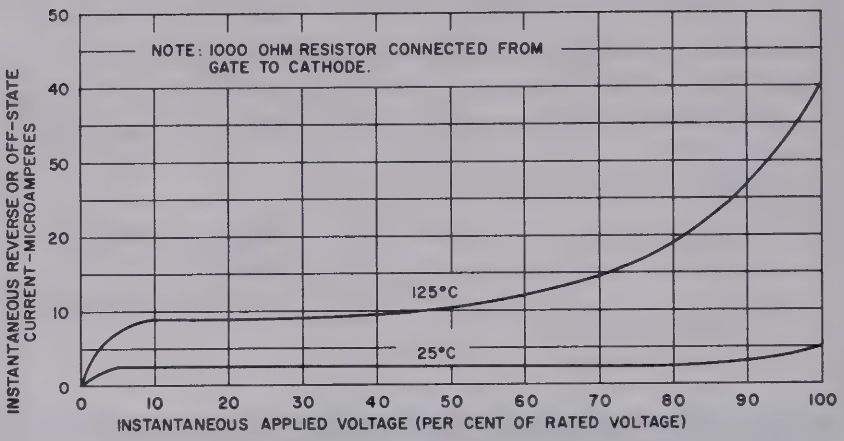
APROX WEIGHT: .05 OZ
ALL DIMENSIONS IN INCHES

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Peak Off-State and Reverse Current	I_{DRM} & I_{RRM}	— —	2.0 100	10 1000*	μA	$V_{DRM} = V_{RRM}$ = Rated volts peak, R_{GK} = 1000 ohms. $T_C = +25°C$ $T_C = +125°C$
D.C. Gate Trigger Current	$I_{GS}^{(1)}$	—	0.9	10*	mAdc	$T_C = +25°C$, V_D = 6 Vdc, R_L = 12 ohms
D.C. Gate Trigger Voltage	V_{GT}	—	0.6	3.0*	Vdc	$T_C = +25°C$, V_D = 6 Vdc, R_L = 12 ohms
Peak On-State Voltage	V_{TM}	—	1.25	2.0*	Volts	$T_C = +25°C$, I_{TM} = 1.0 A peak, 1 msec. wide pulse. Duty cycle $\leqq 2\%$.
Holding Current	I_H	—	1.0	—	mAdc	$T_C = +25°C$, Anode Source Voltage = 12 Vdc, R_{GK} = 1000 ohms.
Circuit Commutated Turn-Off Time	t_q	—	40	—	μsec	$T_C = +125°C$, I_{TM} = 1.0 A peak. Rectangular current pulse, 50 μsec duration. Rate of rise of current < 10A/μsec. Commutation rate $\leqq$ 5 A/μsec. Peak reverse voltage = Rated V_{RRM} volts max. Reverse voltage at end of turn-off time interval 15 volts. Repetition rate = 60 pps. Rate of rise of re-applied off-state voltage (dv/dt) = 20 V/μsec. Off-state voltage = Rated V_{DRM} volts. Gate bias during turn-off time interval = 0 volts, 100 ohms.
Turn-On Time	$t_d + t_r$	—	1.2	—	μsec	$T_C = +25°C$, V_D = Rated V_{DRM} value. I_{TM} = 1.0 A. Gate trigger pulse = 6 volts, 300 ohms, 5 μsec wide, 0.1 μsec rise time. Gate bias = 0 volts, 300 ohms.

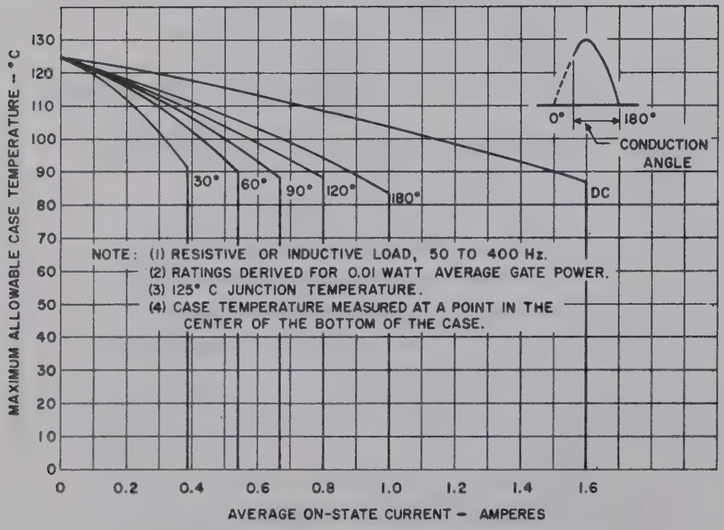
* Indicates data included in JEDEC type number registration.
NOTE: (1) I_{GS} is defined in the circuit below:



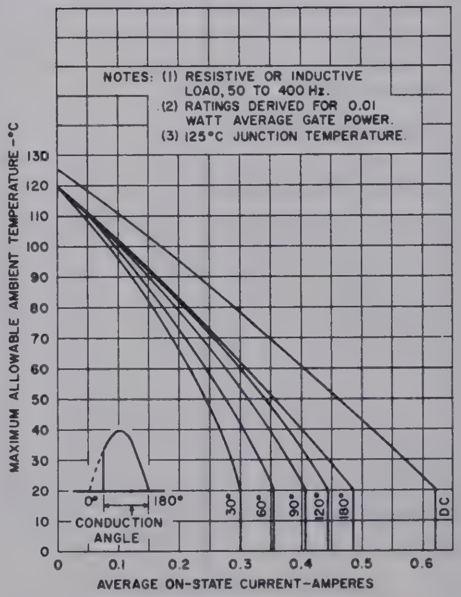
1. TYPICAL ON-STATE CHARACTERISTICS



2. TYPICAL OFF-STATE AND REVERSE BLOCKING CHARACTERISTICS

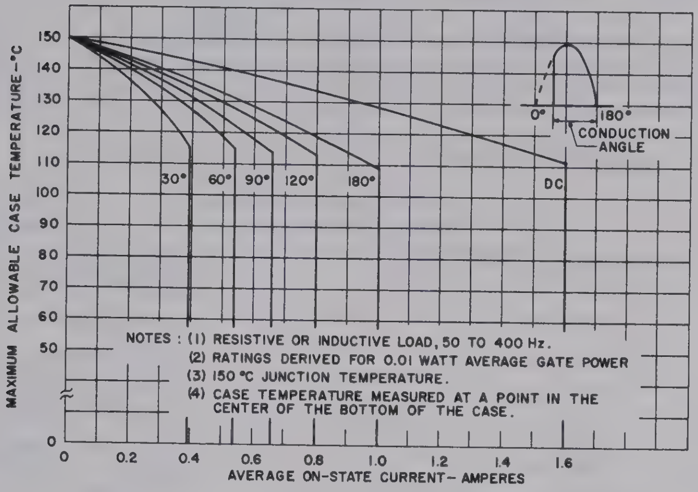


3. MAXIMUM ALLOWABLE CASE TEMPERATURE
(150°C Junction Temp.)

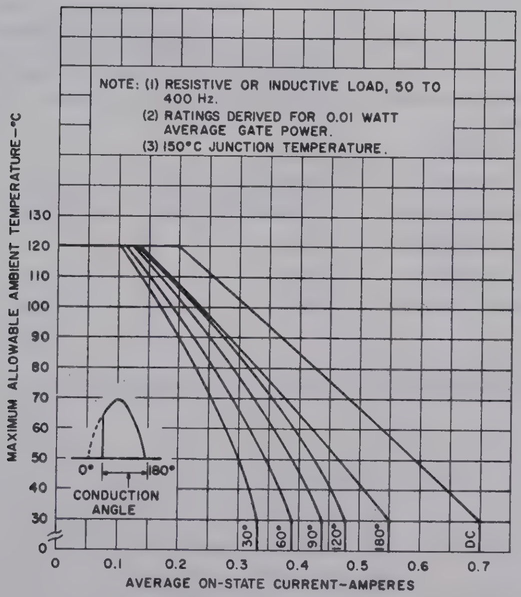


4. MAXIMUM ALLOWABLE AMBIENT TEMPERATURE
(125°C Junction Temp.)

Charts 5 and 6 apply to latching applications where SCR need not block off-state voltage after being turned on, since the V_{DRM} specification does not apply above + 125°C junction temperature. SCR will again block rated off-state voltage after junction temperature drops below + 125°C.



5. MAXIMUM ALLOWABLE CASE TEMPERATURE
(125°C Junction Temp.)



6. MAXIMUM ALLOWABLE AMBIENT TEMPERATURE
(150°C Junction Temp.)

Silicon Transistors

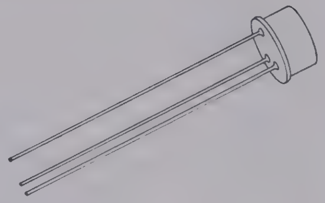
PN

2N1671,1A,B,C

The General Electric Silicon Unijunction Transistor is a three terminal device having a stable "N" type negative resistance characteristic over a wide temperature range. A stable peak point voltage, a low peak point current, and a high pulse current rating make this device useful in oscillators, timing circuits, trigger circuits and pulse generators where it can serve the purpose of two conventional silicon or germanium transistors.

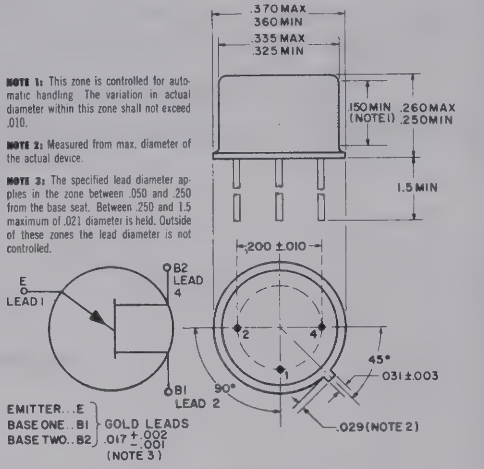
The 2N1671 is intended for general purpose industrial applications where circuit economy is of primary importance. The 2N1671A is intended for industrial use in firing circuits for Silicon Controlled Rectifiers and other applications where a guaranteed minimum pulse amplitude is required. The 2N1671C is intended for applications where a low emitter leakage current and a low peak emitter current (trigger current) are required.

These transistors feature Fixed-Bed Construction and are hermetically sealed in a welded case. All leads are electrically isolated from the case.



absolute maximum ratings (25°C)

RMS Power Dissipation	450 mw[1]
RMS Emitter Current	50 ma
Peak Emitter Current[2]	2 amperes
Emitter Reverse Voltage	30 volts
Interbase Voltage	35 volts
Operating Temperature Range	−65°C to +140°C
Storage Temperature Range	−65°C to +150°C



NOTE 1: This zone is controlled for automatic handling The variation in actual diameter within this zone shall not exceed .010.

NOTE 2: Measured from max. diameter of the actual device.

NOTE 3: The specified lead diameter applies in the zone between .050 and .250 from the base seat. Between .250 and 1.5 maximum of .021 diameter is held. Outside of these zones the lead diameter is not controlled.

electrical characteristics (25°C)

PARAMETER	SYMBOL	2N1671 MIN.	2N1671 MAX.	2N1671A MIN.	2N1671A MAX.	2N1671B MIN.	2N1671B MAX.	2N1671C MIN.	2N1671C MAX.	UNITS
Intrinsic Standoff Ratio ($V_{BB} = 10V$) (Note 3)	η	0.47	0.62	0.47	0.62	0.47	0.62	0.47	0.62	
Interbase Resistance ($V_{BB} = 3V$, $I_E = 0$) (Note 4)	R_{BBO}	4.7	9.1	4.7	9.1	4.7	9.1	4.7	9.1	KΩ
Emitter Saturation Voltage ($V_{BB} = 10V$, $I_E = 50$ ma)	V_E(SAT)		5		5		5		5	volts
Modulated Interbase Current ($V_{BB} = 10V$, $I_E = 50$ ma)	I_{B2}(MOD)	6.8	22	6.8	22	6.8	22	6.8	22	ma
Emitter Reverse Current ($V_{B2E} = 30V$, $I_{B1} = 0$) (Fig. 6)	I_{EO}		12		12		0.2		.02	μa
Peak Point Emitter Current ($V_{BB} = 25V$) (Fig. 8)	I_P		25		25		6		2	μa
Valley Point Current ($V_{BB} = 20V$, $R_{B2} = 100\Omega$) (Fig. 9)	I_V	8		8		8		8		ma
Base-One Peak Pulse Voltage (Note 5)	V_{OB1}			3.0		3.0		3.0		volts
Emitter Reverse Current (V_{BB}=25V, V_{EB1}=V_P—.3V) (Fig.3)	I_{EX}								0.05	μa

NOTES:

(1) Derate 3.9 MW/°C increase in ambient temperature (Thermal resistance to case =0.16°C/MW.)

(2) Capacitor discharge—10μfd or less, 30 volts or less—Total interbase power dissipation must be limited by external circuitry.

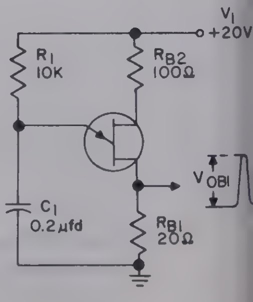
(3) The intrinsic standoff ratio, η, is essentially constant with temperature and interbase voltage. η is defined by the equation:

$$V_P = \eta V_{BB} + \frac{200}{T_J}$$

Where V_P=Peak point emitter voltage
V_{BB}=interbase voltage
T_J=Junction Temperature (Degrees Kelvin)

(4) The interbase resistance is nearly ohmic and increases with temperature in a well defined manner as shown in figures 10 and 11. The temperature coefficient at 25°C is approximately 0.8%/°C.

(5) The base-one peak pulse voltage is measured in the circuit below. This specification on the 2N1671A is used to ensure a minimum pulse amplitude for applications in SCR firing circuits and other types of pulse circuits. The variation of pulse amplitude with temperature and circuit parameters is shown in figures 12 to 15.



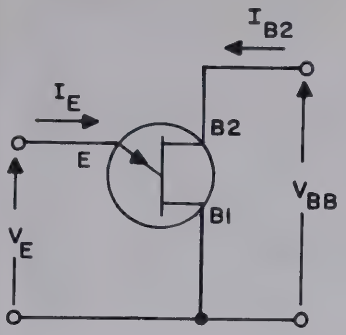


FIG. 1

Unijunction Transistor Symbol with Nomenclature used for voltage and currents.

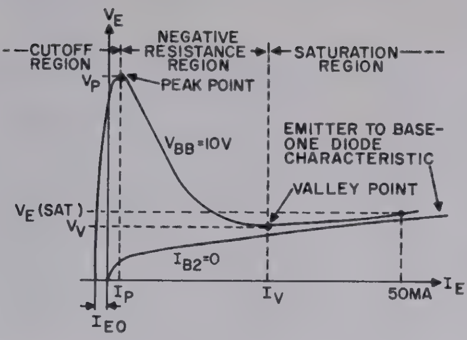


FIG. 2

Static Emitter Characteristic curves showing important parameters and measurement points (exaggerated to show details).

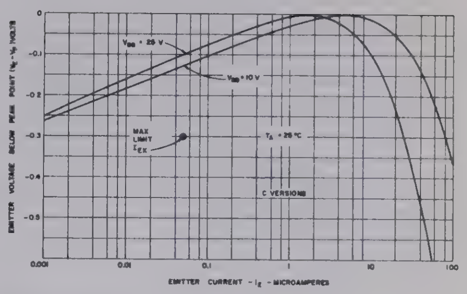


FIG. 3

Static Emitter Characteristics at Peak Point.

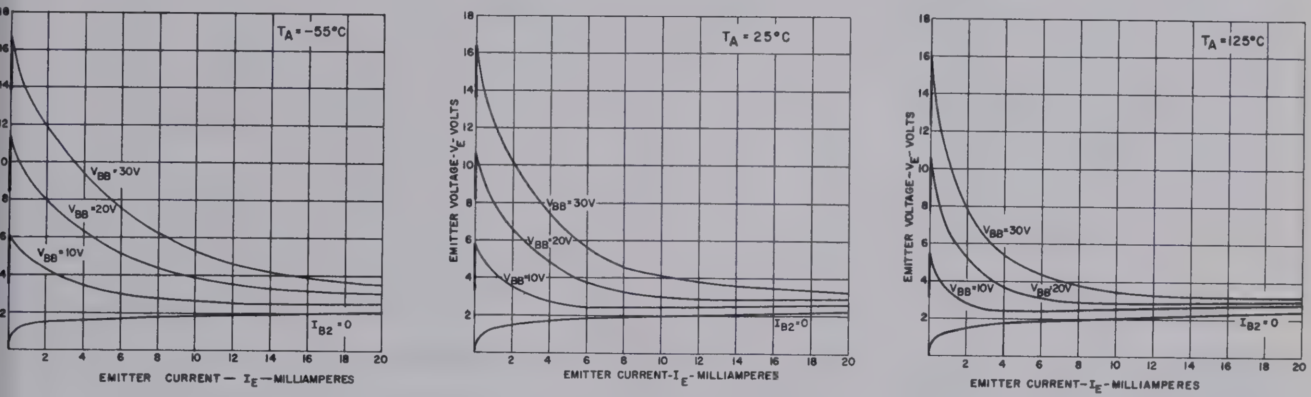


FIG. 4

Static emitter characteristics for a typical 2N1671 unijunction transistor at three different ambient temperatures.

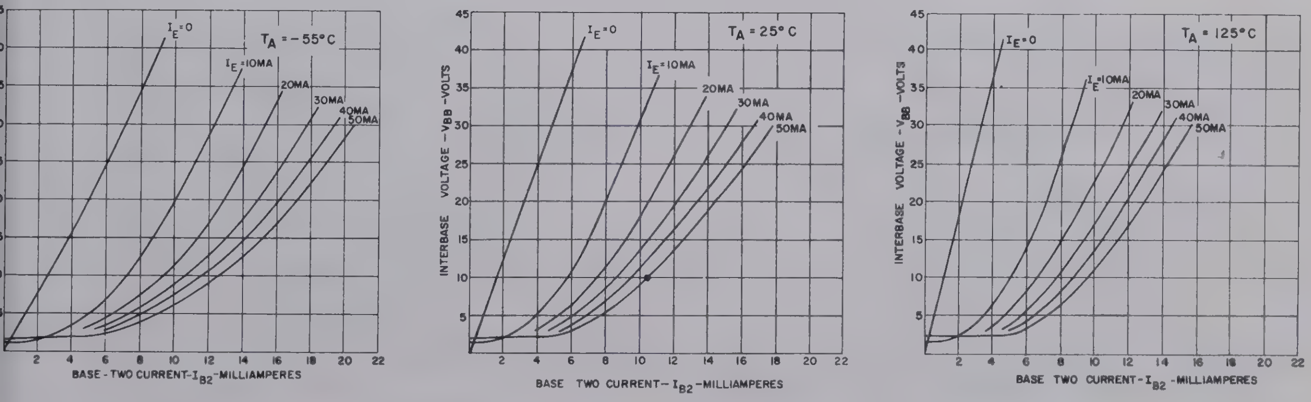


FIG. 5

Static interbase characteristics for a typical 2N1671 unijunction transistor at three different ambient temperatures.

2N1671,1A,B,C

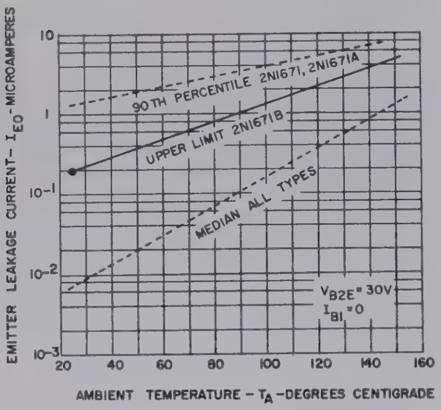


FIG. 6

Emitter reverse current vs. temperature.

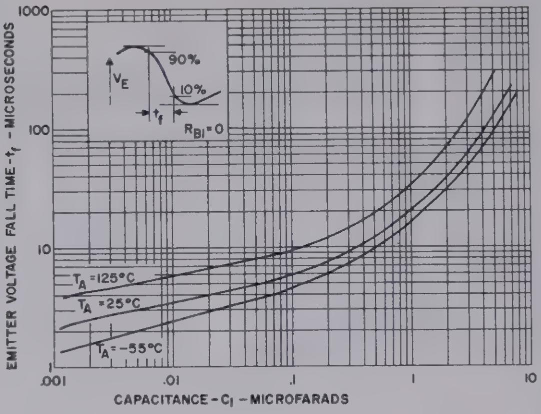


FIG. 7

Emitter voltage fall time vs. capacitance and ambient temperature for a typical unit in relaxation oscillator circuit.

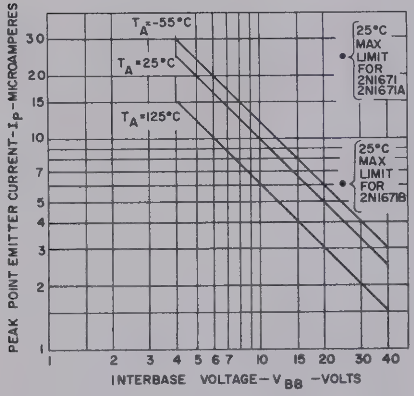


FIG. 8

Peak Point Emitter Current vs. interbase voltage and ambient temperature for a typical unit.

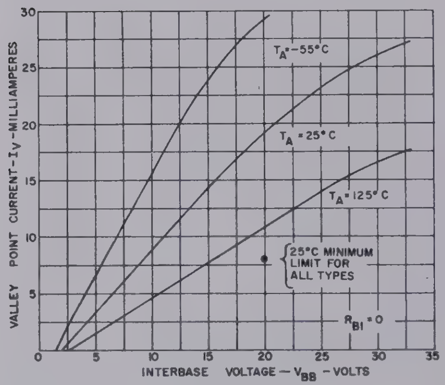


FIG. 9

Valley Point Current vs. interbase voltage and ambient temperature for a typical unit.

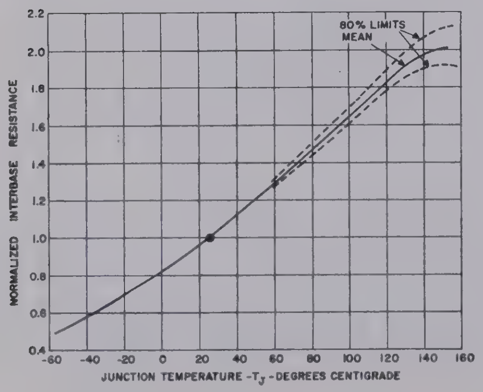


FIG. 10

Normalized interbase resistance vs. junction temperature.

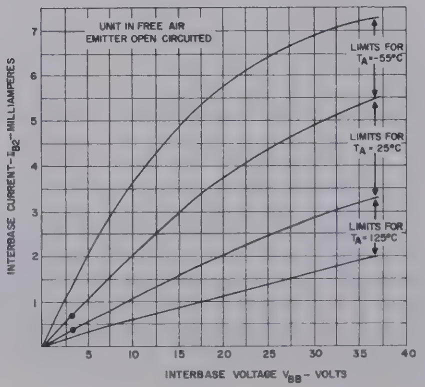


FIG. 11

Limit values of static interbase characteristics with zero emitter current.

2N1671A - 2N1671B

GENERAL PURPOSE PULSE CIRCUITS AND FIRING CIRCUITS FOR SILICON CONTROLLED RECTIFIERS

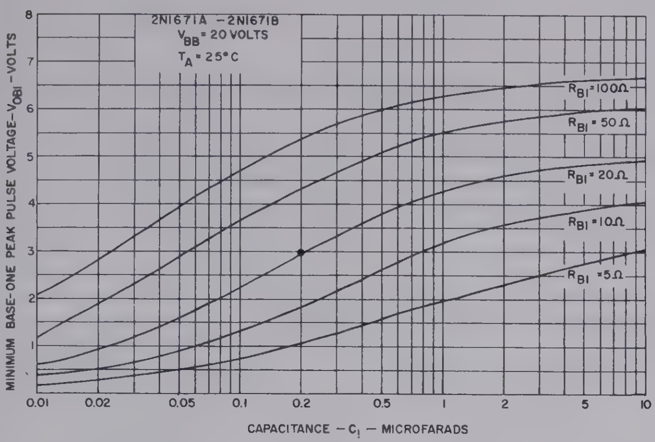


FIG. 12

Minimum base-one peak pulse voltage vs. capacitance and base-one resistance in relaxation oscillator circuit.

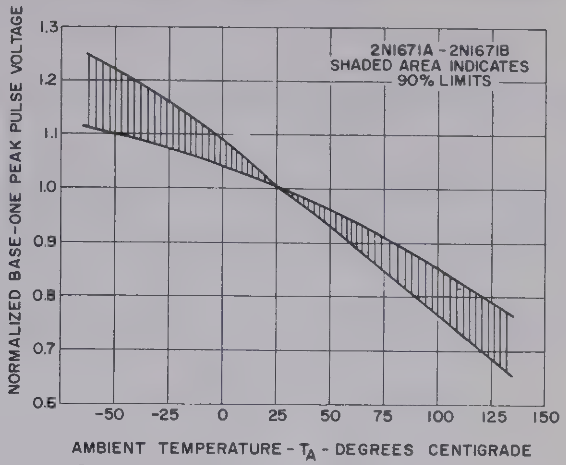


FIG. 13

Normalized base-one peak pulse voltage vs. temperature in relaxation oscillator circuit.

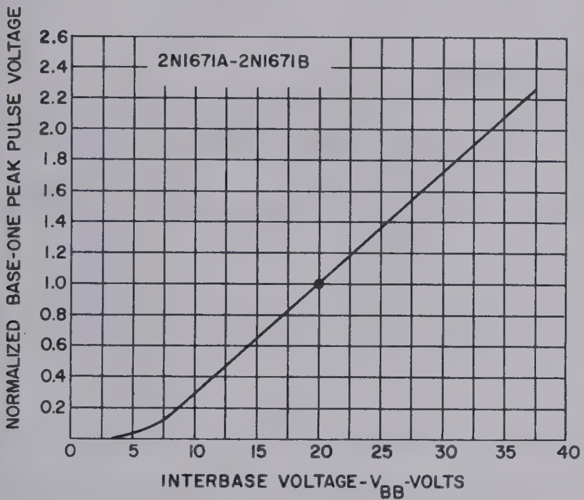


FIG. 14

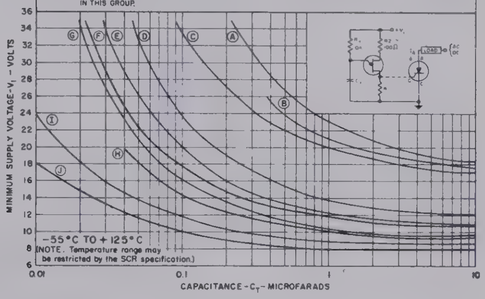
Normalized base-one peak pulse voltage vs. interbase voltage in relaxation oscillator circuit.

UJT TYPE	SCR TYPE	CURVE	RI	$V_{(MAX)}$
2N489A & B THROUGH 2N494A, B, AND C (ALSO USAF TYPES)	C60(2N2023-30) C55 AND C56 C52(2N1792-98) C50(2N1909-16) C46 C45 C37 C36(2N1842-50)	A	27Ω ± 10%	35V
		B	47Ω ± 10%	26V
		C	PULSE TRANS. PE2231	35V
2N2417A & B THROUGH 2N2422A, B, AND C	C40 C38* C35(2N681-92) C30 AND C32** C20 AND C22** C15	D	27Ω ± 10%	35V
		E	47Ω ± 10%	20V
		G	PULSE TRANS. SPRAGUE 31Z204	35V
2N1671A, B, AND C 2N2646	C12 C11(2N1770-78, 2N2619) C10(2N1770A-77A) C9 C8(2N1929-35) 2N1595-99	E	27Ω ± 10%	32V
		G	47Ω ± 10%	18V
		I	PULSE TRANS. SPRAGUE 31Z204	35V
2N2647***	C7(2N2344-48) C6 C5	F	15Ω ± 10%	35V
		H	27Ω ± 10%	20V
		J	SPRAGUE 31Z204	35V

NOTES: * LIMITED TO 27 VOLTS MAX ON "D" CURVE AND 15 VOLTS ON "E" CURVE.

** TRIGGER REQUIREMENTS LESS THAN OTHERS IN THIS GROUP.

*** MINIMUM TRIGGER PULSE IS TWICE THE AMPLITUDE OF OTHER UJT'S, THIS ASSURES 2:1 OVER MINIMUM SCR TRIGGER REQUIREMENTS.



-55°C TO +125°C

NOTE. Temperature range may be restricted by the SCR specification.

FIG. 15

Minimum supply voltage required to fire standard types of silicon controlled rectifiers vs. capacitance in circuit below.

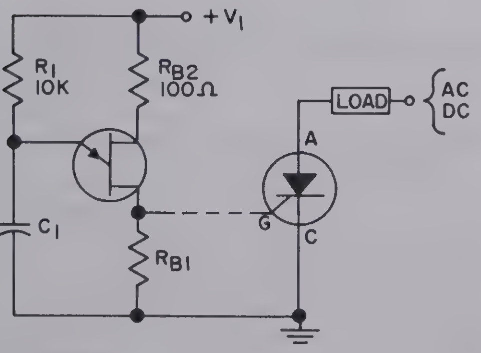


FIG. 16

Basic unijunction transistor firing circuit for silicon controlled rectifiers.

Period of Relaxation Oscillator

$\tau = 0.80\ R_1C_1\ (\pm\ 0.21\ R_1C_1)$

Maximum Value of R_1 for oscillation (−55°C to +140°C)

R_1 (max) = 430 V_1^2 (2N1671-2N1671A)

R_1 (max) = 1800 V_1^2 (2N1671B)

τ = Period in Seconds

C_1 = Capacitance in Farads

R_1 = Resistance in ohms

V_1 = Supply voltage in volts

REFERENCES:

(1) "Application Notes on the Silicon Unijunction Transistor," 90.10

(2) "General Electric Transistor Manual — Seventh Edition" — Chapter 13

(3) "General Electric Controlled Rectifier Manual," Third Edition

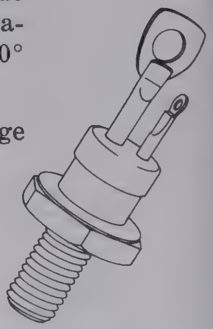
SCR

2N1842-50

The 2N1842 through 2N1850 Series of Silicon Controlled Rectifiers are reverse blocking triode thyristor semiconductor devices for use in medium power switching and phase control applications requiring blocking voltages up to 500 volts, and average load currents (single-phase, 180° conduction angle) up to 10 amperes.

The following General Electric medium current SCR types are recommended for higher voltage ratings and where higher levels of performance are required for a device of this size:

Type	Publication Number
C35	160.20
C37	160.23
C137	160.45



MAXIMUM ALLOWABLE RATINGS

TYPE	PEAK FORWARD BLOCKING VOLTAGE, V_{FOM} $T_C = -40°C +100°C$	PEAK FORWARD VOLTAGE, PFV(2) $T_C = -40°C +100°C$	REPETITIVE PEAK REVERSE VOLTAGE, V_{ROM} (rep)(1) $T_C = -40°C +100°C$	NON-REPETITIVE PEAK REVERSE VOLTAGE (<5 MILLISEC.) V_{ROM} (non-rep)(1) $T_C = -40°C +100°C$
2N1842	25 Volts*	35 Volts	25 Volts*	35 Volts*
2N1843	50 Volts*	75 Volts	50 Volts*	75 Volts*
2N1844	100 Volts*	150 Volts	100 Volts*	150 Volts*
2N1845	150 Volts*	225 Volts	150 Volts*	225 Volts*
2N1846	200 Volts*	300 Volts	200 Volts*	300 Volts*
2N1847	250 Volts*	350 Volts	250 Volts*	350 Volts*
2N1848	300 Volts*	400 Volts	300 Volts*	400 Volts*
2N1849	400 Volts*	500 Volts	400 Volts*	500 Volts*
2N1850	500 Volts*	600 Volts	500 Volts*	600 Volts*

(1)Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for which maximum V_{FOM} and V_{ROM} ratings apply equals 11°C per watt.
(2)Cells with higher PFV ratings are available upon request.

RMS Forward Current, On-State	16 amperes (all conduction angles)
Average Forward Current, On-State	Depends on conduction angle (see Charts 3 and 4)
Rate of Rise of Forward Current, On-State, di/dt	10 amperes per microsecond
Peak One-cycle Surge Forward Current, I_{FM} (surge)	125 amperes*
I^2t (for fusing)	40 ampere^2 seconds (for times ≧1.5 milliseconds)
Peak Gate Power Dissipation, P_{GM}	5 watts*
Average Gate Power Dissipation, $P_{G\ (AV)}$	0.5 watt*
Peak Forward Gate Voltage, V_{GFM}	10 volts*
Peak Reverse Gate Voltage, V_{GRM}	5 volts*
Storage Temperature, T_{stg}	−40°C to +125°C*
Operating Temperature, T_J	−40°C to +100°C*
Stud Torque	30 lb-in (35 kg-cm)

***Indicates Data included on JEDEC type number registration.**

CHARACTERISTICS

TEST	SYMBOL	MIN.	MAX.	UNITS	TEST CONDITIONS
PEAK REVERSE OR FORWARD BLOCKING CURRENT†	I_{ROM} or I_{FOM}			mA	$T_C = -40°C$ to $+100°C$
2N1842		—	45.0		$V_{ROM} = V_{FOM} =$ 25V Peak
2N1843		—	38.0		= 50V
2N1844		—	25.0		= 100V
2N1845		—	13.0		= 150V
2N1846		—	12.0		= 200V
2N1847		—	11.0		= 250V
2N1848		—	10.0		= 300V
2N1849		—	8.0		= 400V
2N1850		—	6.0		= 500V
FULL CYCLE AVG. REVERSE OR FORWARD BLOCKING CURRENT†	$I_{RX(AV)}$ or $I_{FX(AV)}$			mA	$T_C = +35°C$, $I_o = 10A$ 180° Conduction Angle
2N1842		—	22.5*		$V_{RXM} = V_{FXM} =$ 25V Peak
2N1843		—	19.0*		= 50V
2N1844		—	12.5*		= 100V
2N1845		—	6.5*		= 150V
2N1846		—	6.0*		= 200V
2N1847		—	5.5*		= 250V
2N1848		—	5.0*		= 300V
2N1849		—	4.0*		= 400V
2N1850		—	3.0*		= 500V
GATE TRIGGER CURRENT	I_{GT}	—	80	mAdc	$T_C = +25°C$, $V_{FX} = 12Vdc$, $R_L = 50$ ohms
		—	150*	mAdc	$T_C = -40°C$, $V_{FX} = 12Vdc$, $R_L = 50$ ohms
GATE TRIGGER VOLTAGE	V_{GT}	—	3.5*	Vdc	$T_C = 40°C$ to $+100°C$, $V_{FX} = 12Vdc$, $R_L = 50$ ohms
		0.30*	—	Vdc	$T_C = +100°C$, $V_{FXM} =$ Rated V_{FOM}, $R_L = 1000$ ohms
PEAK ON-VOLTAGE	V_{FM}	—	2.9	V	$T_C = +25°C$, $I_{FM} = 50A$ Peak, 1 millisecond wide pulse
EFFECTIVE THERMAL RESISTANCE (DC)	θ_{J-C}	—	2.5	°C/watt	

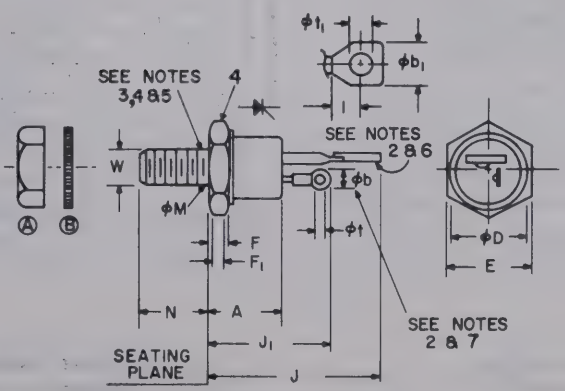
†Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for which maximum V_{FOM} and V_{ROM} ratings apply equals 11°C/watt.
*Indicates data included on JEDEC type number registration.

OUTLINE DRAWING

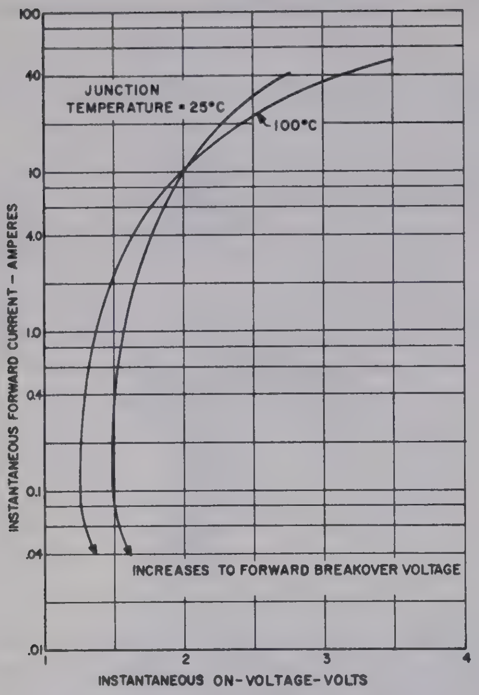
NOTES:
1. Complete threads to extend to within 2½ threads of seating plane. Diameter of unthreaded portion .249″ (6.32MM) Maximum, .220″ (5.59MM) Minimum.
2. Angular orientation of these terminals is undefined.
3. ¼-28 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter .2268″ (5.76MM), minimum pitch diameter .2225″ (5.66MM), reference: screw thread standards for Federal Service 1957, Handbook H28, 1957, P1.
4. A chamfer (or undercut) on one or both ends of hexagonal portions is optional.
5. Case is anode connection.
6. Large terminal is cathode connection.
7. Small terminal is gate connection.
8. Insulating kit available upon request.

A. ¼-28 steel nut, Ni. plated, .178 min. thk.
B. Ext. tooth lockwasher, steel, Ni. plated, .023 min. thk.

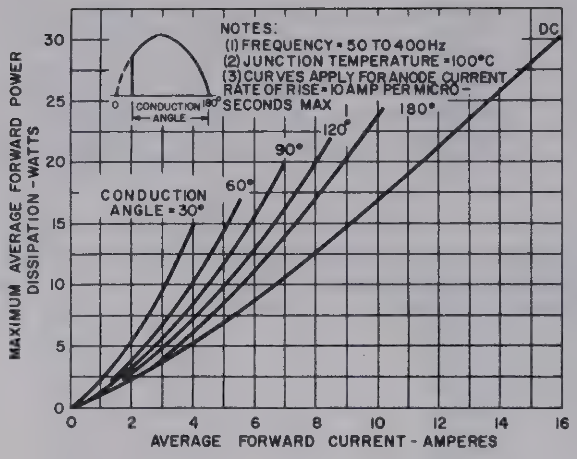
(COMPLIES WITH JEDEC TO-48)



SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	330	.505	8.38	12.83	
φb	.115	.140	2.92	3.56	2
φb₁	.210	.300	5.33	7.62	2
φD		.544		13.82	
E	.544	.562	13.82	14.27	
F	.113	.200	2.87	5.08	4
F₁	.060		1.52		
J		1.193		30.30	
J₁		.875		22.23	
I	.120		3.05		
φM					1
N	.422	.453	10.72	11.51	
φt	.060	.075	1.52	1.91	
φt₁	.125	.165	3.18	4.19	
W					3

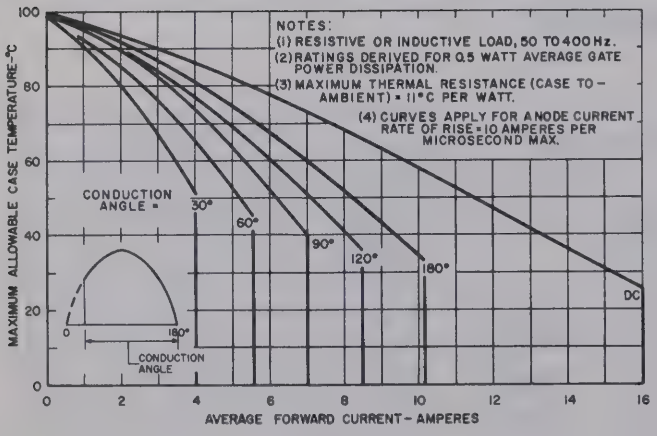


1. MAXIMUM FORWARD CHARACTERISTICS—ON-STATE



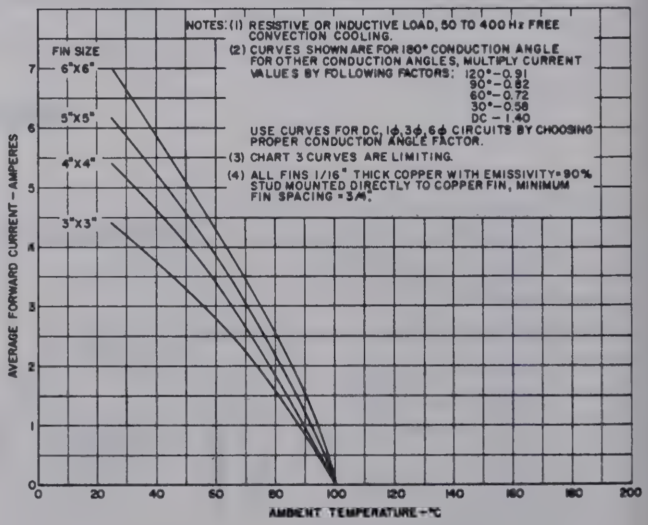
NOTES:
(1) FREQUENCY = 50 TO 400 Hz
(2) JUNCTION TEMPERATURE = 100°C
(3) CURVES APPLY FOR ANODE CURRENT RATE OF RISE = 10 AMP PER MICRO-SECONDS MAX

2. FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



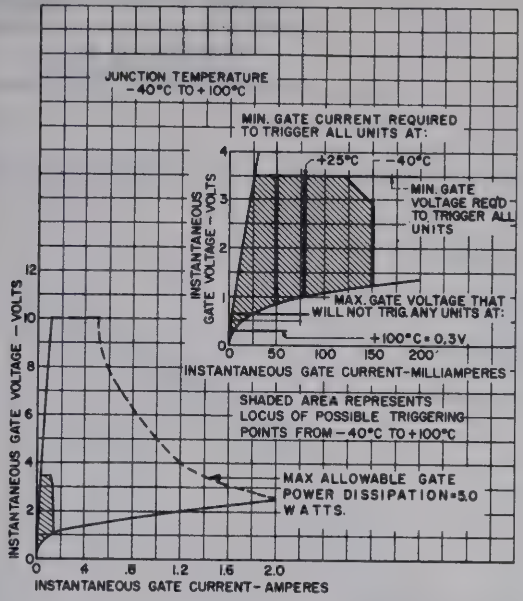
NOTES:
(1) RESISTIVE OR INDUCTIVE LOAD, 50 TO 400 Hz.
(2) RATINGS DERIVED FOR 0.5 WATT AVERAGE GATE POWER DISSIPATION.
(3) MAXIMUM THERMAL RESISTANCE (CASE TO – AMBIENT) = 11°C PER WATT.
(4) CURVES APPLY FOR ANODE CURRENT RATE OF RISE = 10 AMPERES PER MICROSECOND MAX.

3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



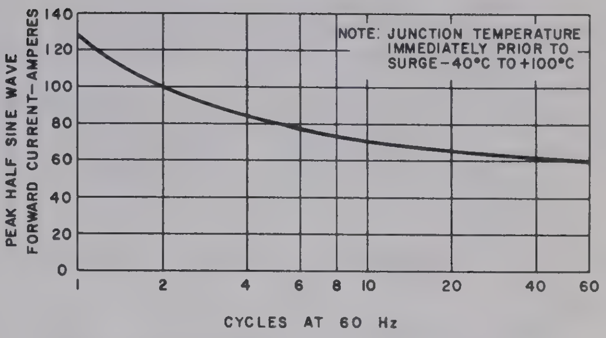
NOTES:
(1) RESISTIVE OR INDUCTIVE LOAD, 50 TO 400 Hz FREE CONVECTION COOLING.
(2) CURVES SHOWN ARE FOR 180° CONDUCTION ANGLE FOR OTHER CONDUCTION ANGLES, MULTIPLY CURRENT VALUES BY FOLLOWING FACTORS:
120°–0.91
90°–0.82
60°–0.72
30°–0.58
DC – 1.40
USE CURVES FOR DC, 1φ, 3φ, 6φ CIRCUITS BY CHOOSING PROPER CONDUCTION ANGLE FACTOR.
(3) CHART 3 CURVES ARE LIMITING.
(4) ALL FINS 1/16" THICK COPPER WITH EMISSIVITY = 90% STUD MOUNTED DIRECTLY TO COPPER FIN, MINIMUM FIN SPACING = 3/4".

4. SUGGESTED MAXIMUM CURRENT VS. AMBIENT TEMPERATURE FOR VARIOUS FIN SIZES



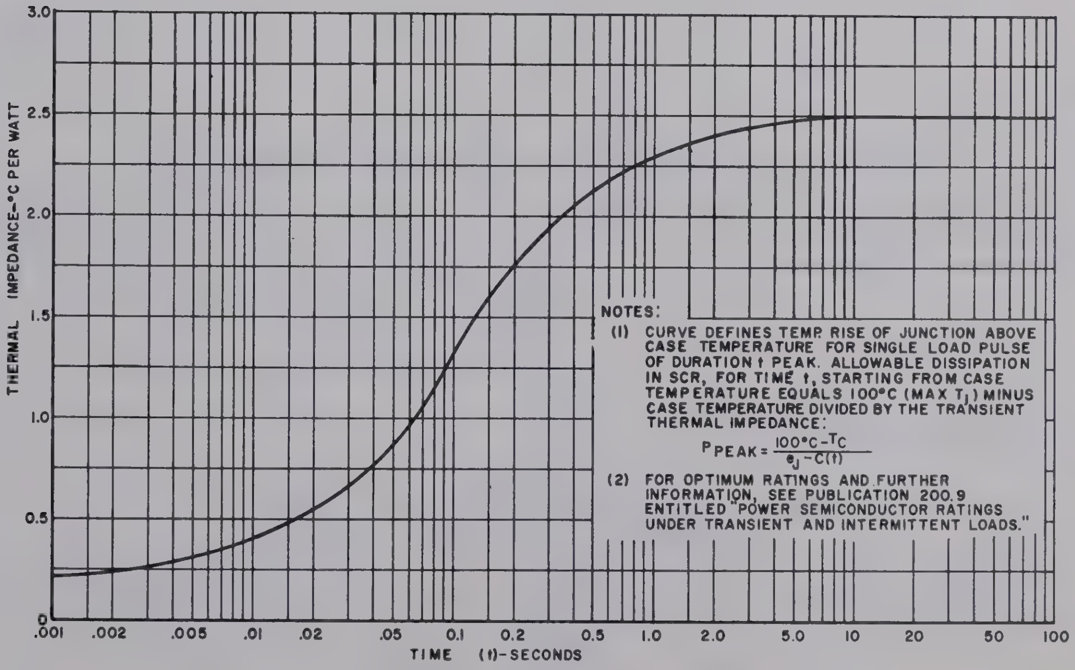
SHADED AREA REPRESENTS LOCUS OF POSSIBLE TRIGGERING POINTS FROM -40°C TO +100°C

5. GATE TRIGGERING CHARACTERISTICS



NOTE: JUNCTION TEMPERATURE IMMEDIATELY PRIOR TO SURGE-40°C TO +100°C

6. MAXIMUM ALLOWABLE NON-RECURRENT PEAK SURGE FORWARD CURRENT AT RATED LOAD CONDITIONS



NOTES:

(1) CURVE DEFINES TEMP. RISE OF JUNCTION ABOVE CASE TEMPERATURE FOR SINGLE LOAD PULSE OF DURATION t PEAK. ALLOWABLE DISSIPATION IN SCR, FOR TIME t, STARTING FROM CASE TEMPERATURE EQUALS 100°C (MAX T_J) MINUS CASE TEMPERATURE DIVIDED BY THE TRANSIENT THERMAL IMPEDANCE:

$$P_{PEAK} = \frac{100°C - T_C}{\theta_J - C(t)}$$

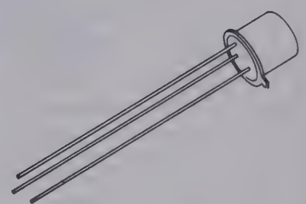
(2) FOR OPTIMUM RATINGS AND FURTHER INFORMATION, SEE PUBLICATION 200.9 ENTITLED "POWER SEMICONDUCTOR RATINGS UNDER TRANSIENT AND INTERMITTENT LOADS."

7. MAXIMUM TRANSIENT THERMAL IMPEDANCE—JUNCTION TO CASE

Germanium
Transistors

PNP
2N1924,5,6

The General Electric types 2N1924, 2N1925, and 2N1926 are PNP germanium alloy transistors for high voltage general purpose low frequency applications.
Excellent reliability in use is assured by inclusion of a 100% hermeticity test* and military environmental testing.
Reliable circuit design is assured by a unique Reliability-Index, and high temperature I_{CBO} and low temperature forward current gain 1000 hour life end points.
The high value of Reliability-Index is achieved by exacting control of parts and processes, and getter encapsulation, to prevent junction contamination.



absolute maximum ratings (25°C)

Voltages		
Collector to Base	V_{CBO}	— 60 volts
Collector to Emitter ($R_{BE} \leqq 10K$)	V_{CER}	— 40 volts
Collector to Emitter ($R_{BE} \leqq 10K$) ($V_{BE} = +1.5v$)	V_{CEX}	— 50 volts
Emitter to Base	V_{EBO}	— 25 volts
Collector Current (RMS)	I_{CM}	— 500 ma
Temperatures		
Storage	T_{STG}	— 65 to + 100°C
Operating	T_j	— 65 to + 85°C
Lead Temperature, 1/16″ ±1/32″ from case for 10 seconds maximum		260°C
Total Transistor Dissipation	P_T	225 mw

(Derate 3.7 mw/°C increase in ambient temperature above 25°C)

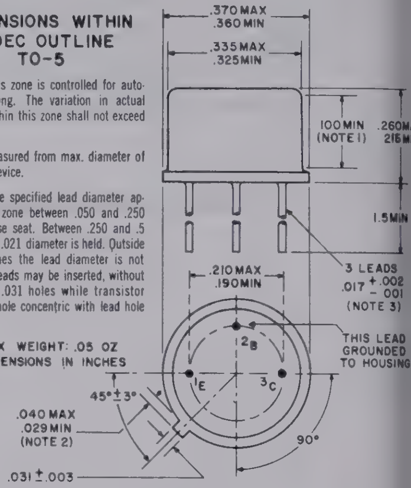
DIMENSIONS WITHIN JEDEC OUTLINE TO-5

NOTE 1: This zone is controlled for automatic handling. The variation in actual diameter within this zone shall not exceed .010.

NOTE 2: Measured from max. diameter of the actual device.

NOTE 3: The specified lead diameter applies in the zone between .050 and .250 from the base seat. Between .250 and .5 maximum of .021 diameter is held. Outside of these zones the lead diameter is not controlled. Leads may be inserted, without damage, in .031 holes while transistor enters .371 hole concentric with lead hole circle.

APPROX WEIGHT: .05 OZ
ALL DIMENSIONS IN INCHES



reliability-index

The Reliability-Index (RI_1) has been developed by General Electric to increase customer assurance of stable life performance. It is based on quality control information on each lot for normalized distribution and dispersion shift of the gain characteristic. A factor of 3.0 or greater for RI_1 indicates excellent extended life performance.

The Reliability-Index is obtained by:

1. Computing the percentage shift (+ or —) in the forward current gain of each unit during life test.
2. Determining the 10th, 50th and 90th percentiles in a distribution of the individual unit percent shifts.
3. Adding the magnitude of the 50th percentile to the magnitude of the algebraic difference between the 90th and 10th percentiles, and
4. Multiplying the reciprocal by 100.

expressed algebraically:

$$RI_1 = \frac{100}{\left|\alpha 50\right| + \left|\alpha 90 - \alpha 10\right|}$$

Where α_{50}, α_{90}, and α_{10} are the particular percentile values of a distribution of αi, and

$$\alpha i = \frac{h_{FE}\,F_i - h_{FE}\,I_i}{h_{FE}\,I_i}$$

Where $h_{FE}\,F_i$ is the final and $h_{FE}\,I_i$ the initial value of forward current gain of the ith transistor.

*All transistors are stabilized for at least 100 hours at 100°C minimum and are subjected to a 100% hermetic seal test insuring a maximum leak rate of 10^{-10} cc/sec.

2N1924,5,6 ELECTRICAL CHARACTERISTICS ($T_A = 25°C$)

TEST	CONDITIONS	SYMBOL	UNITS	2N1924 MIN.	2N1924 TYP.	2N1924 MAX.	2N1925 MIN.	2N1925 TYP.	2N1925 MAX.	2N1926 MIN.	2N1926 TYP.	2N1926 MAX.	AQL	INSP. LEVEL
DC Characteristics														
Subgroup I														
Collector to Base Voltage	$I_C = -200\ \mu a$	V_{CBO}	volts	— 60			— 60			— 60			1%	II
Collector to Emitter Voltage	$R_{BE} = 10K$ ohms, $I_C = -600\ \mu a$	V_{CER}	volts	— 40			— 40			— 40				
Collector to Emitter Voltage	$V_{BE} = +1.5v$, $R_{BE} = 10K$ ohms, $I_C = -50\ \mu a$	V_{CEX}	volts	— 50			— 50			— 50				
Reach-through Voltage		V_{RT}	volts	— 50			— 50			— 50				
Emitter Cutoff Current	$V_{EB} = -25v$	I_{EBO}	μa		— 3	— 10		— 3	— 10		— 3	— 10		
Subgroup II														
Collector Cutoff Current	$V_{CB} = -45v$	I_{CBO}	μa		— 4	— 10		— 4	— 10		— 4	— 10	0.65%	II
Forward Current Transfer Ratio	$I_C = -20ma$, $V_{CE} = -1v$ (Note 1)	h_{FE}		34(38)	50	(59)65	53(59)	70	(80)90	72(80)	95	(110)121		
Forward Current Transfer Ratio	$I_C = -100$ ma, $V_{CE} = -1v$	h_{FE}		30	45		47	60		65	80			
Subgroup III														
Base Input Voltage, Common Emitter	$I_C = -20$ ma, $V_{CE} = -1v$	V_{BE}	volts	—.200	—.235	—.300	—.190	—.230	—.290	—.180	—.225	—.280	1%	L6
Collector Saturation Voltage	$I_C = -20$ ma, I_B as shown	V_{CE} (SAT)	volts	—.050	—.080	—.110	—.055	—.085	—.110	—.060	—.090	—.110		
		@I_B	ma		—1.33			—1.00			—0.67			
Small Signal Characeristics														
Subgroup I														
AC Forward Current Transfer Ratio	$I_E = 1$ ma, $V_{CE} = -5v$, f = 1kc	h_{fe}		30	44	64	44	64	88	60	80	120	2.5%	L6
Input Impedance	$I_E = 1$ ma, $V_{CE} = -5v$, f = 1kc	h_{ie}	ohms	700	1400	2200	1200	2000	3200	1500	2500	4200		
Output Admittance	$I_E = 1$ ma, $V_{CE} = -5v$, f = 1kc	h_{oe}	μmhos	15	30	60	20	35	65	25	40	70		
Reverse Voltage Transfer Ratio	$I_E = 1$ ma, $V_{CE} = -5v$, f = 1kc	h_{re}	$x10^{-4}$	2.0	4.5	8.0	3.0	6.0	9.0	4.0	7.0	10.0		
Subgroup II														
Cutoff Frequency	$I_E = 1ma$, $V_{CB} = -5v$	f_{hfb}	mc	1.0	3.0		1.3	3.5		1.5	4.0			
Output Capacity	$I_E = 1$ ma, $V_{CB} = -5v$, f = 1mc	C_{ob}	pf		18	30		18	30		18	30		

Note 1: A minimum of 95% of the h_{FE} distribution is normally contained between values in parenthesis.

RELIABILITY SPECIFICATIONS

RELIABILITY SPECIFICATIONS

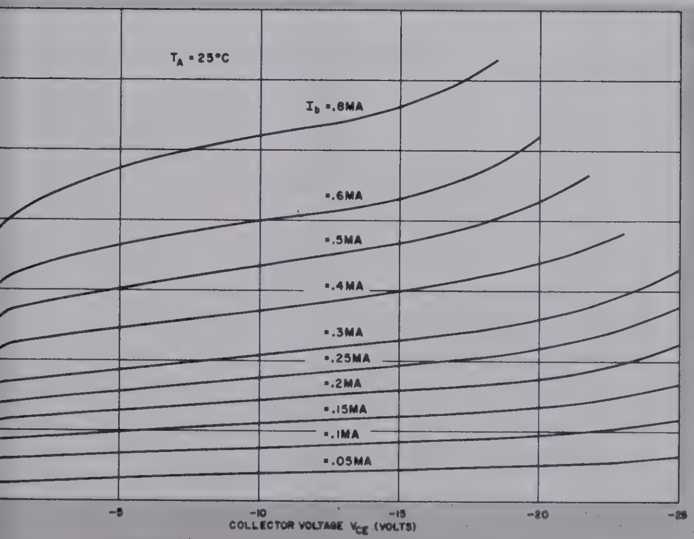
TEST	CONDITIONS	% AQL	SAMPLING LEVEL
Subgroup I	MIL-S-19500		
Physical Inspection		2.5	L5
Appearance		1.0	L8
Lead Solderability		1.0	L8
Subgroup II	MIL-S-19500	4.0	L5
Temperature Cycling	—65° to 100°C, 10 cycles		
Thermal Shock	0° to 85°C, 5 cycles		
Subgroup III	MIL-S-19500	4.0	L5
Shock, operating	1000 G, 5 blows each orientation of approx. 0.8 msec.		
Constant Acceleration	10,000 G		
Vibration Fatigue	10G		
Vibration, Variable Frequency	20G		
Subgroup IV	MIL-S-19500	4.0	L5
Lead Fatigue			

TEST	CONDITIONS	Symbol	Units	Min.	Max.
END POINTS (Subgroup II and III)					
Collector Cutoff Current	$V_{CB} = -30V$, $T_A = 25°C$	I_{CBO}	μa		—15
Forward Current Transfer Ratio	$I_C = -20$ ma, $V_{CE} = -1V$, $T_A = 25°C$				
2N1924		h_{FE}		30	71
2N1925		h_{FE}		48	100
2N1926		h_{FE}		65	133

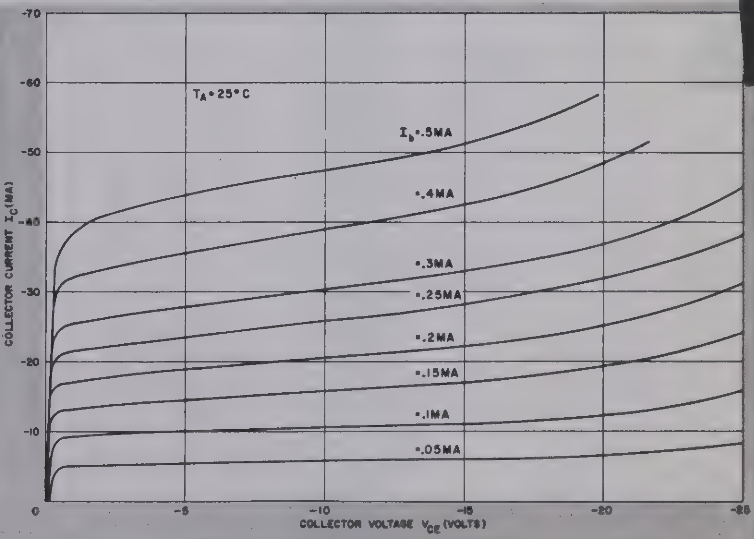
TEST	CONDITIONS	MAXIMUM FAILURE RATE, λ (in percent per 1000 hours with 90% confidence)
Subgroup V	MIL-S-19500 Method B	
Storage Life (1000 hours)	100° + 10°C, —0°C	5
Subgroup VI	MIL-S-19500 Method B	
Intermittent Power Life (1000 hours)	225 mw, $T_A = 25° \pm 4°C$ $V_{CB} = -22.5v$, $I_E = -10$ ma On 50±2 min, Off 10±2 min	5 (25°C End Points) 10 (—55°C and + 70°C End Points)

TEST	CONDITIONS	Symbol	Units	Min.	Typ.	Max.
END POINTS (Subgroup VI)						
Reliability-Index	Based on 25°C Forward Current Transfer Ratio, Subgroup VI	RI_1		3.33	12	
Collector Cutoff Current	$V_{CB} = -10v$, $T_A = +70° \pm 1°C$	I_{CBO}	μa		—80	—150
Forward Current Transfer Ratio	$I_C = -20$ ma, $V = -1v$, $T_A = -55° \pm 2°C$					
2N1924		h_{FE}		15	33	
2N1925		h_{FE}		24	46	
2N1926		h_{FE}		32	63	
END POINTS (Subgroup V and VI)						
Collector Cutoff Current	$V_{CB} = -30v$, $T_A = 25°C$	I_{CBO}	μa			—15
Forward Current Transfer Ratio	$I_C = -20$ ma, $V_{CE} = -1v$, $T_A = 25°C$					
2N1924		h_{FE}		30		71
2N1925		h_{FE}		48		100
2N1926		h_{FE}		65		133

COMMON EMITTER COLLECTOR CHARACTERISTICS



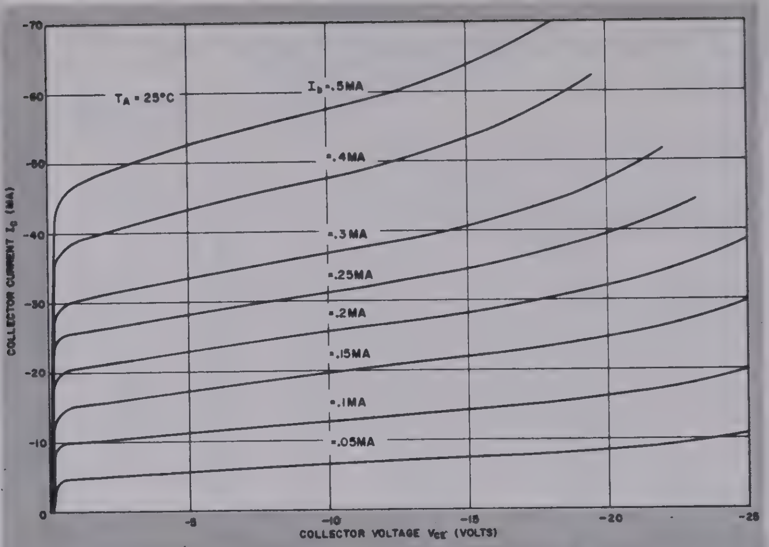
COMMON EMITTER COLLECTOR CHARACTERISTICS TYPE 2N1924



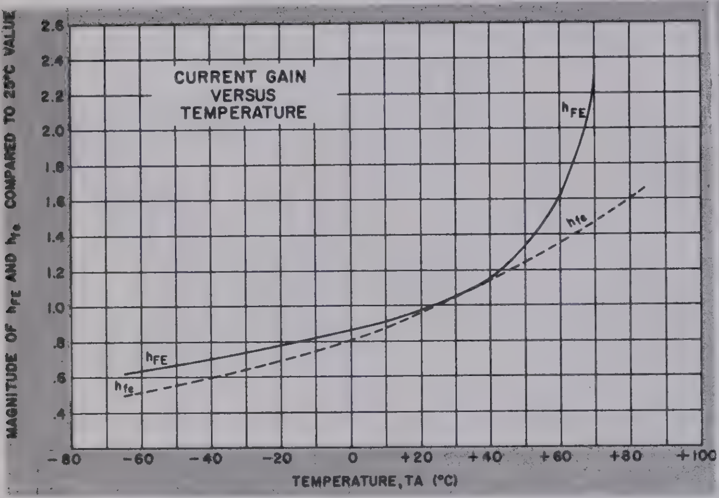
COMMON EMITTER COLLECTOR CHARACTERISTICS TYPE 2N1925

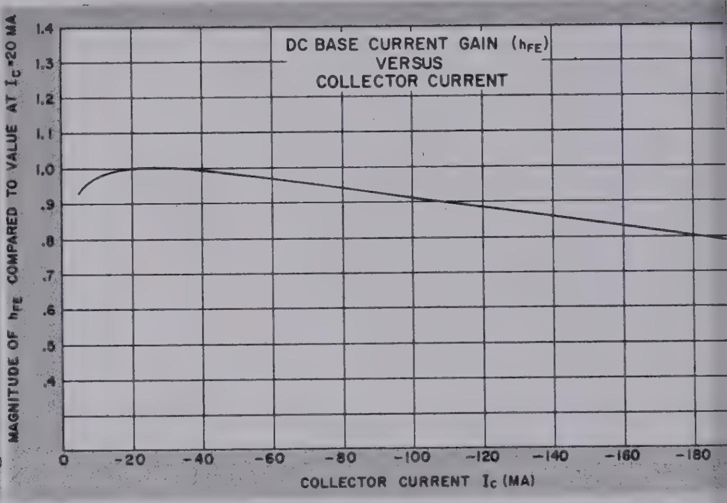
2N1924,5,6

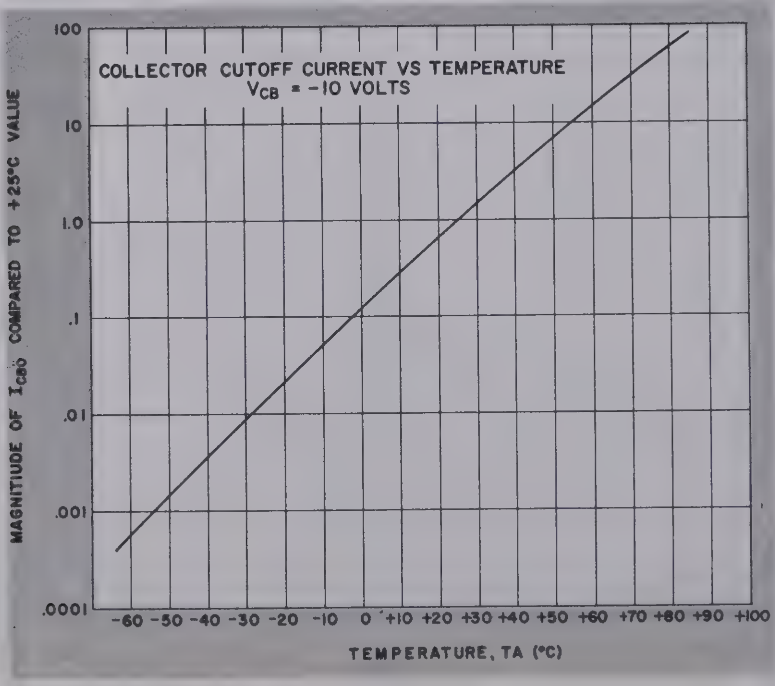
2N1926

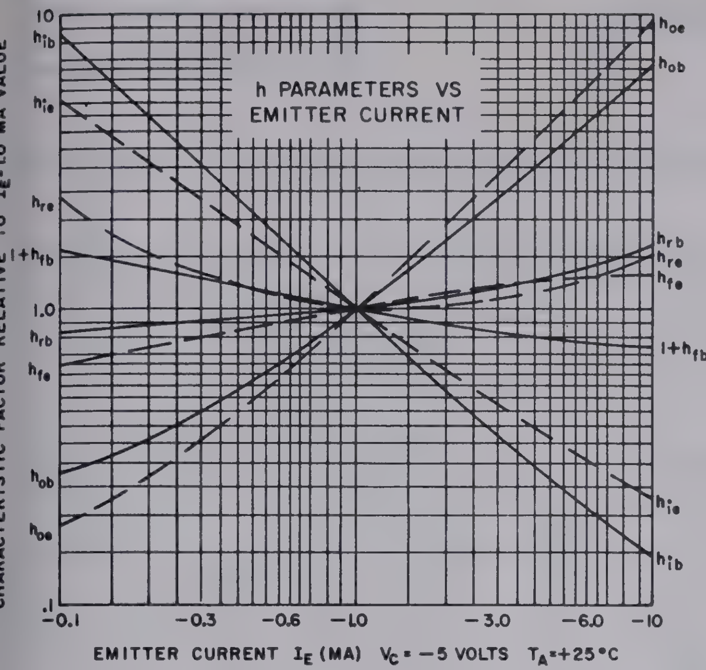


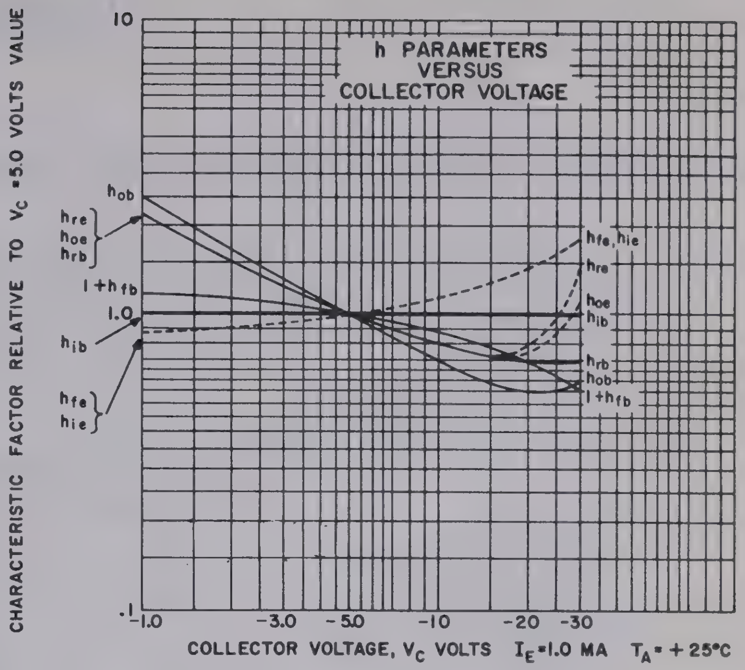
COMMON EMITTER COLLECTOR CHARACTERISTICS TYPE 2N1926

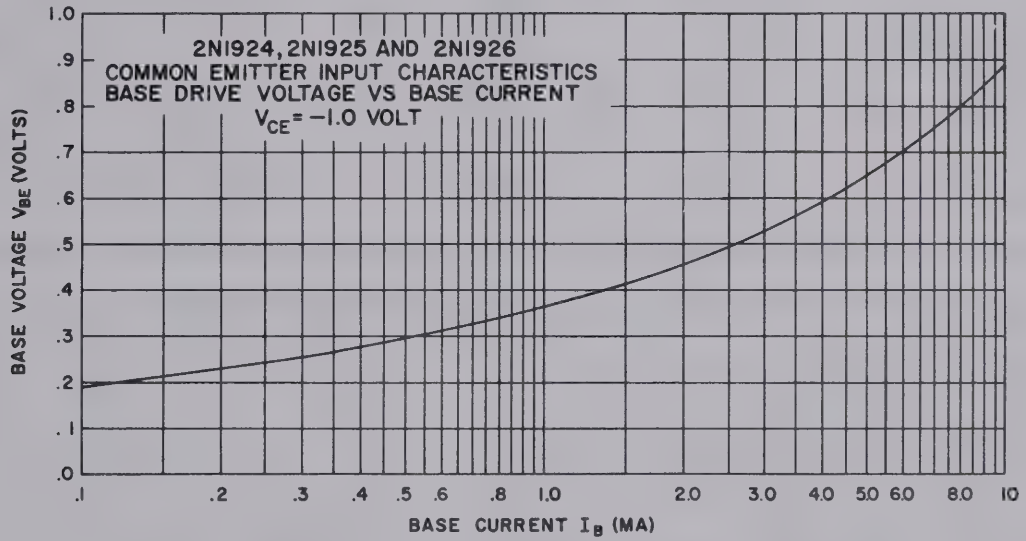

CURRENT GAIN VERSUS TEMPERATURE

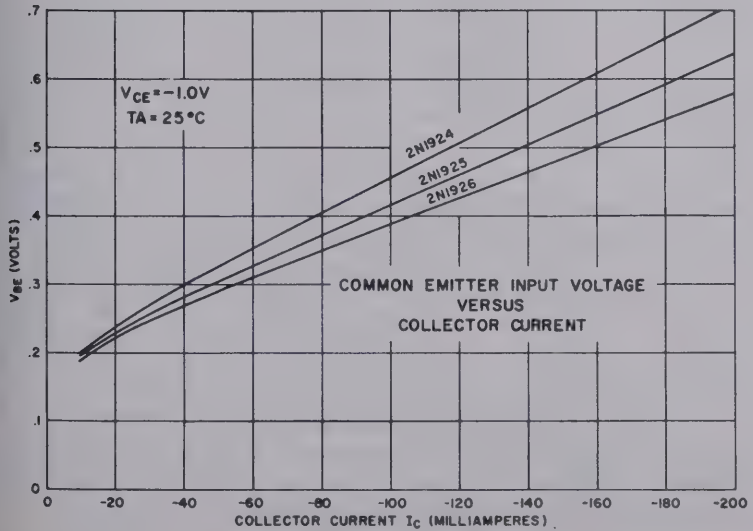

DC BASE CURRENT GAIN (h_{FE}) VERSUS COLLECTOR CURRENT

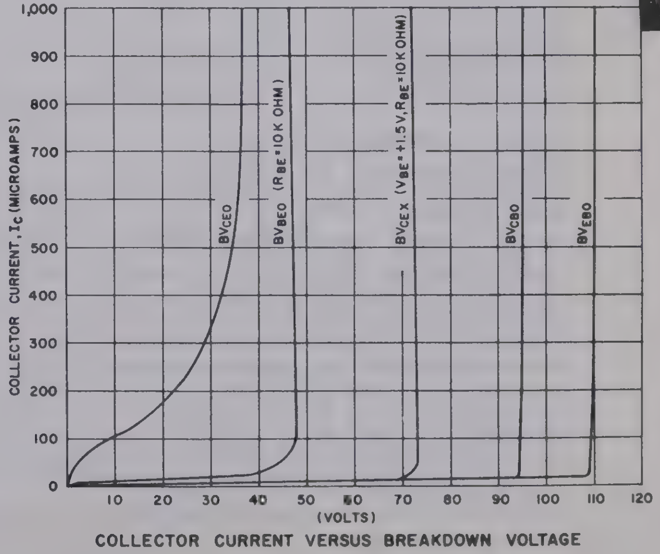

COLLECTOR CUTOFF CURRENT VS TEMPERATURE
$V_{CB} = -10$ VOLTS


h PARAMETERS VS
EMITTER CURRENT
CHARACTERISTIC FACTOR RELATIVE TO I_E=1.0 MA VALUE
10
1.0
.1
h_ib
h_ie
h_re
1+h_fb
h_rb
h_fe
h_ob
h_oe
h_oe
h_ob
h_rb
h_re
h_fe
1+h_fb
h_ie
h_ib
-0.1
-0.3
-0.6
-1.0
-3.0
-6.0
-10
EMITTER CURRENT I_E (MA) V_C = -5 VOLTS T_A=+25°C


h PARAMETERS
VERSUS
COLLECTOR VOLTAGE
CHARACTERISTIC FACTOR RELATIVE TO V_C =5.0 VOLTS VALUE
10
1.0
.1
h_ob
h_re
h_oe
h_rb
1+h_fb
h_ib
h_fe
h_ie
h_fe, h_ie
h_re
h_oe
h_ib
h_rb
h_ob
1+h_fb
-1.0
-3.0
-5.0
-10
-20
-30
COLLECTOR VOLTAGE, V_C VOLTS I_E=1.0 MA T_A= +25°C


2N1924, 2N1925 AND 2N1926
COMMON EMITTER INPUT CHARACTERISTICS
BASE DRIVE VOLTAGE VS BASE CURRENT
V_CE= -1.0 VOLT
BASE VOLTAGE V_BE (VOLTS)
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
.0
.1
.2
.3
.4
.5
.6
.8
1.0
2.0
3.0
4.0
5.0
6.0
8.0
10
BASE CURRENT I_B (MA)


V_CE=-1.0V
TA=25°C
2N1924
2N1925
2N1926
COMMON EMITTER INPUT VOLTAGE
VERSUS
COLLECTOR CURRENT
V_BE (VOLTS)
.7
.6
.5
.4
.3
.2
.1
0
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
COLLECTOR CURRENT I_C (MILLIAMPERES)

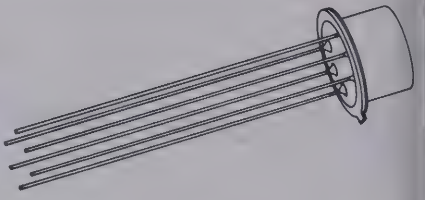

COLLECTOR CURRENT, I_C (MICROAMPS)
1,000
900
800
700
600
500
400
300
200
100
0
BV_CEO
BV_BEO (R_BE=10K OHM)
BV_CEX (V_BE=+1.5V, R_BE=10K OHM)
BV_CBO
BV_EBO
10
20
30
40
50
60
70
80
90
100
110
120
(VOLTS)
COLLECTOR CURRENT VERSUS BREAKDOWN VOLTAGE

Silicon Transistor

NPN

2N2060

The General Electric type 2N2060 is a NPN planar passivated 6-terminal device containing two completely isolated transistors assuring the optimum in hFE and VBE tracking and thermal impedance. These devices are particularly advantageous when used as a differential amplifier where matched VBE over temperature range is of prime importance.



absolute maximum ratings: (25°C)

		2N2060	
Package		TO-5	
Voltages			
Collector to Base	V_{CBO}	100	volts
Collector Base R = 10Ω	V_{CER}	80	volts
Collector to Emitter	V_{CEO}	40	volts
Emitter to Base	V_{EBO}	7	volts
Dissipation (Free air @ 25°C Amb.)			
Each Transistor	P_T	500	mw
Derate		2.86	mw/°C
Both Transistors	P_T	600	mw
Derate		3.43	mw/°C
Dissipation (Case Temp. @ 25°C)			
Each Transistor	P_T	1500	mw
Derate		8.6	mw/°C
Both Transistors	P_T	3000	mw
Derate		17.2	mw/°C
Temperatures			
Storage	T_{STG}	−65 to +200	°C
Operating Junction	T_J	200	

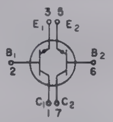
DIMENSIONS WITHIN
JEDEC OUTLINE TO-5
EXCEPT FOR
LEAD CONFIGURATION

NOTE 1: Lead diameter is controlled in the zone between .050 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

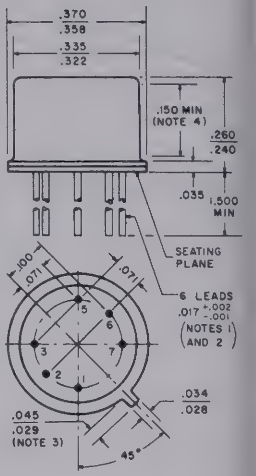
NOTE 2: Leads having maximum diameter (.019) measured in gaging plane .054 $^{+.001}_{-.000}$ below the seating plane of the device shall be within .007 of true position relative to a maximum width tab.

NOTE 3: Measured from max. diameter of the actual device.

NOTE 4: This zone is controlled for automatic handling. The variation in actual diameter within this zone shall not exceed .010.



ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED



electrical characteristics: each side (25°C) (unless otherwise specified)

	Sym.	Min.	Max.	Units
DC CHARACTERISTICS				
Collector Base Voltage ($I_C = 100\ \mu a$, $I_E = 0$)	V_{CBO}	100		volts
Collector Emitter Voltage ($I_C = 100$ ma, $R_{BE} = 10\Omega$)	V_{CER}*	80		volts
Collector Emitter Voltage ($I_C = 30$ ma, $I_B = 0$)	V_{CEO}	60		volts
Emitter Base Voltage ($I_E = 100\ \mu a$, $I_C = 0$)	V_{EBO}	7		volts
Forward Current Transfer Ratio ($I_C = .01$ ma, $V_{CE} = 5V$)	h_{FE}	25	75	
Forward Current Transfer Ratio ($I_C = 0.1$ ma, $V_{CE} = 5V$)	h_{FE}	30	90	
Forward Current Transfer Ratio ($I_C = 1.0$ ma, $V_{CE} = 5V$)	h_{FE}	40	120	
Forward Current Transfer Ratio ($I_C = 10$ ma, $V_{CE} = 5V$)	h_{FE}*	50	150	
DC Current Gain Ratio ($I_C = 0.1$ ma, $V_{CE} = 5V$)	h_{FE1}/h_{FE2}**	0.9	1.0	
DC Current Gain Ratio ($I_C = 1$ ma, $V_{CE} = 5V$)	h_{FE1}/h_{FE2}**	0.9	1.0	
Collector Saturation Voltage ($I_C = 50$ ma, $I_B = 5$ ma)	$V_{CE(SAT)}$		1.2	volts
Base Saturation Voltage ($I_C = 50$ ma, $I_B = 5$ ma)	$V_{BE(SAT)}$		0.9	volts
Base Voltage Differential ($I_C = 0.1$ ma, $V_{CE} = 5V$)	$\lvert V_{BE1}-V_{BE2}\rvert$		5	mv
Base Voltage Differential ($I_C = 1$ ma, $V_{CE} = 5V$)	$\lvert V_{BE1}-V_{BE2}\rvert$		5	mv
Voltage Differential Charge ($I_C = 0.1$ ma, $V_{CE} = 5V$, $T_A = -55$ to 125°C)	$\triangle\lvert V_{BE1}-V_{BE2}\rvert$		10	μV/°C
CUTOFF CHARACTERISTICS				
Collector Leakage Current ($V_{CB} = 80V$, $I_E = 0$)	I_{CBO}		2	mμa
Collector Leakage Current ($V_{CB} = 80V$, $I_E = 0$, $T_A = 150°C$)	I_{CBO}		10	μa
Emitter Leakage Current ($V_{EB} = 5V$, $I_C = 0$)	I_{EBO}		2	mμa
SMALL SIGNAL CHARACTERISTICS				
Current Transfer Ratio ($V_{CE} = 5V$, $I_C = 1$ ma, f = 1 kc)	h_{fe}	50	150	
Input Resistance ($V_{CB} = 5V$, $I_C = 1$ ma, f = 1 kc)	h_{ib}	20	30	ohms
Input Resistance ($V_{CE} = 5V$, $I_C = 1$ ma, f = 1 kc)	h_{ie}	1000	4000	ohms
Output Conductance ($V_{CE} = 5V$, $I_C = 1$ ma, f = 1 kc)	h_{oe}	4	16	μmho
HIGH FREQUENCY CHARACTERISTICS				
Current Transfer Ratio ($I_C = 50$ ma, $V_{CE} = 10V$, f = 20 mc)	h_{fe}			
Output Capacitance ($V_{CB} = 10V$, $I_E = 0$)	C_{ob}	3.0	15	pf
Input Capacitance ($V_{EB} = 0.5V$, $I_E = 0$)	C_{ib}		85	pf
Noise Figure ($I_C = 0.3$ ma, $V_{CE} = 10V$, f = 1 kc, Rg = 510 ohms, BW = 1 cps)	NF		10	db

* Pulse width ≤ 300 μsec. Duty cycle ≤ 2%.

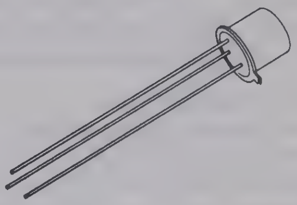
** Lowest of two h_{FE} readings is taken as h_{FE1} for purposes of this ratio.

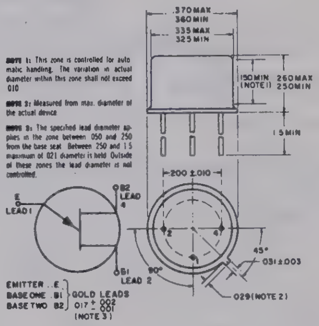
Silicon
Transistor

2N2160

The General Electric Silicon Unijunction Transistor is a three terminal device having a stable "N" type negative resistance characteristic over a wide temperature range. A stable peak point voltage, a low peak point current, and a high pulse current rating make this device useful in oscillators, timing circuits, trigger circuits and pulse generators where it can serve the purpose of two conventional silicon or germanium transistors.

The 2N2160 is intended for hobbyist applications where circuit economy is of primary importance. This transistor features Fixed-Bed Construction and is hermetically sealed in a welded case. All leads are electrically isolated from the case.




.370 MAX
.360 MIN
.335 MAX
.325 MIN
NOTE 1: This zone is controlled for automatic handling. The variation in actual diameter within this zone shall not exceed .010
NOTE 2: Measured from max. diameter of the actual device
NOTE 3: The specified lead diameter applies in the zone between .050 and .250 from the base seat. Between .250 and 1.5 maximum of .021 diameter is held. Outside of these zones the lead diameter is not controlled.
.150 MIN (NOTE 1)
.260 MAX
.250 MIN
1.5 MIN
.200 ±.010
E
LEAD 1
B2
LEAD 4
B1
LEAD 2
2
4
1
45°
.031±.003
90°
.029 (NOTE 2)
EMITTER ... E
BASE ONE ... B1
BASE TWO ... B2
GOLD LEADS
.017 + .002 − .001
(NOTE 3)

absolute maximum ratings: (25°C) (unless otherwise specified)

RMS Power Dissipation	450 mw[1]
RMS Emitter Current	50 ma
Peak Emitter Current	2 amperes
Emitter Reverse Voltage	30 volts
Interbase Voltage	35 volts
Operating Temperature Range	-65°C to +140°C
Storage Temperature Range	-65°C to +150°C

electrical characteristics: (25°C) (unless otherwise specified)

		Note	Min.	Max.	Units
Intrinsic Standoff Ratio ($V_{BB}=10V$)	N	2	0.47	0.80	
Interbase Resistance ($V_{BB}=3V$, $I_E=0$)	R_{BBO}	3	4.0	12.0	Kohms
Modulated Interbase Current ($V_{BB}=10V$, $I_E=50ma$)	$I_{B2(MOD)}$		6.8	30	ma
Emitter Reverse Current ($V_{B2E}=30V$, $I_{B1}=O$)	I_{EO}			12	ua
Peak Point Emitter Current ($V_{BB}=25V$)	I_P			25	ua
Valley Point Current ($V_{BB}=20V$, $R_{B2}=100$ ohms)	I_V		8		ma
Base-One Peak Pulse Voltage (See Circuit Shown)	V_{OB1}		3.0		volts

Notes:

(1) Derate 3.9 mw/°C increase in ambient temperature (Thermal Resistance to case = 0.16°C/mw).

(2) The intrinsic standoff ratio, η, is essentially constant with temperature and interbase voltage. is defined by the equation:

$$V_P = \eta V_{BB} + \frac{200}{T_j}$$

Where V_P = Peak point emitter voltage
V_{BB} = Interbase voltage
T_j = Junction Temperature (Degrees Kelvin)

(3) The interbase resistance is nearly ohmic and increases with temperature in a well-defined manner. The temperature coefficient at 25°C is approximately 0.8%/°C.

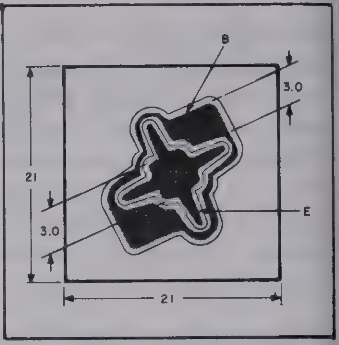
Silicon Transistor Chips

NPN

2N2219-22 (Chips)

(M23P-X504)

These General Electric NPN silicon planar passivated epitaxial transistor chips are designed primarily for high-speed switching, amplifier, and core driver applications. The chips feature excellent switching speeds and low collector saturation voltages up to the maximum current rating.



General specifications:
- Gold collector contact backing, minimum thickness—3000Å
- Aluminum base and emitter contact metalization
- Maximum conditions for mounting chips—425°C for 5 minutes (Max.) in an inert atmosphere
- Shipping containers: Glass vials sealed with a nitrogen back-fill
  Maximum of 10k chips per vial
  Egg crate containers available at extra cost
- Chip drawing dimensions are in mils
- Chip thickness = 6.8 $^{+0.7}_{-0.8}$ mils

absolute maximum ratings: ($T_A = 25°C$)

	Symbol		
Voltages			
Collector to Base	V_{CBO}	60	V
Collector to Emitter	V_{CEO}	30	V
Emitter to Base	V_{EBO}	5	V
Current			
Collector	I_C	0.8	A
Temperature			
Storage	T_{STG}	−65°C to +200°C	
Operating	T_J	−65°C to +200°C	

electrical characteristics: 100% Probe ($T_A = 25°C$)

Tested at outgoing acceptance to a 10% LTPD with a maximum accept number of 3.

	Symbol	Min.	Max.	
Collector Base Breakdown Voltage ($I_C = 0.1$ mA)	BV_{CBO}	60	—	V
Collector Emitter Breakdown Voltage ($I_C = 10$ mA)	BV_{CEO}	30	—	V
Emitter Base Breakdown Voltage ($I_E = 0.1$ mA)	BV_{EBO}	5	—	V
Collector Cutoff Current ($V_{CB} = 50V$)	I_{CBO}	—	50	nA
Forward Current Transfer Ratio ($I_C = 10$ mA, $V_{CE} = 10V$)	h_{FE}	75	—	
Forward Current Transfer Ratio ($I_C = 1$ mA, $V_{CE} = 10V$)	h_{FE}	50	—	

specifications: ($T_A = 25°C$)

Product yield is at least 93% to each of the following parameters:

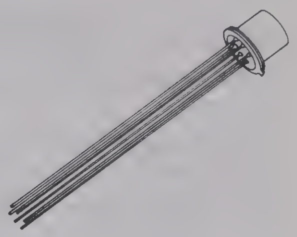
	Symbol	Min.	Max.	
***Forward Current Transfer Ratio** ($I_C = 500$ mA, $V_{CE} = 10V$ Pulsed)	h_{FE}	30	—	
***Collector Saturation Voltage** ($I_C = 500$ mA, $I_B = 50$ mA Pulsed)	$V_{CE(SAT)}$	—	1.6	V
***Base Saturation Voltage** ($I_C = 500$ mA, $I_B = 50$ mA Pulsed)	$V_{BE(SAT)}$	—	2.6	V
Collector-Base Capacitance ($V_{CB} = 10V$, f = 1 MHz)	C_{cb}	—	8	pF
Emitter-Base Capacitance ($V_{EB} = 0.5V$, f = 1 MHz)	C_{eb}	—	25	pF
Forward Current Transfer Ratio ($I_C = 20$ mA, $V_{CE} = 20V$, f = 100 MHz)	h_{fe}	2.5	—	

*Pulse conditions: pulse width ≤300 μsec, duty cycle ≤2%.

Silicon Transistors

2N2223,A

The General Electric types 2N2223 and 2N2223A are 6-terminal devices containing two completely isolated silicon planar transistors in a hermetically sealed package of TO-5 size. The 2N2223 is particularly advantageous when used as a differential amplifier where matched VBE over a temperature range is of prime importance.



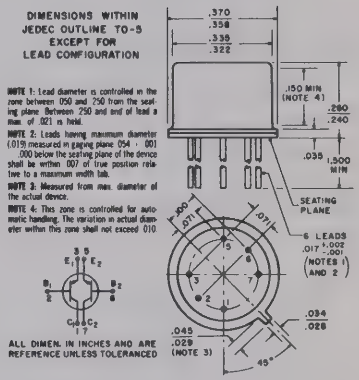
absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Base	V_{CBO}	100	volts
Collector to Emitter (R_{BE} =10 ohms)	V_{CER}	80	volts
Collector to Emitter	V_{CEO}	60	volts
Emitter to Base	V_{EBO}	7	volts
Temperatures			
Storage	T_{STG}	-65 to +300	°C
Operating Junction	T_J	-65 to +200	°C

Dissipation	**One Side Only**	**Both Sides**
Unit at 25°C Case Temperature (1)	1.6 w	3.0 w
Unit at 100°C Case Temperature (1)	.91 w	1.7 w
Unit in 25°C Ambient (2)	0.5 w	0.6 w

(1) Derate 9.1 mw/°C (one side only) and 17.2 mw/°C (both sides) for operation above 25°C case temp.

(2) Derate 2.86 mw/°C (one side only) and 3.43 mw/°C (both sides) for operation above 25°C ambient.


DIMENSIONS WITHIN JEDEC OUTLINE TO-5 EXCEPT FOR LEAD CONFIGURATION
.370
.358
.335
.322
.150 MIN (NOTE 4)
.260
.240
.035
1.500 MIN
SEATING PLANE
.100
.071
.071
6 LEADS .017 +.002 -.001 (NOTES 1 AND 2)
5
6
3
7
2
1
.034
.028
.045
.029 (NOTE 3)
45°
3 5
E1 E2
B1 2
B2 6
C1 C2
1 7
ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

NOTE 1: Lead diameter is controlled in the zone between .050 and .250 from the sealing plane. Between .250 and end of lead a max. of .021 is held.

NOTE 2: Leads having maximum diameter (.019) measured in gaging plane .054 + .001 .000 below the seating plane of the device shall be within .007 of true position relative to a maximum width tab.

NOTE 3: Measured from max. diameter of the actual device.

NOTE 4: This zone is controlled for automatic handling. The variation in actual diameter within this zone shall not exceed .010.

electrical characteristics: (25°C) (unless otherwise specified)

DC CHARACTERISTICS

Collector Base Voltage (I_C=100ua, I_E=0)	V_{CBO}	100		volts
Collector Emitter Voltage (I_C=100ma, R_{BE}=10)	V_{CER*}	80		volts
Collector Emitter Voltage (I_C=30ma, I_B=0)	V_{CEO}	60		volts
Emitter Base Voltage (I_E=100ua, I_C=0)	V_{EBO}	7		volts
Forward Current Transfer Ratio (I_C=0.01ma, V_{CE}=5V)	h_{FE}	15		
Forward Current Transfer Ratio (I_C=0.1ma, V_{CE}=5V)	h_{FE}	25		
Forward Current Transfer Ratio (I_C=10ma, V_{CE}=5V)	h_{FE*}	50		
DC Current Gain Ratio (I_C=0.1ma, V_{CE}=5V) (2N2223)	h_{FE1}/h_{FE2}	0.8	1.0	
DC Current Gain Ratio (I_C=0.1ma, V_{CE}=5V) (2N2223A)	h_{FE1}/h_{FE2}	0.9	1.0	
Collector Saturation Voltage (I_C=50ma, I_B=5ma)	$V_{CE(SAT)}$		1.2	volts
Base Saturation Voltage (I_C=50ma, I_B=5ma)	$V_{BE(SAT)}$		0.9	volts
Base Voltage Differential (I_C=0.1ma, V_{CE}=5V) (2N2223)	$V_{BE1}-V_{BE2}$		15	mv
Base Voltage Differential (I_C=0.1ma, V_{CE}=5V) (2N2223A)	$V_{BE1}-V_{BE2}$		5	mv
Voltage Differential Charge I_C=0.1ma, V_{CE}=5V, T_A=-55 to +125°C)	$\Delta\lvert V_{BE1}-V_{BE2}\rvert$		25	uv/°C

2N2223,A

electrical characteristics: (25°C)(cont.)

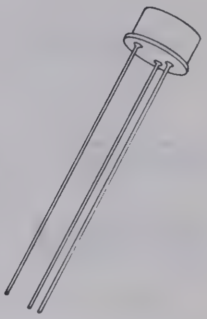
CUTOFF CHARACTERISTICS				
Collector Leakage Current (V_{CB} =80V, I_E =0)	I_{CBO}		10	mua
Collector Leakage Current (V_{CB} =80V, I_E =0, TA=150°C)	I_{CBO}		15	ua
Emitter Leakage Current (V_{EB} =5V, I_C =0)	I_{EBO}		10	mua
SMALL SIGNAL CHARACTERISTICS				
Current Transfer Ratio (V_{CE} =5V, I_C =1ma, f=1kc) (2N2223)	h_{fe}	40	200	
Current Transfer Ratio (V_{CE} =5V, I_C =1ma, f=1kc) (2N2223A)	h_{fe}	50	200	
Input Resistance (V_{CB} =5V, I_C =1ma, f=1kc)	h_{ib}	20	30	ohms
Output Conductance (V_{CB} =5V, I_C =1ma, f=1kc)	h_{ob}		0.5	umho
Voltage Feedback Ratio (V_{CB} =5V, I_C =1ma, f=1kc) (2N2223A)	h_{rb}		3	$X10_{-4}$
HIGH FREQUENCY CHARACTERISTICS				
Current Transfer Ratio (I_C =50ma, V_{CE} =10V, F=20mc)	h_{fe}	2.5		
Output Capacitance (V_{CB} =10V, I_E =0)	C_{ob}		15	pf
Input Capacitance (V_{EB} =0.5V, I_E =0)	C_{ib}		85	pf

*Pulse width 300 usec. Duty cycle 2%.

SCR

2N2344-48

The 2N2344 series of Silicon Controlled Rectifiers are reverse blocking thyristors for use in low power switching and control applications. This series features maximum gate sensitivity and high external gate-cathode shunting resistance. The specified blocking voltages are consistent with the Maximum Junction Temperature limit, permitting simple, straightforward circuit design.



- All welded construction
- Glass to metal seals
- Low holding current
- Extremely high gate sensitivity ($I_{GT} = 20\ \mu A$)
- Single-ended package ideal for printed circuit applications

maximum allowable ratings

Type	**Peak Forward Blocking Voltage, V_{FXM}† $T_J = -65°C$ to $+100°C$**	**Working and Repetitive Peak Reverse Voltage V_{ROM}(wkg) & V_{ROM}(rep) $T_J = -65°C$ to $+100°C$**	**Non-Repetitive Peak Reverse Voltage ($<$5 Millisec.), V_{ROM}(non-rep) $T_J = -65°C$ to $+100°C$**
2N2344	25 Volts*	25 Volts*	40 Volts*
2N2345	50 Volts*	50 Volts*	75 Volts*
2N2346	100 Volts*	100 Volts*	150 Volts*
2N2347	150 Volts*	150 Volts*	225 Volts*
2N2348	200 Volts*	200 Volts*	300 Volts*

†With 40,000 ohms or less connected from gate to cathode.

Peak Forward Voltage, PFV	300 Volts
RMS Forward Current	1.6 Amperes
Average Forward Current, On-state	Depends on conduction angle (see charts 3 and 4)
Peak One Cycle Surge Forward Current, non-repetitive, I_{FM} (surge)	15 Amperes*
Peak Gate Power, P_{GM}	0.1 Watt*
Average Gate Power, $P_{G(AV)}$	0.01 Watt*
Peak Gate Current, I_{GFM}	0.1 Ampere*
Peak Gate Voltage, Forward & Reverse, V_{GFM} & V_{GRM}	6 Volts*
Storage Temperature	−65°C to +150°C*
Operating Temperature	−65°C to +100°C*

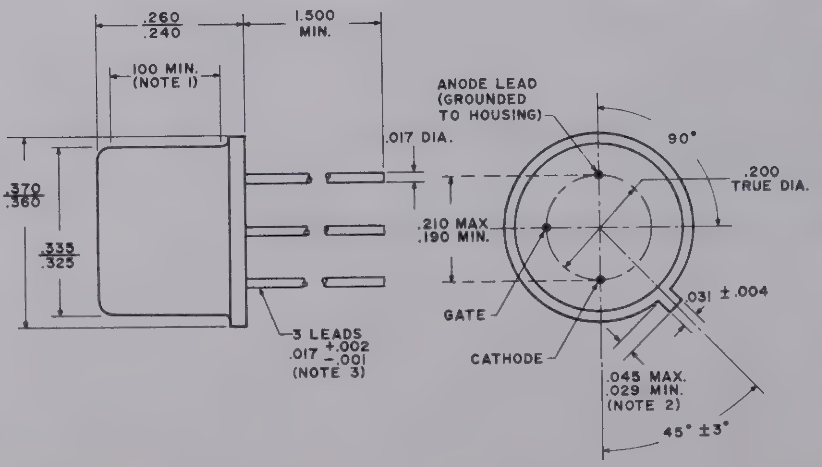
*Indicates data included on JEDEC type number registration.

characteristics

Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions
REVERSE BLOCKING CURRENT	I_{RX}	——	2.0	10	μA	V_{RX} = Rated V_{ROM}(rep), $T_J = +25°C$, R_{GK} = 40,000 ohms
		——	40	100*	μA	V_{RX} = Rated V_{ROM}(rep), $T_J = +100°C$, R_{GK} = 40,000 ohms
FORWARD BLOCKING CURRENT	I_{FX}	——	2.0	10	μA	V_{FX} = Rated V_{FXM}, $T_J = +25°C$, R_{GK} = 40,000 ohms
		——	40	100*	μA	V_{FX} = Rated V_{FXM}, $T_J = +100°C$, R_{GK} = 40,000 ohms
GATE TRIGGER CURRENT	I_{GT}	——	5	20	μAdc	$V_{FX} = +6$ Vdc, $T_J = +25°C$, R_L = 100 ohms max.
		——	——	75*	μAdc	$V_{FX} = +6$ Vdc, $T_J = -65°C$, R_L = 100 ohms max.
GATE SUPPLY TRIGGER CURRENT	I_{GS}	——	10	40	μAdc	$V_{FX} = +6$ Vdc, $T_J = +25°C$, R_L = 100 ohms max. R_{GK} = 40,000 ohms
GATE TRIGGER VOLTAGE	V_{GT}	0.35	0.5	0.8	Vdc	$V_{FX} = +6$ Vdc, $T_J = +25°C$, R_L = 100 ohms max.
		——	——	1.0*	Vdc	$V_{FX} = +6$ Vdc, $T_J = -65°C$, R_L = 100 ohms max.
PEAK ON-VOLTAGE	V_{FM}	——	1.6	2.0*	V	I_{FM} = 3.14 amps, $T_J = +25°C$, R_{GK} = 40,000 ohms
HOLDING CURRENT	I_{HX}	——	0.2	1.0*	mA	R_{GK} = 40,000 ohms, $T_J = 25°C$
TURN-ON TIME	$t_d + t_r$	——	1.4	——	μsec.	I_F = 1 amp, $T_J = 25°C$
DELAY TIME	t_d	——	0.6	——	μsec.	I_F = 1 amp, $T_J = 25°C$
RISE TIME	t_r	——	0.8	——	μsec.	I_F = 1 amp, $T_J = 25°C$
TURN-OFF TIME	t_o	——	20	——	μsec.	i_F = 1 amp, i_R = 1 amp dv/dt = 20v/μsec. R_{GK} = 100 ohms, $T_J = 100°C$ (See Application Notes)

*Includes data included on JEDEC type number registration.

OUTLINE DRAWING
(Conforms to JEDEC TO-5 Package Outline)

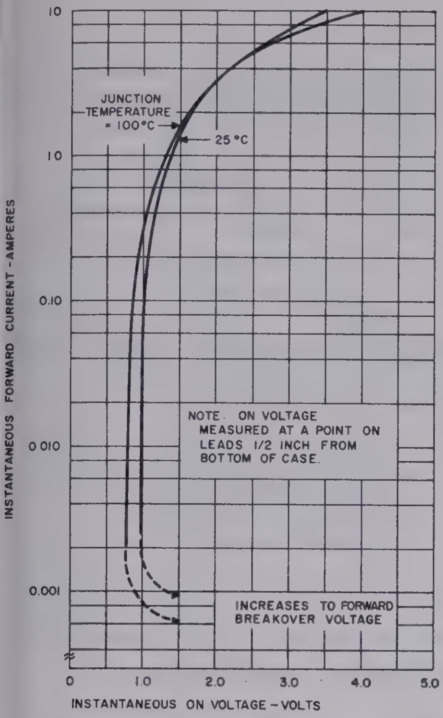

.260
.240
1.500
MIN.
100 MIN.
(NOTE 1)
.017 DIA.
ANODE LEAD
(GROUNDED
TO HOUSING)
90°
.200
TRUE DIA.
.370
.360
.335
.325
.210 MAX
.190 MIN.
GATE
CATHODE
.031 ±.004
3 LEADS
.017 +.002 −.001
(NOTE 3)
.045 MAX.
.029 MIN.
(NOTE 2)
45° ±3°

NOTE 1: THIS ZONE IS CONTROLLED FOR AUTOMATIC HANDLING. THE VARIATION IN ACTUAL DIAMETER WITHIN THIS ZONE SHALL NOT EXCEED .010.

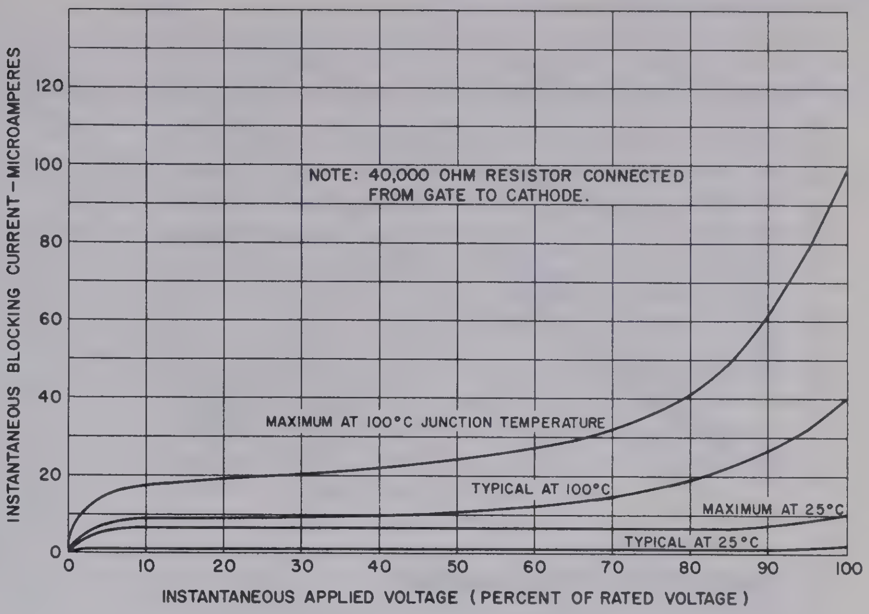
NOTE 2: MEASURED FROM MAX. DIAMETER OF THE ACTUAL DEVICE.

NOTE 3: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN .050 AND .250 FROM THE BASE SEAT. BETWEEN .250 AND 1.5 MAXIMUM OF .021 DIAMETER IS HELD. OUTSIDE OF THESE ZONES THE LEAD DIAMETER IS NOT CONTROLLED. LEADS MAY BE INSERTED, WITHOUT DAMAGE, IN .031 HOLES WHILE DEVICE ENTERS .371 HOLE CONCENTRIC WITH LEAD HOLE CIRCLE.

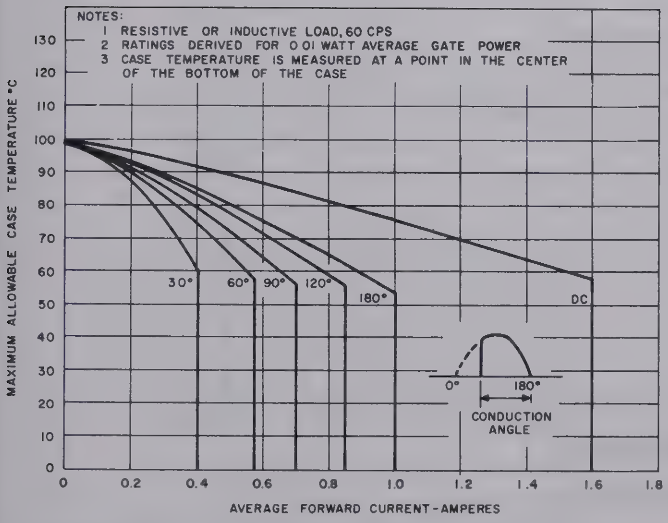
APROX WEIGHT: .05 OZ
ALL DIMENSIONS IN INCHES



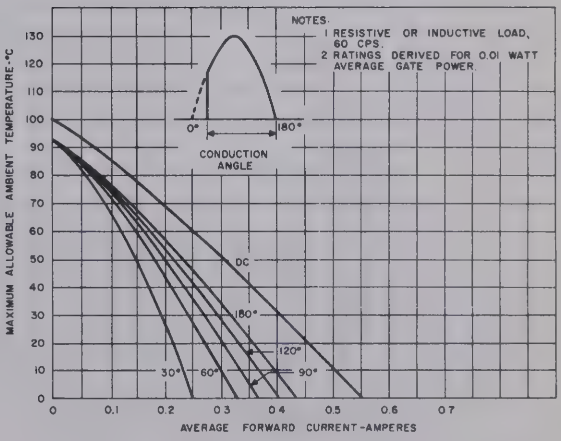
1. **MAXIMUM FORWARD CHARACTERISTICS CONDUCTING STATE**



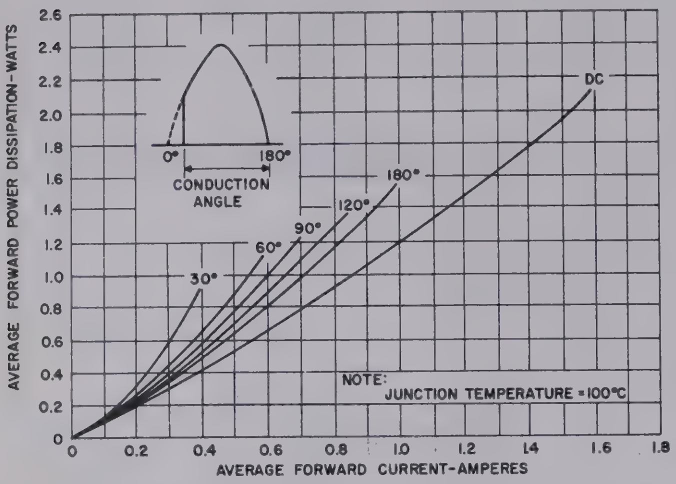
2. **TYPICAL AND MAXIMUM FORWARD AND REVERSE BLOCKING CHARACTERISTICS**



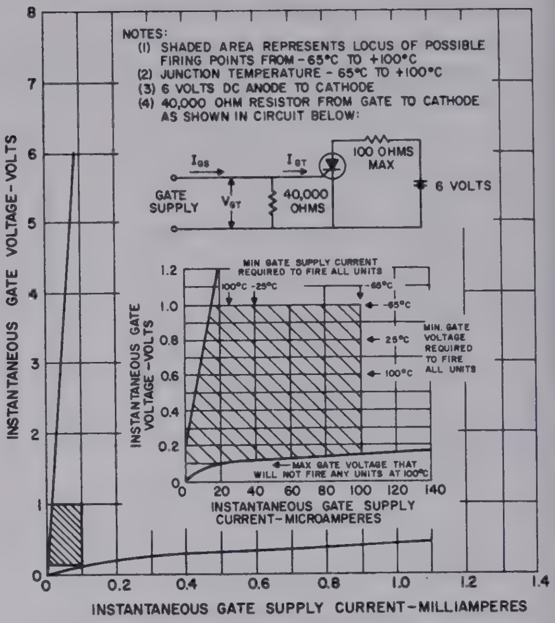
3. **MAXIMUM ALLOWABLE CASE TEMPERATURE**



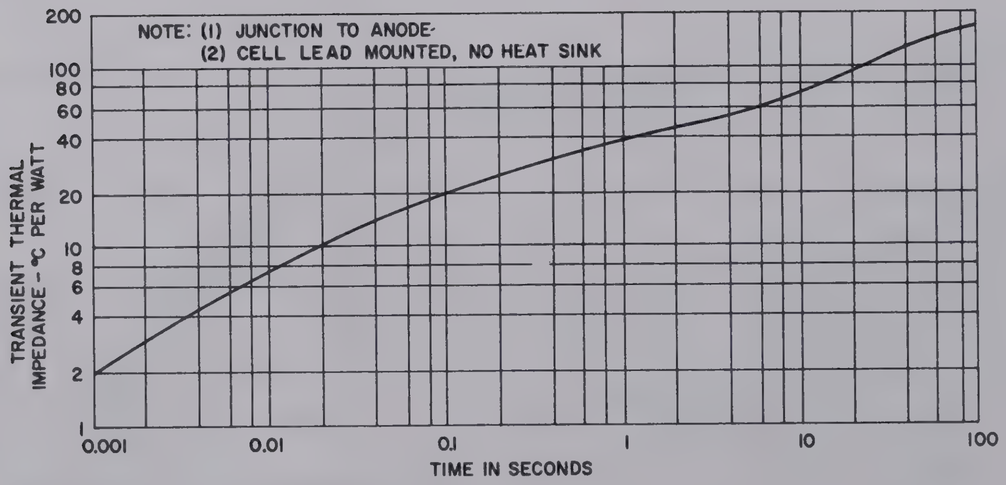
4. **MAXIMUM ALLOWABLE AMBIENT TEMPERATURE**



5. FORWARD POWER DISSIPATION



6. GATE TRIGGERING CHARACTERISTICS



7. MAXIMUM TRANSIENT THERMAL IMPEDANCE

Silicon Differential Amplifier

NPN

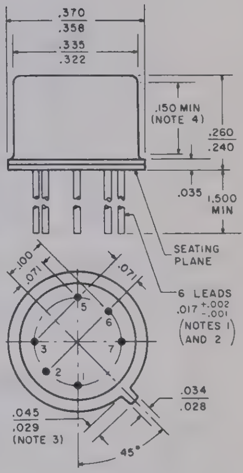
2N2453,A

The General Electric types 2N2453, 2N2453A, are NPN planar passivated Differential Amplifiers in TO-5 packages. The 2N2453A is a selected version of the 2N2453. This family of devices is particularly useful for high gain applications requiring h_{FE} matches of ± 10% at extremely low collector currents.

absolute maximum ratings: (25°C) (unless otherwise specified)

		(TO-5) 2N2453	(TO-5) 2N2453A	
Voltages				
Collector to Base	V_{CBO}	60	80	v
Collector to Emitter	V_{CEBO}	30	50	v
Emitter to Base	V_{EBO}	7	7	v
Current				
Collector	I_C	50 max		ma
Dissipation				
Free Air @ 25° C	P_T			
Each Transistor		300	300	mw
Derate		1.72	1.72	mw/°C
Both Transistors		600	600	mw/
Derate		3.43	3.43	mw/°C
Case Temperature at 25°C	P_T			
Each Transistor		1000	1000	mw
Derate		5.72	5.72	mw°C
Both Transistors		2000	2000	mw—
Derate		10.4	10.4	mw/°C
Temperature				
Storage	T_{STG}	-65 to + 300		°C
Operating	T_J	-65 to +200		°C

DIMENSIONS WITHIN
JEDEC OUTLINE TO-5
EXCEPT FOR
LEAD CONFIGURATION

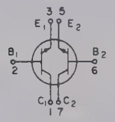


NOTE 1: Lead diameter is controlled in the zone between .050 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

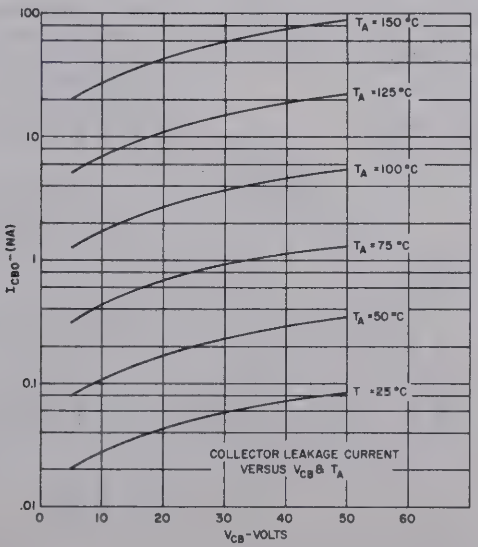
NOTE 2: Leads having maximum diameter (.019) measured in gaging plane .054 $^{+.001}_{-.000}$ below the seating plane of the device shall be within .007 of true position relative to a maximum width tab.

NOTE 3: Measured from max diameter of the actual device.

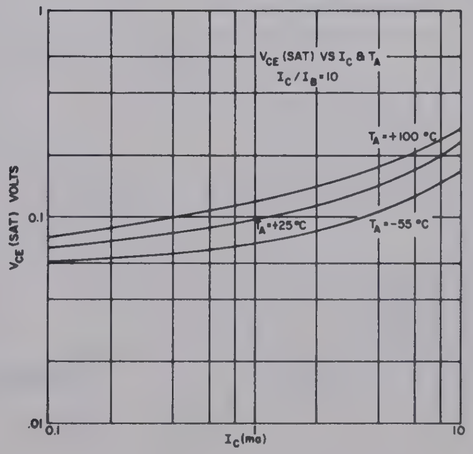
NOTE 4: This zone is controlled for automatic handling. The variation in actual diameter within this zone shall not exceed .010



ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED



COLLECTOR LEAKAGE CURRENT VERSUS V_{CB} & T_A



V_{CE} (SAT) VS I_C & T_A
I_C/I_B = 10

electrical characteristics: (25°C) (unless otherwise specified)

DC CHARACTERISTICS

			Min.	Max.	
Collector Base Voltage (I_C=10ua)		BV_{CBO}	60		volts
Collector Base Voltage (I_C=10ua)	(2N2453A)	BV_{CBO}	80		volts
Collector Emitter Voltage (I_C=10ma)*		BV_{CEO}	30		volts
Collector Emitter Voltage (I_C=10 ma)*	(2N2453A)	BV_{CEO}	50		volts
Emitter Base Voltage (IE=100 ua)		BV_{EBO}	7		volts
Collector Leakage Current (V_{CB} =50V)		ICBO		5	n amp
Collector Leakage Current (V_{CB} =60V)	(2N2453A)	ICBO		5	n amp
Collector Leakage Current (V_{CB} =50V) 150°C		ICBO		10	u amp
Collector Leakage Current (V_{CB} =60V, 150°C)	(2N2453A)	I_{CEO}		10	u amp
Emitter Leakage Current (V_{EB} =5V)		I_{EBO}		2	n amp
Collector Saturation Voltage (I_C=5 ma, I_B=0.5 ma)		$V_{CE(SAT)}$		1.0	volts
Base Saturation Voltage (I_C=5 ma, (I_B=0.5 ma)		$V_{BE(SAT)}$		0.9	volts
Forward Current Transfer Ratio (V_{CE} =5V, I_C=10 ua)		h_{FE}	80		
Forward Current Transfer Ratio (V_{CE} =5V, I_C=1 ma)		h_{FE}	150	600	
Forward Current Transfer Ratio (V_{CE} =5V, I_C=10 ua, -55°C)		h_{FE}	40		
Forward Current Transfer Ratio (V_{CE} =5V, I_C=1 ma, -55°C)		h_{FE}	75		

MATCHING CHARACTERISTICS

		Min.	Max.	
DC Beta Match (V_{CE} =5V, I_C=100 ua)	$\frac{h_{FE1}{**}}{h_{FE2}}$	.9	1.0	
DC Beta Match (V_{CE} =5V, I_C=1 ma)	$\frac{h_{FE1}}{h_{FE2}{**}}$	.9	1.0	
DC Beta Match (V_{CE} =5V, I_C=1 ma, TA=-5 to + 125*C)	$\frac{h_{FE1}}{h_{FE2}}$	.85	1.0	
Voltage Differential (V_{CE} =5V, I_C=10 ua)	$V_{BE1}-V_{BE2}$		3	mv
Voltage Differential (V_{CE} =5V, I_C=1 ma)	$V_{BE1}-V_{BE2}$		5	mv
Voltage Differential Gradient (V_{CE} =5V, I_C=0.1 ma, T_A=-55 to + 125°C)	$\Delta\left\lvert\frac{V_{BE1}-V_{BE2}}{\Delta T}\right\rvert$		10	uv/°C
Voltage Differential Gradient (VCE=5V, I_C=10 ua, T_A=-55 to + 125°C)	$\Delta\left\lvert\frac{V_{BE1}-V_{BE2}}{\Delta T}\right\rvert$		5	uv/°C

High Frequency Characteristics

			Min.	Max.	
Current Transfer Ratio (V_{CE} =30V, IC=10 ma, f=30 mc)		h_{fe}	2		
Collector Capacitance (V_{CB} =10V, f=1 kc)		C_{ob}		8	pf
Noise Figure (I_C=10 ua, V_{CE} =50V, f=1 kc, bandwidth = 200 CPS)		N.F.		7	db
Noise Figure (I_C=10 ua, V_{CE} =50 V, f=1 kc, bandwidth = 200 CPS)	(2N2453A)	N.F.		4	db

* Pulse width = 300 usec, Duty Cycle = 2%

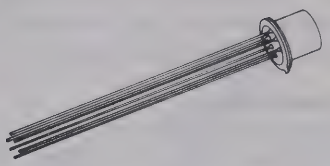
** Lowest of two h_{FE} readings is taken as h_{FE1} for purpose of this ratio.

Silicon
Transistors

NPN

2N2480,A

The General Electric types 2N2480, 2N2480A are NPN planar passivated 6-terminal devices containing two completely isolated transistors in TO-5 packages. These devices are particularly advantageous when used as a differential amplifier where matched V_{BE} over temperature range is of prime importance.



absolute maximum ratings: (25°C)

		2N2480	2N2480A	
Package		TO-5	TO-5	
Voltages				
Collector to Base	V_{CBO}	75	80	volts
Collector to Emitter	V_{CEO}	40	40	volts
Emitter to Base	V_{EBO}	5	5	volts
Dissipation (Free air @ 25°C Amb.)				
Each Transistor	P_T	300	300	mw
Derate		1.72	1.72	mw/°C
Both Transistors	P_T	600	600	mw
Derate		3.43	3.43	mw/°C
Dissipation (Case Temp. @ 25°C)				
Each Transistor	P_T	1000	1000	mw
Derate		5.72	5.72	mw/°C
Both Transistors	P_T	1500	1500	mw
Derate		8.56	8.56	mw/°C
Temperatures				
Storage	T_{STG}	−65 to +200		°C
Operating Junction	T_J	200	200	°C

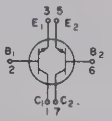
DIMENSIONS WITHIN
JEDEC OUTLINE TO-5
EXCEPT FOR
LEAD CONFIGURATION

NOTE 1: Lead diameter is controlled in the zone between .050 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

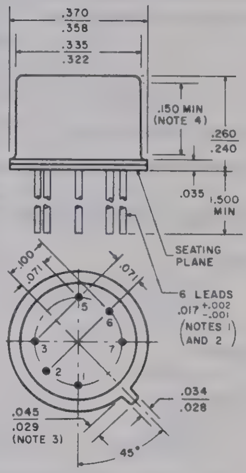
NOTE 2: Leads having maximum diameter (.019) measured in gaging plane .054 + .001 .000 below the seating plane of the device shall be within .007 of true position relative to a maximum width tab

NOTE 3: Measured from max. diameter of the actual device.

NOTE 4: This zone is controlled for automatic handling. The variation in actual diameter within this zone shall not exceed .010.



ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED



electrical characteristics: (25°C) (unless otherwise specified)

		2N2480			2N2480A		
		Min.	Typ.	Max.	Min.	Max.	
DC CHARACTERISTICS							
Collector Base Voltage ($I_C = 100\ \mu a$)	V_{CBO}	75			80		volts
Collector to Emitter Voltage ($I_C = 20$ ma)	V_{CEO}†	40			40		volts
Collector Leakage Current ($V_{CB} = 60V$)	I_{CBO}			50		20	mμa
Collector Leakage Current ($V_{CB} = 30V$, $T_A = 150°C$)	I_{CBO}			15		15	μa
Emitter Base Leakage Current ($V_{EB} = 5V$)	I_{EBO}			50		20	mμa
Forward Current Transfer Ratio ($I_C = 1$ ma, $V_{CE} = 5V$)	h_{FE}	30			50	200	
Forward Current Transfer Ratio ($I_C = 100\ \mu a$, $V_{CE} = 5V$)	h_{FE}	20			35		
Collector Saturation Voltage ($I_C = 50$ ma, $I_B = 5$ ma)	$V_{CE(SAT)}$			2.5		1.2	volts
Base Saturation Voltage ($I_C = 50$ ma, $I_B = 5$ ma)	$V_{BE(SAT)}$					0.9	volts
MATCHING CHARACTERISTICS							
‡**DC Beta Ratio** ($V_{CE} = 5V$) ($I_C = 100\ \mu a$)	$\frac{h_{FE1}}{h_{FE2}}$	0.8		1.0	0.8	1.0	
‡**DC Beta Ratio** ($V_{CE} = 5V$) ($I_C = 1$ ma)	$\frac{h_{FE1}}{h_{FE2}}$	0.8		1.0	0.8	1.0	
Voltage Differential ($V_{CE} = 5V$, $I_C = 100\ \mu a$)	$\lvert V_{BE1} - V_{BE2}\rvert$			10		5	mv
Voltage Differential ($V_{CE} = 5V$, $I_C = 1$ ma)	$\lvert V_{BE1} - V_{BE2}\rvert$			10		5	mv
Voltage Differential Gradient ($I_C = 100\ \mu a$, $V_{CE} = 5V$, $T_A = -55$ to 125°C)	$\frac{\Delta(\lvert V_{BE1} - V_{BE2}\rvert)}{\Delta T}$			15		15	μV/°C
SMALL SIGNAL CHARACTERISTICS							
Input Impedance ($I_C = 1$ ma, $V_{CB} = 5V$, f = 1 kc)	h_{ib}		28		20	35	ohms
Input Impedance ($I_C = 1$ ma, $V_{CE} = 5V$, f = 1 kc)	h_{ie}		2500		1000	5000	ohms
Output Admittance ($I_C = 1$ ma, $V_{CE} = 5V$, f = 1 kc)	h_{oe}		20		4	16	μmhos
Current Transfer Ratio ($I_C = 1$ ma, $V_{CE} = 5V$, f = 1 kc)	h_{fe}	40	75		50	300	
HIGH FREQUENCY CHARACTERISTICS							
Collector Capacity ($V_{CB} = 10V$, $I_E = 0$, f = 1 mc)	C_{ob}			20		18	μμf
Current Transfer Ratio ($I_C = 50$ ma, $V_{CE} = 10V$, f = 20 mc)	h_{fe}	2.5			2.5		
Noise Figure ($I_C = .3$ ma, $V_{CE} = 10V$, f = 1 kc, $R_G = 510\Omega$, B.W. = 1 cps)	NF			8		8	db

†Pulse width ≤ 300 μsec. Duty Cycle ≤ 2%.

‡Lowest of two h_{FE} readings is taken as h_{FE1} for purposes of this ratio.

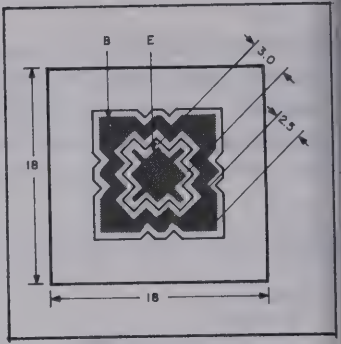
Silicon
Transistor Chips

NPN

2N2484 (Chip)

(M26P-X504)

This General Electric NPN silicon planar passivated epitaxial transistor chip is designed primarily for low-level, high gain preamplifier use in hybrid and microminiature circuit applications.



General specifications:
- Gold collector contact backing, minimum thickness—3000Å
- Aluminum base and emitter contact metalization
- Maximum conditions for mounting chips—425°C for 5 minutes (Max.) in an inert atmosphere
- Shipping containers: Glass vials sealed with a nitrogen back-fill
  Maximum of 10k chips per vial
  Egg crate containers available at extra cost
- Chip drawing dimensions are in mils
- Chip thickness = 5.4 $^{+0.8}_{-0.9}$ mils

absolute maximum ratings: ($T_A = 25°C$)

	Symbol		
Voltages			
Collector to Base	V_{CBO}	60	V
Collector to Emitter	V_{CEO}	60	V
Emitter to Base	V_{EBO}	6	V
Current			
Collector	I_C	50	m
Temperature			
Storage	T_{STG}	−65°C to +200°C	
Operating	T_J	−65°C to +200°C	

electrical characteristics: 100% Probe ($T_A = 25°C$)

Tested at outgoing acceptance to a 10% LTPD with a maximum accept number of 3.

	Symbol	Min.	Max.	
Collector Base Breakdown Voltage ($I_C = 10\ \mu A$)	BV_{CBO}	60	—	V
Collector Emitter Breakdown Voltage ($I_C = 10$ mA)	BV_{CEO}	60	—	V
Emitter Base Breakdown Voltage ($I_E = 10\ \mu A$)	BV_{EBO}	6	—	V
Collector Cutoff Current ($V_{CB} = 55V$)	I_{CBO}	—	50	nA
Forward Current Transfer Ratio ($I_C = 100\ \mu A$, $V_{CE} = 5V$)	h_{FE}	175	—	

specifications: ($T_A = 25°C$)

Product yield is at least 93% to each of the following parameters:

	Symbol	Min.	Max.	
Forward Current Transfer Ratio	h_{FE}			
($I_C = 1$ mA, $V_{CE} = 5V$)		250	—	
($I_C = 10$ mA, $V_{CE} = 5V$)		—	800	
Collector Saturation Voltage ($I_C = 1$ mA, $I_B = 0.1$ mA)	$V_{CE(SAT)}$	—	0.35	V
Base Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)	$V_{BE(SAT)}$	—	0.78	V
Gain Bandwidth Product ($V_{CE} = 5V$, $I_C = 500\ \mu A$, f = 30 MHz)	f_t	60	—	MH
Collector Base Capacitance ($V_{CB} = 5V$, f = 1 MHz)	C_{cb}	—	6	pF
Noise Figure ($V_{CE} = 5V$, $I_C = 10\ \mu A$, Rs = 10 kΩ, BW = 15.7 kHz, f = 10 Hz to 10 kHz)	N_F	—	3	db

Silicon
Transistors

NPN

2N2639-44

DIFFERENTIAL AMPLIFIER

The General Electric types 2N2639-44 are 6-terminal devices containing two completely isolated NPN passivated planar transistors.
These devices are designed for use in high performance amplifiers and differential amplifier circuits requiring high gain and low noise at low current.

2N2639-44

absolute maximum ratings: (25°C)

		2N2639-44	
Voltages—Each Transistor			
Collector to Base	V_{CBO}	45	volts
Collector to Emitter	V_{CEO}	45	volts
Emitter to Base	V_{EBO}	5	volts
Current—Each Transistor			
Collector	I_C	30	mA
Temperatures			
Storage	T_{STG}	−65°C to +200°C	
Operating Junction	T_J	175	°C
Lead (soldering, 60 sec. time limit)		300	°C

Dissipation

		One Side	Both Sides	
Total at 25°C Case	P_T	.60	1.2	watts
Derate—Each Transistor		4	4	mW/°C
Total at 25°C Ambient	P_T	0.3	0.6	watts
Derate—Each Transistor		2	2	mW/°C

electrical characteristics: (25°C Free Air) (Unless otherwise specified)

DC CHARACTERISTICS

		2N2639 2N2640 2N2641		2N2642 2N2643 2N2644		
DC Current Gain		Min.	Max.	Min.	Max.	
($V_{CE} = 5V, I_C = 1.0$ mA)	h_{FE}	65		130		
($V_{CE} = 5V, I_C = 100\ \mu A$)	h_{FE}	55		110		
($V_{CE} = 5V, I_C = 10\ \mu A$)	h_{FE}	50	300	100	300	
($V_{CE} = 5V, I_C = 10\ \mu A, T_A = -55°C$)	h_{FE}	10		20		
Collector—Base Breakdown Voltage						
($I_C = 10\ \mu A, I_E = 0$)	BV_{CBO}	45		45		volts
Collector—Emitter Breakdown Voltage						
($I_C = 10$ mA, $I_B = 0$, Note 1)	BV_{CEO}	45		45		volts
Emitter—Base Breakdown Voltage						
($I_C = 0, I_E = 0$)	BV_{EBO}	5		5		volts
Collector Cutoff Current						
($I_E = 0, V_{CB} = 45V$)	I_{CBO}		10		10	nA
($I_E = 0, V_{CB} = 45V, T_A = 150°C$)	I_{CBO}		10		10	μA
Collector Cutoff Current						
($I_B = 0, V_{CE} = 5V$)	I_{CEO}		10		10	nA
Emitter Cutoff Current						
($I_C = 0, V_{EB} = 5V$)	I_{EBO}		10		10	nA

electrical characteristics: (cont.)

SMALL SIGNAL CHARACTERISTICS

		2N2639 2N2640 2N2641		2N2642 2N2643 2N2644	
		Min.	Max.	Min.	Max.
Collector Saturation Voltage ($I_C = 10$ mA, $I_B = 0.5$ mA)	$V_{CE(SAT)}$		1.0		1.0
Base—Emitter Voltage ($I_C = 10$ mA, $V_{CE} = 5$V)	V_{BE}	.6	1.0	.6	1.0
Input Resistance ($I_C = 1.0$ mA, $V_{CB} = 5$V, f = 1 kHz)	h_{ib}	25	32	25	32
Output Conductance ($I_C = 1.0$ mA, $V_{CB} = 5$V, f = 1 kHz)	h_{ob}		1.0		1.0
Input Impedance ($I_C = 1$ mA, $V_{CE} = 5$V, f = 1 kHz)	h_{ie}				
Current Transfer Ratio ($I_C = 1$ mA, $V_{CE} = 5$V, f = 1 kHz)	h_{fe}				
Output Admittance ($I_C = 1$ mA, $V_{CE} = 5$V, f = 1 kHz)	h_{oe}				

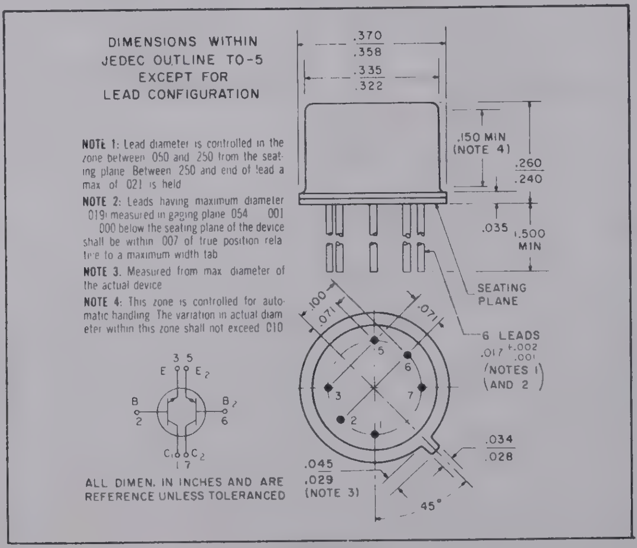
HIGH FREQUENCY CHARACTERISTICS

		Min.	Max.	Min.	Max.
Output Capacitance ($I_E = 0$, $V_{CB} = 5$V, f = 1 MHz)	C_{ob}		8		8
High Frequency Current Gain ($I_C = 1$ mA, $V_{CE} = 5$V, f = 20 MHz)	$\lvert h_{FE}\rvert$	4		4	
Wide Band Noise Figure ($I_C = 10\ \mu$A, $V_{CE} = 5$V, $R_G = 10$ kΩ, Note 2)	NF		4.0		4.0

MATCHING CHARACTERISTICS: (25°C Free Air) (Unless otherwise specified)

		2N2639 2N2642		2N2640 2N2643	
DC Current Gain Ratio ($I_C = 10\ \mu$A, $V_{CE} = 5.0$V, Note 3)	h_{FE1}/h_{FE2}	0.9	1.0	0.8	1.0
Base-Emitter Voltage Differential ($I_C = 10\ \mu$A, $V_{CE} = 5.0$V)	$\lvert V_{BE1} - V_{BE2}\rvert$		5.0		10
Base-Emitter Voltage Differential Change with Temperature ($I_C = 10\ \mu$A, $V_{CE} = 5$V, $T_A = 25$°C to -55°C)	$\Delta\lvert V_{BE1} - V_{BE2}\rvert/\Delta T$		10		20
($I_C = 10\ \mu$A, $V_{CE} = 5$V, $T_A = 25$°C to $+125$°C)	$\Delta\lvert V_{BE1} - V_{BE2}\rvert/\Delta T$		10		20

Notes:
1. Pulse conditions: length $\leq 300\ \mu$sec; duty cycle $\leq 2\%$.
2. The amplifier used for this measurement has a power bandwith of 15.7 kHz and a response which rolls off 6 dB per octave where the 3 dB points are approximately at 25 Hz and 10 kHz.
3. Lowest of two h_{FE} readings is taken as h_{FE1} for purposes of this ratio.


DIMENSIONS WITHIN JEDEC OUTLINE TO-5 EXCEPT FOR LEAD CONFIGURATION
.370
.358
.335
.322
.150 MIN (NOTE 4)
.260
.240
.035
.500 MIN
SEATING PLANE
.100
.071
.071
6 LEADS .017 +.002 .001 (NOTES 1 AND 2)
.034
.028
.045
.029 (NOTE 3)
45°
5
6
3
7
2
1
3 5
E E2
B 2
B2 6
C1 C2
1 7
ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

NOTE 1: Lead diameter is controlled in the zone between 050 and 250 from the seating plane Between 250 and end of lead a max of 021 is held

NOTE 2: Leads having maximum diameter 019 measured in gaging plane 054 001 000 below the seating plane of the device shall be within 007 of true position relative to a maximum width tab

NOTE 3. Measured from max diameter of the actual device

NOTE 4: This zone is controlled for automatic handling The variation in actual diameter within this zone shall not exceed 010

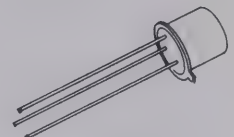
2N2639-44

Silicon
Transistors

2N2646,7

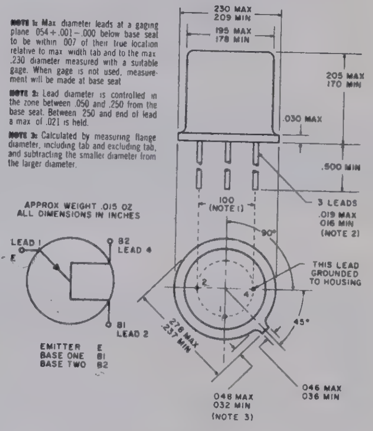
The General Electric 2N2646 and 2N2647 Silicon Unijunction Transistors have an entirely new structure resulting in lower saturation voltage, peak-point current and valley current as well as a much higher base-one peak pulse boltage. In addition, these devices are much faster switches.

The 2N2646 is intended for general purpose industrial applications where circuit economy is of primary importance, and is ideal for use in firing circuits for Silicon Controlled Rectifiers and other applications where a guaranteed minimum pulse amplitude is required. The 2N2647 is intended for applications where a low emitter leakage current and a low peak point emitter current (trigger current) are required (i.e. long timing applications), and also for triggering high power SCR's.



absolute maximum ratings: (25°C) (unless otherwise specified)

Power Dissipation (Note 1)	300 mw
RMS Emitter Current	50 ma
Peak Emitter Current (Note 2)	2 amperes
Emitter Reverse Voltage	30 volts
Interbase Voltage	35 volts
Operating Temperature Range	−65°C to +125°C
Storage Temperature Range	−65°C to +150°C



NOTE 1: Max diameter leads at a gaging plane 054 + .001 − .000 below base seat to be within 007 of their true location relative to max width tab and to the max .230 diameter measured with a suitable gage. When gage is not used, measurement will be made at base seat

NOTE 2: Lead diameter is controlled in the zone between .050 and .250 from the base seat. Between 250 and end of lead a max of .021 is held.

NOTE 3: Calculated by measuring flange diameter, including tab and excluding tab, and subtracting the smaller diameter from the larger diameter.

APPROX WEIGHT .015 OZ
ALL DIMENSIONS IN INCHES

EMITTER E
BASE ONE B1
BASE TWO B2

electrical characteristics: (25°C) (unless otherwise specified)

PARAMETER		2N2646 Min.	2N2646 Typ.	2N2646 Max.	2N2647 Min.	2N2647 Typ.	2N2647 Max.	
Intrinsic Standoff Ratio ($V_{BB} = 10V$)	η	0.56	0.65	0.75	0.68	0.75	0.82	
Interbase Resistance ($V_{BB} = 3V, I_E = 0$)	R_{BBO}	4.7	7	9.1	4.7	7	9.1	KΩ
Emitter Saturation Voltage ($V_{BB} = 10V, I_E = 50$ ma)	$V_{E(SAT)}$		2			2		volts
Modulated Interbase Current ($V_{BB} = 10V, I_E = 50$ ma)	$I_{B2(MOD)}$		12			12		ma
Emitter Reverse Current ($V_{B2E} = 30V, I_{B1} = 0$)	I_{EO}		0.05	12		0.01	0.2	μa
Peak Point Emitter Current ($V_{BB} = 25V$)	I_P		0.4	5		0.4	2	μa
Valley Point Current ($V_{BB} = 20V, R_{B2} = 100\Omega$)	I_V	4	6		8	11	18	ma
Base-One Peak Pulse Voltage (Note 3)	V_{OB1}	3.0	6.5		6.0	7.5		volts
SCR Firing Conditions (See Figure 26, back page)								

1. Derate 3.0 MW/°C increase in ambient temperature. The total power dissipation (available power to Emitter and Base-Two) must be limited by the external circuitry.
2. Capacitor discharge—10μfd or less, 30 volts or less.
3. The Base-One Peak Pulse Voltage is measured in the circuit below. This specification on the 2N2646 and 2N2647 is used to ensure a minimum pulse amplitude for applications in SCR firing circuits and other types of pulse circuits.
4. The intrinsic standoff ratio, η, is essentially constant with temperature and interbase voltage. η is defined by the equation:

$$V_P = \eta V_{BB} + V_D$$

Where V_P = Peak Point Emitter Voltage
V_{BB} = Interbase Voltage

V_D = Junction Diode Drop (Approx. .5V)

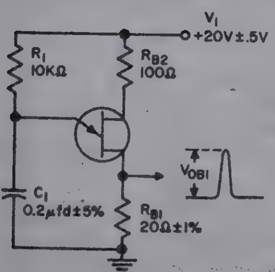


FIGURE 1

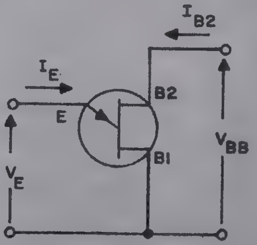


FIGURE 2

Unijunction Transistor Symbol with Nomenclature used for voltage and currents.

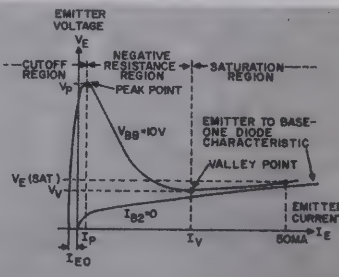


FIGURE 3

Static Emitter Characteristics curves showing important parameters and measurement points (exaggerated to show details).

T_A = 125°C

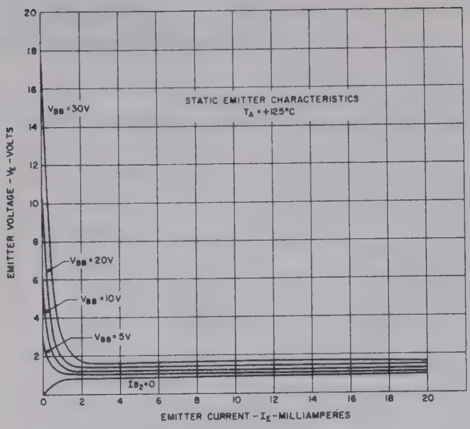


FIGURE 4

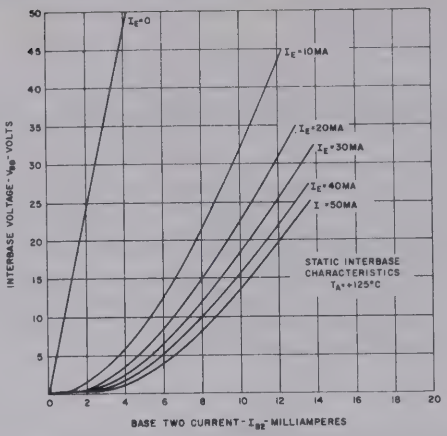


FIGURE 5

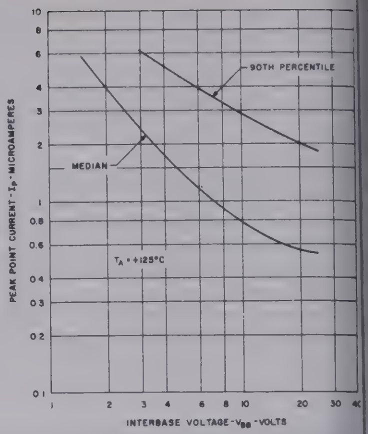


FIGURE 6

T_A = 25°C

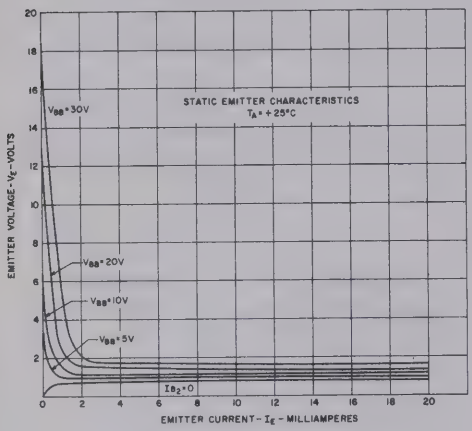


FIGURE 7

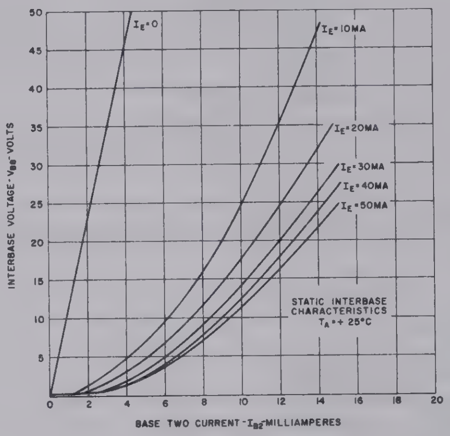


FIGURE 8

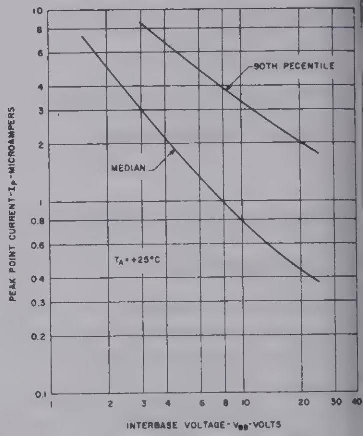


FIGURE 9

T_A = -55°C

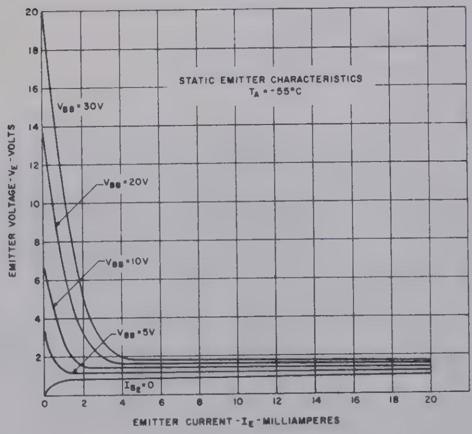


FIGURE 10

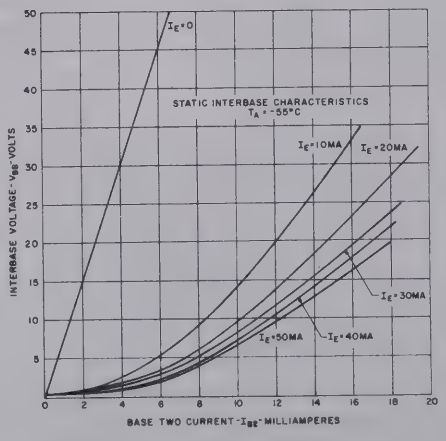


FIGURE 11

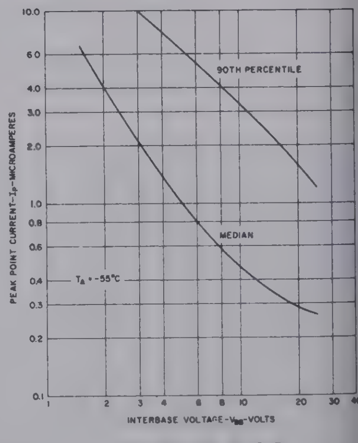


FIGURE 12

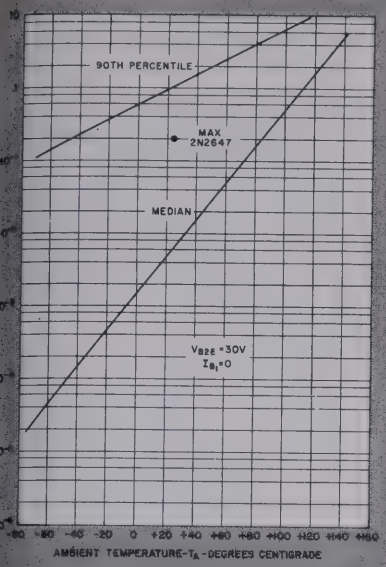


FIGURE 13

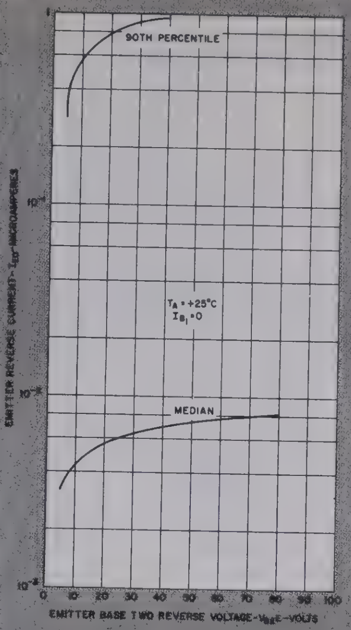


FIGURE 14

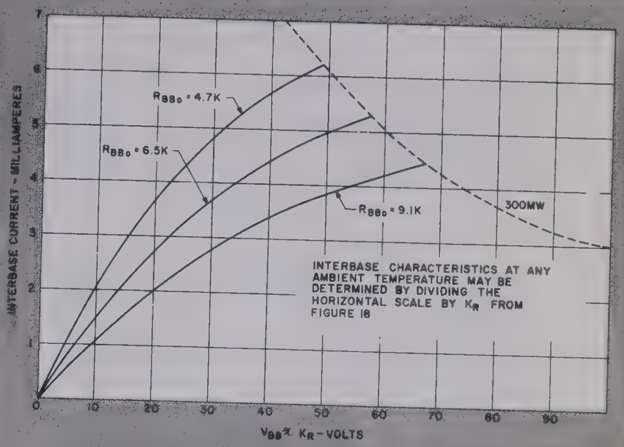


FIGURE 15

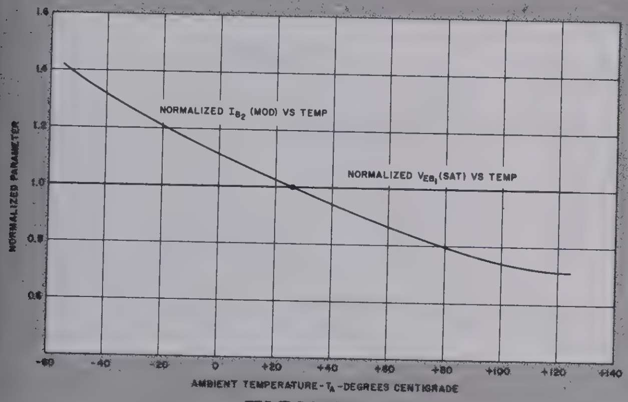


FIGURE 16

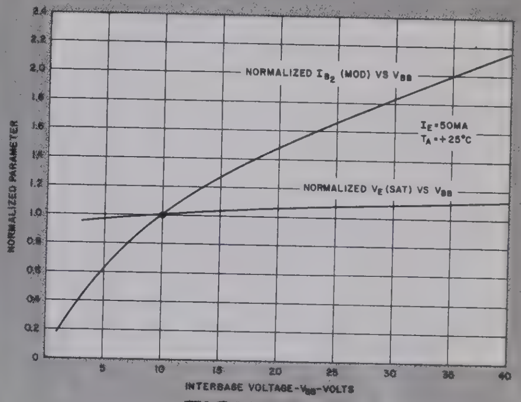


FIGURE 17

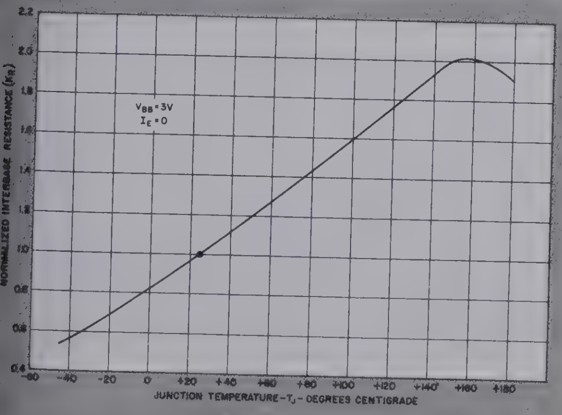


FIGURE 18

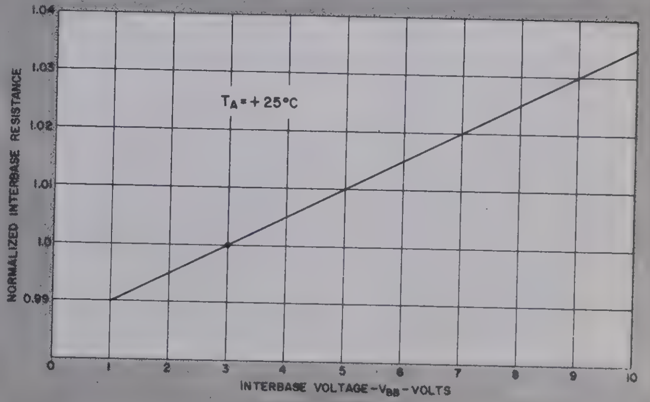


FIGURE 19

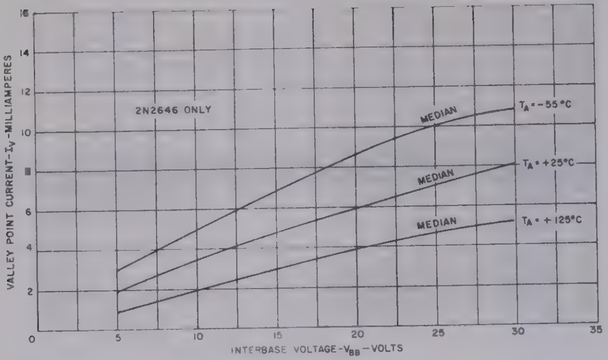


FIGURE 20

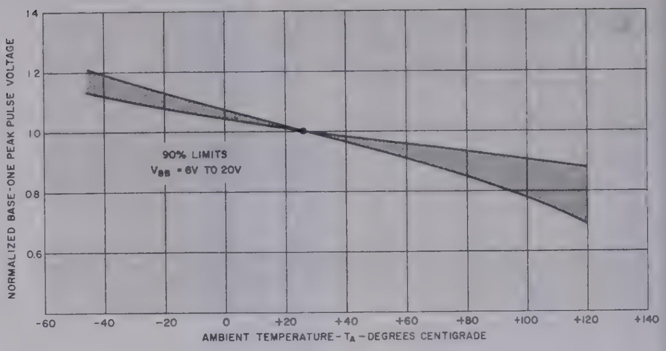


FIGURE 21

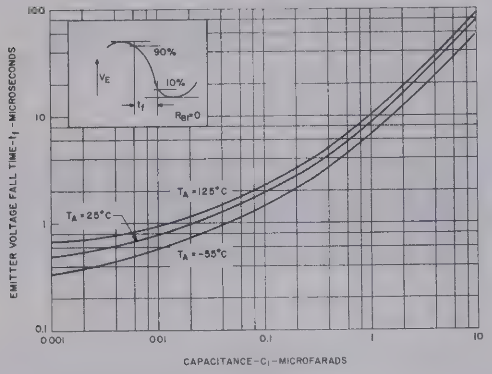
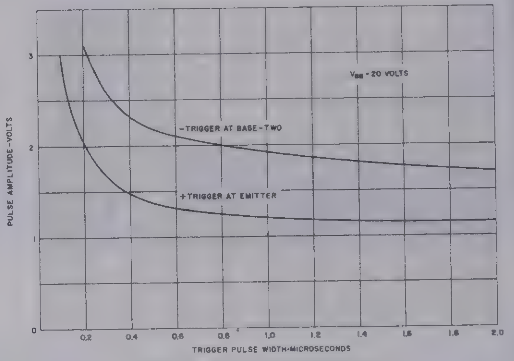


FIGURE 22



MINIMUM TRIGGER AMPLITUDE AS A FUNCTION OF TRIGGER PULSE WIDTH FOR TURN ON OF UNIJUNCTION TRANSISTOR

FIGURE 23

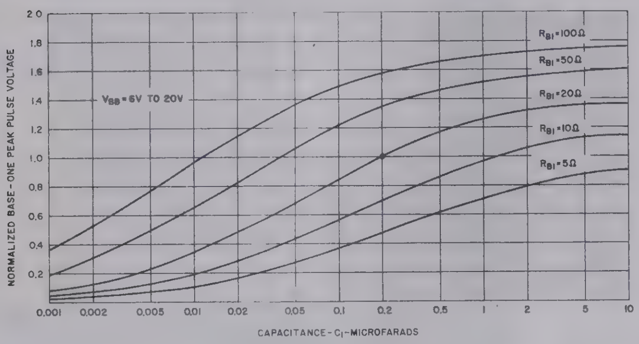


FIGURE 24

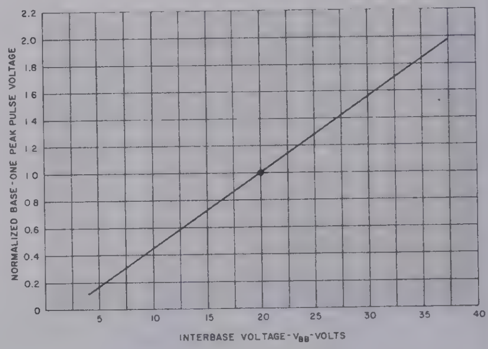
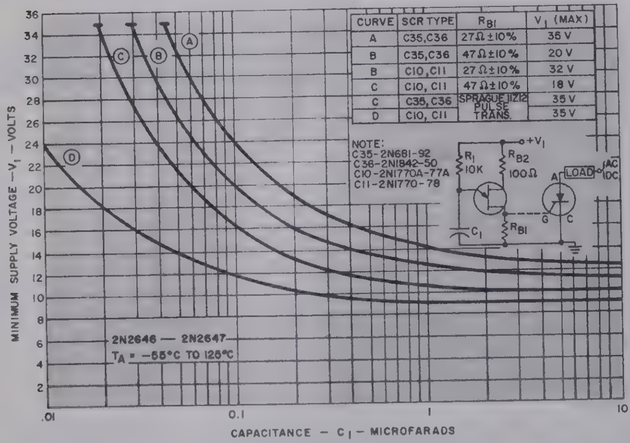


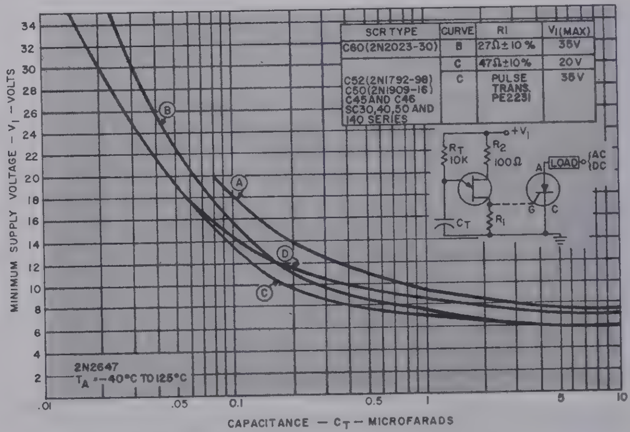
FIGURE 25



CURVE	SCR TYPE	R_{B1}	V_1 (MAX)
A	C35,C36	27Ω ±10%	35 V
B	C35,C36	47Ω ±10%	20 V
B	C10,C11	27Ω ±10%	32 V
C	C10, C11	47Ω ±10%	18 V
C	C35, C36	SPRAGUE 11Z12 PULSE TRANS.	35 V
D	C10, C11		35 V

NOTE:
C35-2N681-92
C36-2N1842-50
C10-2N1770A-77A
C11-2N1770-78

FIGURE 26A-Both types- Lo &Med. SCR's



SCR TYPE	CURVE	R1	V_1(MAX)
C60(2N2023-30)	B	27Ω ± 10%	35V
C52(2N1792-98) C50(2N1909-16) C45 AND C46 SC30,40,50 AND 140 SERIES	C	47Ω±10%	20 V
	C	PULSE TRANS. PE2231	35V

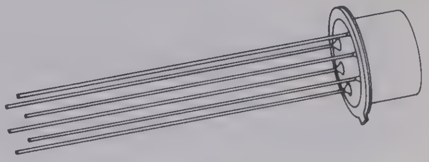
FIGURE 26B-2N2647-Hi Current SCR's

Silicon
Transistors

NPN

2N2652,A

The General Electric types 2N2652, 2N2652A, are NPN planar passivated 6-terminal devices containing two completely isolated transistors in TO-5 packages. These devices are particularly advantageous when used as a differential amplifier where matched VBE over temperature range is of prime importance.



absolute maximum ratings: (25°C)

		2N2652	2N2652A	
Package		TO-5	TO-5	
Voltages				
Collector to Base	V_{CBO}	100	100	volts
Collector to Emitter	V_{CEO}	60	60	volts
Emitter to Base	V_{EBO}	7	7	volts
Dissipation (Free air @ 25°C Amb.)				
Each Transistor	P_T	300	300	mw
Derate		1.72	1.72	mw/°C
Both Transistors	P_T	600	600	mw
Derate		3.43	3.43	mw/°C
Dissipation (Case Temp. @ 25°C)				
Each Transistor	P_T	1000	1000	mw
Derate		5.72	5.72	mw/°C
Both Transistors	P_T	1500	1500	mw
Derate		8.56	8.56	mw/°C
Temperatures				
Storage	T_{STG}	−65 to +200		°C
Operating Junction	T_J	200	200	°C

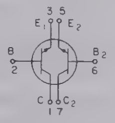
DIMENSIONS WITHIN
JEDEC OUTLINE TO-5
EXCEPT FOR
LEAD CONFIGURATION

NOTE 1: Lead diameter is controlled in the zone between .050 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

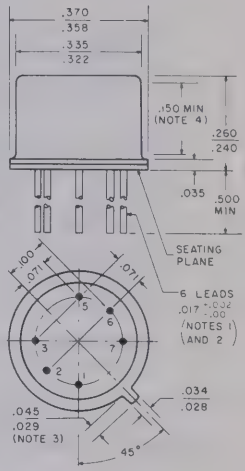
NOTE 2: Leads having maximum diameter (.019) measured in gaging plane .054 +.001 −.000 below the seating plane of the device shall be within .007 of true position relative to a maximum width tab.

NOTE 3: Measured from max. diameter of the actual device.

NOTE 4: This zone is controlled for automatic handling. The variation in actual diameter within this zone shall not exceed .010.



ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED



electrical characteristics (25°C) (unless otherwise specified)

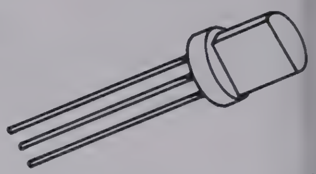
		2N2652		2N2652A		
		Min.	Max.	Min.	Max.	
DC CHARACTERISTICS						
Collector Base Voltage ($I_C = 100\ \mu a$)	V_{CBO}	100		100		volts
Collector to Emitter Voltage ($I_O = 20$ ma)	V_{CEO}*	60		60		volts
Collector Leakage Current ($V_{CE} = 50V$)	I_{CBO}		10		2	na
Collector Leakage Current ($V_{CB} = 50V$, $T_A = 150°C$)	I_{CBO}		15		10	μa
Emitter Base Leakage Current ($V_{EB} = 5V$)	I_{EBO}		10		2	na
Forward Current Transfer Ratio ($I_C = 1$ ma, $V_{CE} = 5V$)	h_{FE}	50	200	50	200	
Forward Current Transfer Ratio ($I_C = 100\ \mu a$, $V_{CE} = 5V$)	h_{FE}	35		35		
Forward Current Transfer Ratio ($I_C = 1.0$ ma, $V_{CE} = 5V$, $T_A = 55°C$)	h_{FE}	15		15		
Collector Saturation Voltage ($I_C = 50$ ma, $I_B = 5$ ma)	$V_{CE(SAT)}$		1.2		1.2	volts
Base Saturation Voltage ($I_C = 50$ ma, $I_B = 5$ ma)	$V_{BE(SAT)}$		0.9		0.9	volts
MATCHING CHARACTERISTICS						
DC Beta Ratio ($V_{CE} = 5V$)	h_{FE1}	0.85	1.0			
($I_C = 100\ \mu a$)**	h_{FE2}			0.9		
DC Beta Ratio ($V_{CE} = 5V$)	h_{FE1}	0.85	1.0			
($I_C = 1$ ma)**	h_{FE2}			0.9		
Voltage Differential ($V_{CE} = 5V$, $I_C = 100\ \mu a$)	$\lvert V_{BE1} - V_{BE2}\rvert$		3.0		3.0	mv
Voltage Differential ($V_{CE} = 5V$, $I_C = 1$ ma)	$\lvert V_{BE1} - V_{BE2}\rvert$		3.0		3.0	mv
Voltage Differential Gradient ($I_C = 100\ \mu a$, $V_{CE} = 5V$, $T_A = 55$ to $125°C$)	$\frac{\Delta\lvert V_{BE1} - V_{BE2}\rvert}{\Delta T}$		10		10	$\mu V/°C$
SMALL SIGNAL CHARACTERISTICS						
Input Impedance ($I_C = 1$ ma, $V_{CB} = 5V$, f = 1 kc)	h_{ib}	20	35	20	35	ohms
Input Impedance ($I_C = 1$ ma, $V_{CE} = 5V$, f = 1 kc)	h_{ie}	1000	10,500	1000	10,500	ohms
Output Admittance ($I_C = 1$ ma, $V_{CE} = 5V$, f = 1 kc)	h_{oe}	4	50	4	50	μmhos
Current Transfer Ratio ($I_C = 1$ ma, $V_{CE} = 5V$, f = 1 kc)	h_{fe}	50	300	50	300	
HIGH FREQUENCY CHARACTERISTICS						
Collector Capacity ($V_{CB} = 10V$, $I_E = 0$, f = 1 ma)	C_{ob}		15		15	pf
Current Transfer Ratio ($I_C = 50$ ma, $V_{CE} = 10V$, f = 20 mc)	h_{fe}	3.0		3.0		
Noise Figure ($I_C = .3$ ma, $V_{CE} = 10V$, f = 1 kc, $R_G = 510\ \Omega$, B. W. = 1 cps)	NF		8		8	db
Input Capacitance ($V_{EB} = 0.5V$, $I_E = 0$)	C_{ib}		85		85	pf

*Pulse width ≦ 300 μsec. Duty cycle ≦ 2%.
**Lowest of two h_{FE} readings is taken as h_{FE1} for purposes of this ratio.

Silicon
Transistors

NPN
2N2711,2

The 2N2711 and 2N2712 are planar passivated NPN Silicon transistors specifically manufactured for radio and general purpose commercial applications. They are housed in an epoxy case and are intended to perform all small signal functions in a conventional AM radio.



absolute maximum ratings: (25°C) (unless otherwise specified)

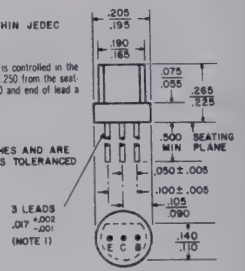
		2N2711 2N2712	
Voltages			
Collector to Emitter	V_{CEO}	18	volts
Emitter to Base	V_{EBO}	5	volts
Collector to Base	V_{CBO}	18	volts
Current			
Collector* (Steady State)	I_C	100	mA
Dissipation			
Total Power (Free air @ 25°C)**	P_T	200	mW
Total Power (Free air @ 55°C)**	P_T	120	mW
Temperature			
Storage	T_{STG}	−55 to +125	°C
Operating	T_J	+100	°C

*Determined from power limitations due to saturation voltage at this current.
**Derate 2.67 mW/°C increase in ambient temperature above 25°C.

DIMENSIONS WITHIN JEDEC OUTLINE TO-98

NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

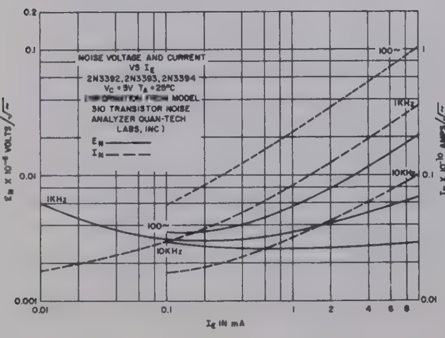
ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED



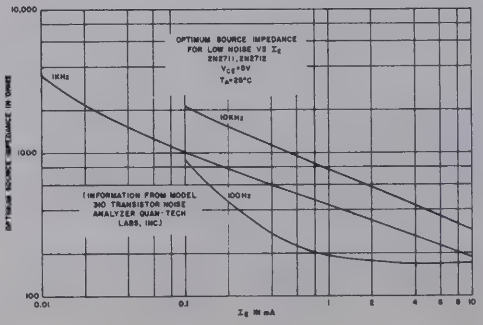
electrical characteristics: (25°C) (unless otherwise specified)

		2N2711			2N2712		
		Min.	Typ.	Max.	Min.	Typ.	Max.
D-C CHARACTERISTICS							
Collector Cutoff Current ($V_{CB} = 18V$)	I_{CBO}			0.5			0.5 μA
($V_{CB} = 18V$, $T_A = 100°C$)	I_{CBO}			15			15 μA
Emitter Cutoff Current ($V_{EB} = 5V$)	I_{EBO}			0.5			0.5 μA
Forward Current Transfer Ratio ($V_{CE} = 4.5V$, $I_C = 2$ mA)	h_{FE}	30		90	75		225
SMALL SIGNAL CHARACTERISTICS							
Common Emitter ($V_{CE} = 5V$, $I = 2$ mA, $f = 455$ kHz)							
Forward Current Transfer Ratio: Output a.c. Short Circuited	h_{fe}		55∠−11°			169∠−42°	
Input Impedance: Output a.c. Short Circuited	h_{ie}		1040∠−10°			2580∠−41°	ohm
Reverse Voltage Transfer Ratio: Input a.c. Open Circuited	h_{re}		.027∠79°			.071∠48°	
Output Admittance: Input a.c. Open Circuited	h_{oe}		1610∠79°			4770∠48°	μmh
Forward Transfer Admittance: Output a.c. Short Circuited	y_{fe}		.053∠0°			.066∠0°	mh
Input Admittance: Output a.c. Short Circuited	y_{ie}		960∠10°			388∠41°	μmh
Reverse Transfer Admittance: Input a.c. Short Circuited	y_{re}		−26∠90°			−28∠90°	μmh
Output Admittance: Input a.c. Short Circuited	y_{oe}		170∠90°			71∠45°	μmh
HIGH FREQUENCY CHARACTERISTICS							
Collector Capacitance ($V_{CB} = 10V$, $I_E = 0$, $f = 1$ MHz)	C_{cbo}	4.5	9	12	4.5	9	12 pF
NOISE							
Noise Figure ($I_C = 100$ μA, $V_{CE} = 5V$, $f = 10$ kHz, BW = 1 Hz, Rg = 2000 Ω)	N.F.		2.8			2.8	dB
Signal to Noise Ratio in Typical RF Circuit (1600 kHz, 12 μV signal)	S/N		22			22	dB

NOISE VOLTAGE AND CURRENT vs. I_E

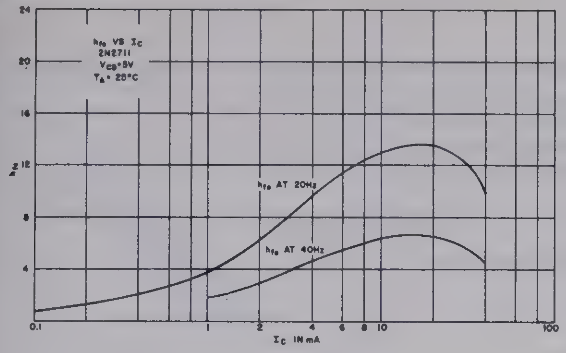


OPTIMUM SOURCE IMPEDANCE FOR LOW NOISE vs. I_E

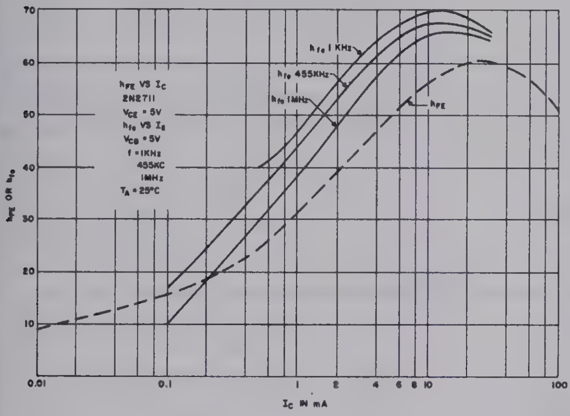


TYPE 2N2711,

h_{fe} vs. I_C

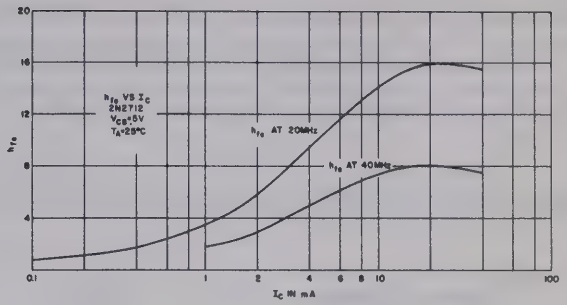


h_{fe} or h_{FE} vs. I_C

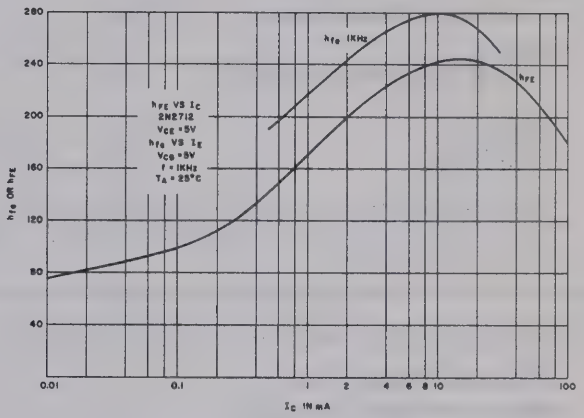


TYPE 2N2712

h_{fe} vs. I_C

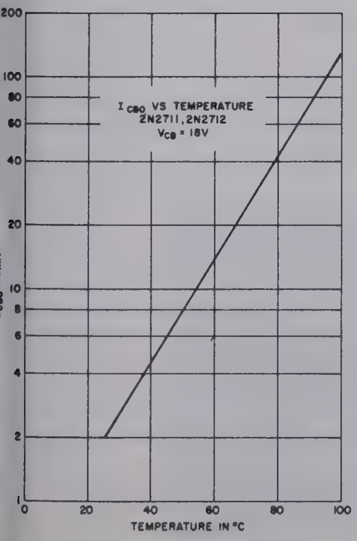


h_{fe} or h_{FE} vs. I_C

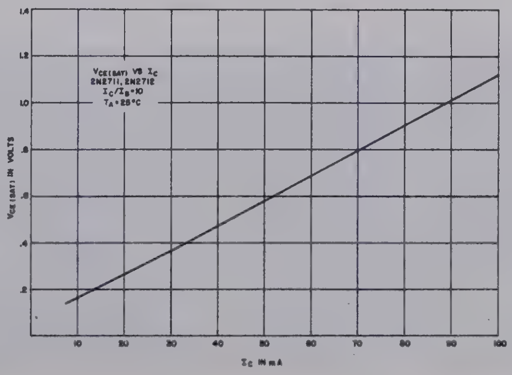


TYPE 2N2711,2N2712

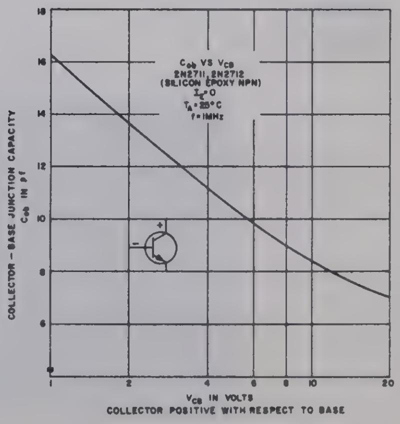
I_{CBO} vs. TEMPERATURE



$V_{CE\ (SAT)}$ vs. I_C



C_{ob} vs. V_{CB}

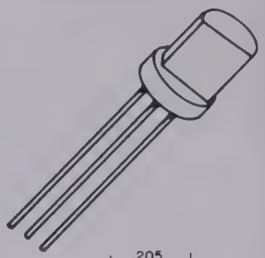


Silicon
Transistors

NPN

2N2713,4

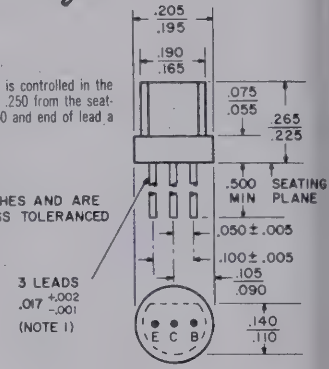
The General Electric 2N2713 and 2N2714 are epoxy encapsulated planar epitaxial passivzted NPN silicon transistors specifically manufactured for general purpose commercial applications. They are particularly useful in output stages where low saturation voltage is desirable. They may also be used to advantage in switching applications due to their low storage time, good beta holdup to beyond 150 ma and low $V_{CE(SAT)}$.



absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	18	volts
Emitter to Base	V_{EBO}	5	volts
Collector to Base	V_{CBO}	18	volts
Current			
Collector* (Steady State)	I_C	200	mA
Dissipation			
Total Power (Free air @ 25°C)**	P_T	360	mW
Temperature			
Storage	T_{STG}	−55°C to +125	°C
Operating	T_J	+100	°C

*Determined from power limitations due to saturation voltage at this current.
**Derate 3.6 mw/°C increase in ambient temperature above 25°C.


.205
.195
.190
.165
.075
.055
.265
.225
.500 MIN
SEATING PLANE
.050 ± .005
.100 ± .005
.105
.090
.140
.110
E C B
3 LEADS
.017 +.002 −.001
(NOTE 1)

NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

electrical characteristics: (25°C)

		Min.	Typ.	Max.	
DC CHARACTERISTICS					
Collector Cutoff Current ($V_{CB} = 18V$)	I_{CBO}			0.1	μA
($V_{CB} = 18V$, $T_A = 100°C$)	I_{CBO}			15	μA
Emitter Cutoff Current ($V_{EB} = 5V$)	I_{EBO}			0.5	μA
Forward Current Transfer Ratio ($V_{CE} = 4.5V$, $I_C = 2$ mA)					
2N2713	h_{FE}	30		90	
2N2714	h_{FE}	75		225	
Collector Saturation Voltage ($I_B = 3$ mA, $I_C = 50$ mA)	$V_{CE(SAT)}$			0.30	volts
Base Saturation Voltage ($I_B = 3$ mA, $I_C = 50$ mA)	$V_{BE(SAT)}$			1.3	volts
LARGE SIGNAL CHARACTERISTICS					
Input Impedance ($\frac{V_{BE2} - V_{BE1}}{I_{B2} - I_{B1}}$; where condition "1" is $I_B = .05$ mA and condition "2" is $I_B = .5$ mA, $V_{CE} = 1V$)	h_{IE}		200		ohms
SWITCHING SPEEDS (See Figure 1)					
Delay Time	t_d		60		ns
Rise Time	t_r		85		ns
Storage Time	t_s		85		ns
Fall Time	t_f		40		ns

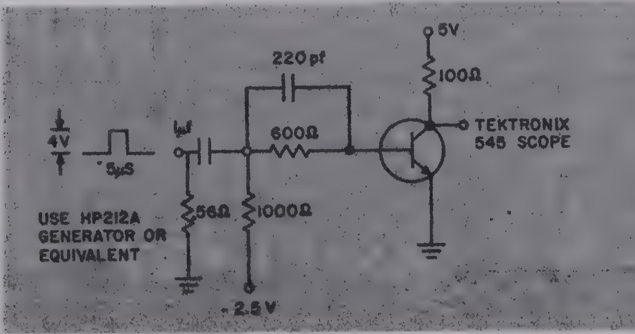
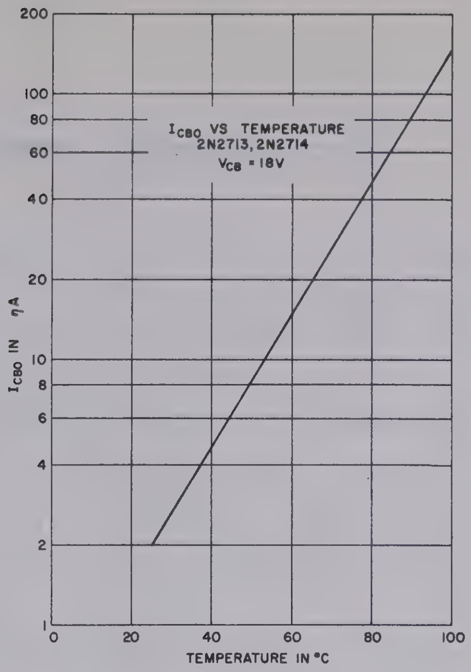
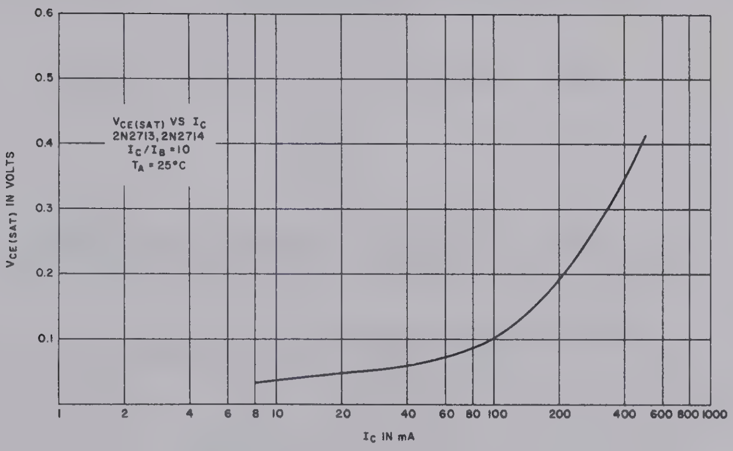
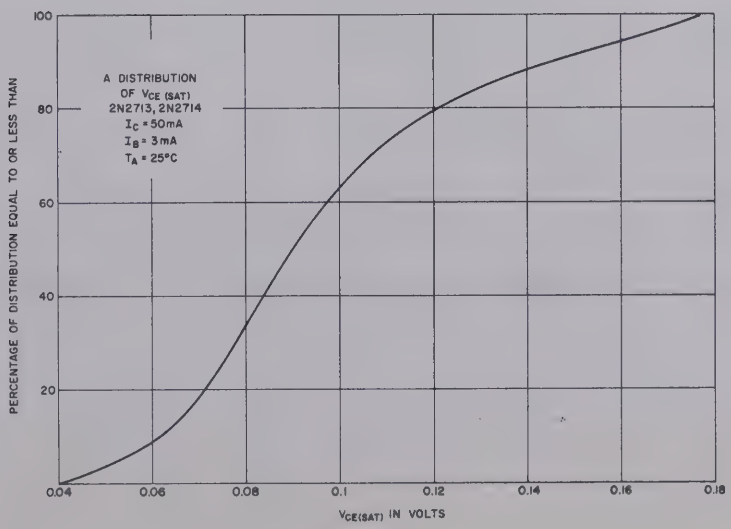

5V
100Ω
220 pf
600Ω
1μf
TEKTRONIX 545 SCOPE
4V
5μS
56Ω
1000Ω
USE HP212A GENERATOR OR EQUIVALENT
-2.5 V

FIGURE 1 SWITCHING CIRCUIT

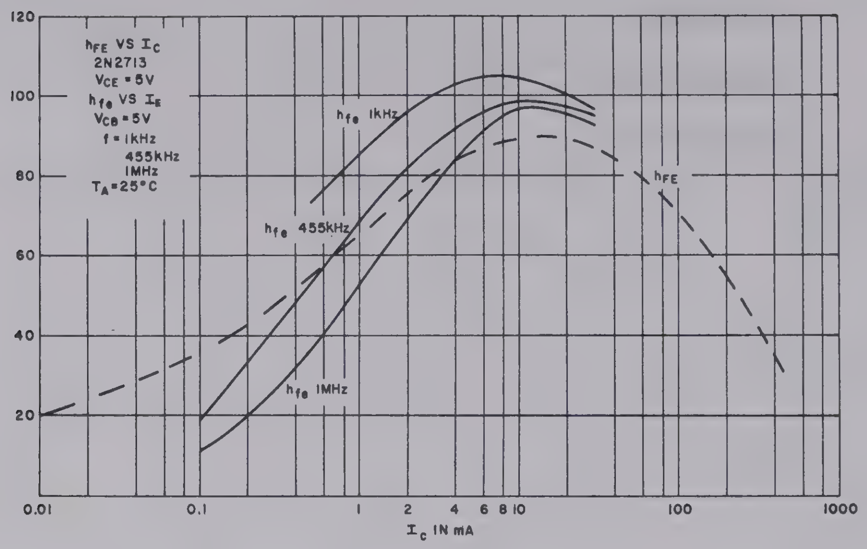
TYPES
2N2713,
2N2714



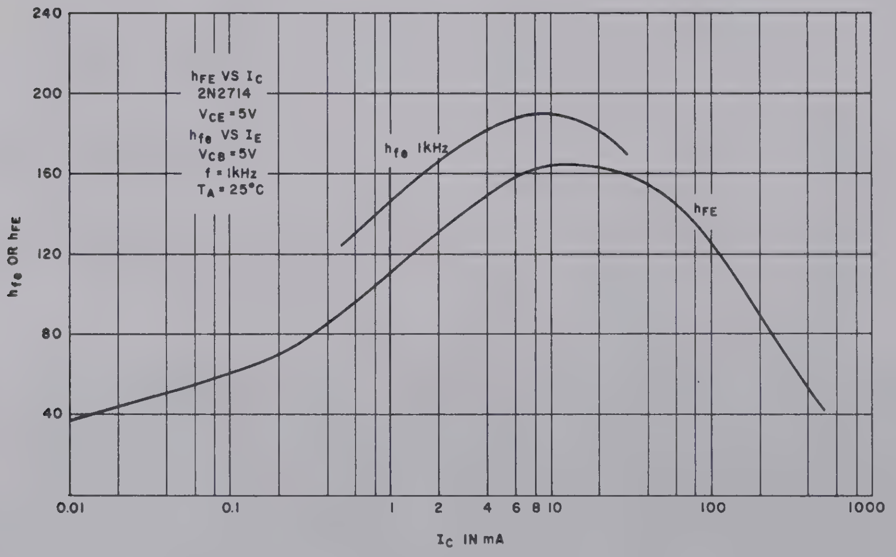




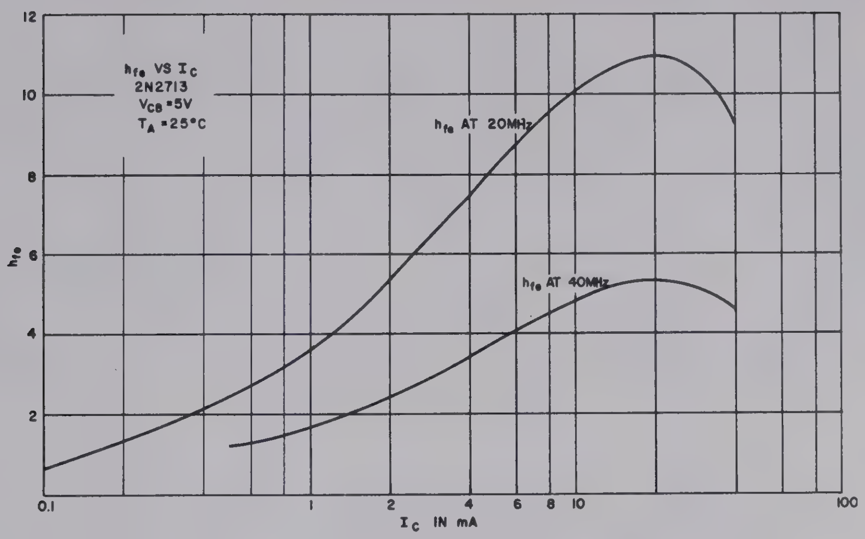
h_{fe} or h_{FE} vs. I_C - TYPE 2N2713



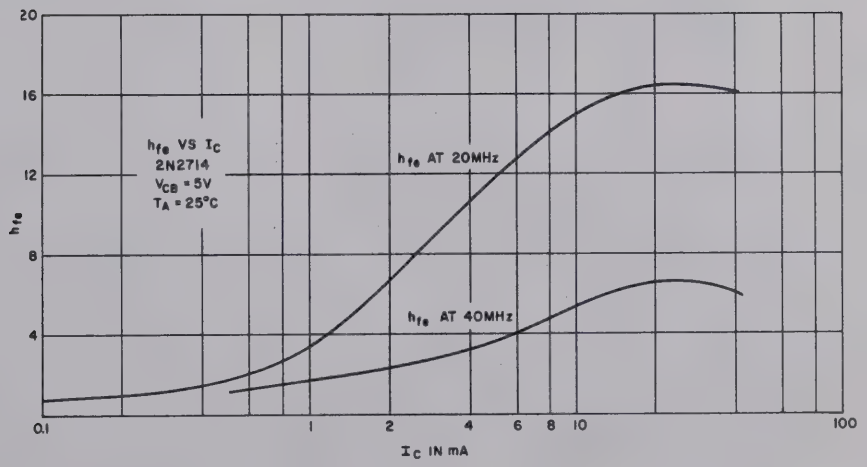
h_{fe} or h_{FE} vs. I_C - TYPE 2N2714



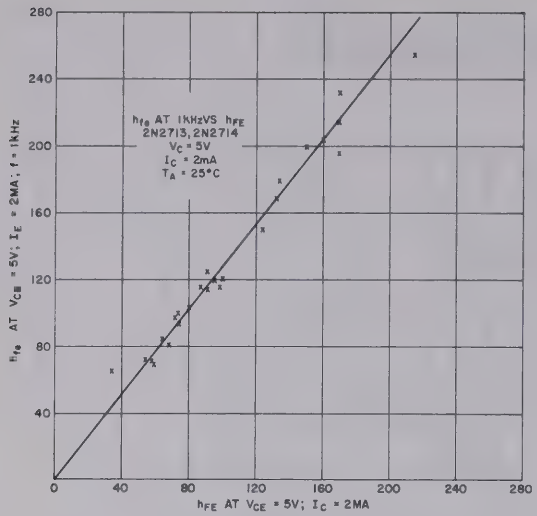
h_{fe} vs. I_C - TYPE 2N2713

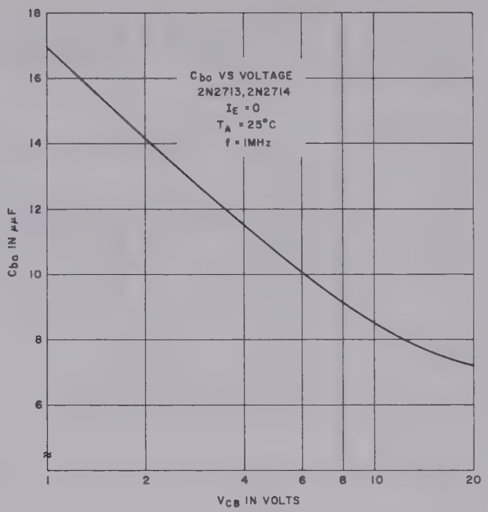


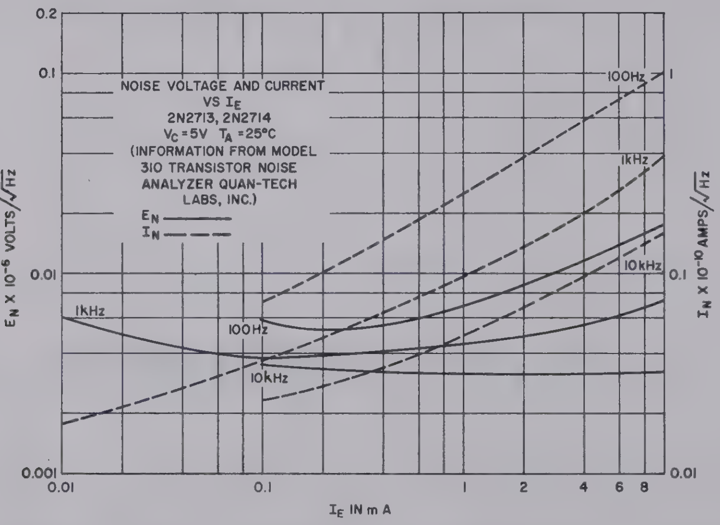
h_{fe} vs. I_C - TYPE 2N2714

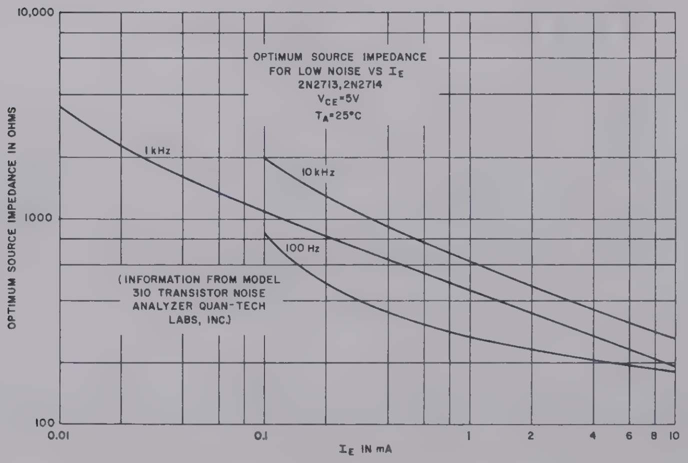


TYPES 2N2713, 2N2714









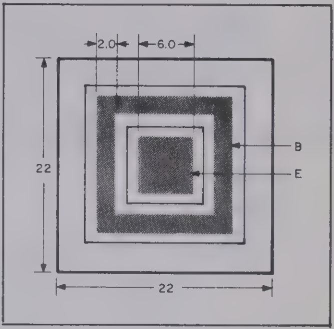
Silicon
Transistor Chips

NPN

2N2714 (Chip)

(M24P-X502)

This General Electric NPN silicon planar passivated transistor chip is designed primarily for general purpose applications. The chip is particularly useful in output stages where low saturation voltage is desirable, and in switching applications due to the low storage time and good Beta holdup of the device.



General specifications:

- Gold collector contact backing, minimum thickness—3000Å
- Aluminum base and emitter contact metalization
- Maximum conditions for mounting chips—425°C for 5 minutes (Max.) in an inert atmosphere
- Shipping containers: Glass vials sealed with a nitrogen back-fill
  Maximum of 10k chips per vial
  Egg crate containers available at extra cost
- Chip drawing dimensions are in mils
- Chip thickness = 5.4 $^{+0.8}_{-0.9}$ mils

absolute maximum ratings: ($T_A = 25°C$)

	Symbol		
Voltages			
Collector to Base	V_{CBO}	25	V
Collector to Emitter	V_{CEO}	25	V
Emitter to Base	V_{EBO}	5	V
Current			
Collector	I_C	200	mA
Temperature			
Storage	T_{STG}	−65°C to +200°C	
Operating	T_J	−65°C to +200°C	

electrical characteristics: 100% Probe ($T_A = 25°C$)

Tested at outgoing acceptance to a 10% LTPD with a maximum accept number of 3.

	Symbol	Min.	Max.	
Collector Base Breakdown Voltage ($I_C = 0.1\ \mu A$)	BV_{CBO}	25	—	V
Collector Emitter Breakdown Voltage ($I_C = 10$ mA)	BV_{CEO}	25	—	V
Emitter Base Breakdown Voltage ($I_E = 0.1\ \mu A$)	BV_{EBO}	5	—	V
Forward Current Transfer Ratio ($I_C = 2$ mA, $V_{CE} = 5V$)	h_{FE}	75	225	

specifications: ($T_A = 25°C$)

Product yield is at least 93% to each of the following parameters:

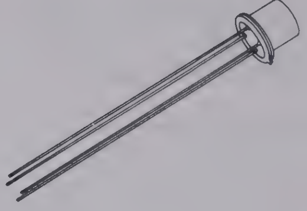
	Symbol	Min.	Max.	
Collector Saturation Voltage ($I_C = 50$ mA, $I_B = 3$ mA)	$V_{CE(SAT)}$	—	0.3	V
Base Saturation Voltage ($I_C = 50$ mA, $I_B = 3$ mA)	$V_{BE(SAT)}$	0.6	0.9	V
Forward Current Transfer Ratio ($I_C = 2$ mA, $V_{CE} = 5V$, f = 1 kHz)	h_{fe}	80	300	

Silicon
Transistor

NPN

2N2785

The General Electric 2N2785 consists of two planar transistors connected in the Darlington configuration and hemetically sealed in a standard TO-18 package. The device features high gain and high input resistance.



absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Base	V_{CBO}	60 volts	
Collector to Emitter	V_{CEO}	40 volts	
Emitter to Base (pin 1 to pin 2)	V_{EBO}	15 volts	
Emitter to Base (pin 4 to 2 or pin 1 to 4)	V_{EBO}	7.5 volts	
Current			
IC-limited by power dissipation only			
Power Dissipation			
Total unit (Free Air @ 25°C) (Note 1)	P_T	500 mw	
Total unit (Case Temp. @ 25°C) (Note 2)	P_T	1.8 watts	
Total unit (Case Temp. @ 100°C) (Note 2)	P_T	1 watt	
Temperature			
Storage	T_{STG}	-65 to +300	°C
Operating Junction	T_J	-65 to +175	°C
Lead Temperature (soldering, no time limit)	T_J	300	°C

Note 1: Derate 3.33 mw/°C increase in ambient temperature above 25°C.

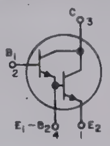
Note 2: Derate 10 wm/°C increase in case temperature above 25°C.

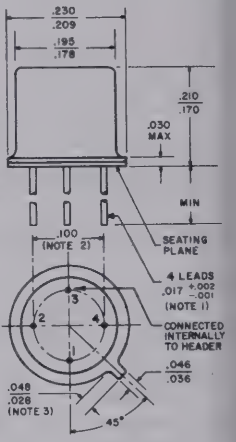
DIMENSIONS WITHIN
JEDEC OUTLINE TO-18
EXCEPT FOR
LEAD CONFIGURATION

NOTE 1: Lead diameter is controlled in the zone between .050 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

NOTE 2: Leads having maximum diameter (.019) measured in gaging plane .054 + .001 — .000 below the seating plane of the device shall be within .007 of true position relative to a maximum width tab.

NOTE 3: Measured from max. diameter of the actual device.





ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

electrical characteristics: (25°C) (unless otherwise specified)

(Note: Unless otherwise specified, lead 4 is open circuited)

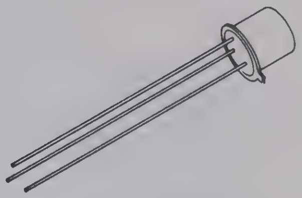
Collector to base (I_C=100 ua)	V_{CBO}	60		volts
Collector to emitter (I_C=20 ma)	V_{CEO}	40		volts
Emitter to base (I_E=100 ua) (pin 1 to 2)	V_{EBO}	15		volts
Forward current transfer ratio (I_C=100 ma, V_{CE}=5V)	h_{FE}*	2000	20,000	
(I_C=10 ma, V_{CE}=5V)	h_{FE}*	1200		
(I_C=1 ma, V_{CE}=4V)	h_{FE}*	600		
Collector leakage current (V_{CB}=30V)	I_{CBO}		50	na
(V_{CB}=30V, T_A=150°C)	I_{CBO}		10	ua
Emitter base leakage current (V_{EB}=5V)	I_{EBO}		20	na
Collector saturation voltage (I_C=15 ma, I_B=3 ma)	$V_{CE(SAT)}$		1.0	volts
Collector to emitter leakage current (V_{CE}=20V)	I_{CEO}		500	na
Current transfer ratio (V_{CE}=5V, I_C=1 ma, f=1 kc)	h_{fe}	600		
Voltage feedback ratio (V_{CB}=5V, I_C=1 ma, f=1 kc)	h_{rb}		10x10$_{-4}$	
Input impedance (V_{CB}=5V, I_C=1 ma, f=1 kc)	h_{ib}	30	80	ohms
Output impedance (V_{CB}=5V, I_C=1 ma, f=1 kc)	h_{ob}		0.5	umho
Current transfer ratio (I_C=1 ma, V_{CE}=5V, F=10 mc)	h_{fe}	1.0		
Collector capacitance (I_E=0, V_{CB}=10V, f=1 mc)	C_{ob}		30	pf

* Pulse width 300 usec, Duty cycle 2%.

Silicon Transistor

NPN

2N2840



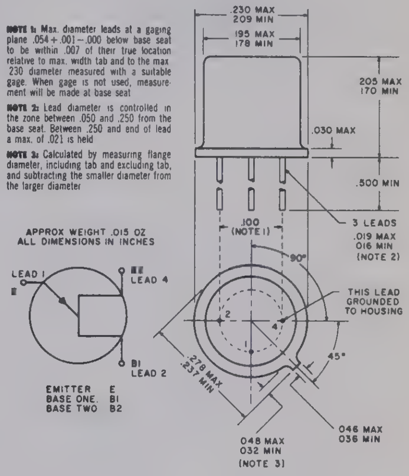
The General Electric Type 2N2840 Silicon Unijunction transistor maintains its negative resistance region for extremely low interbase voltages. This transistor is specifically characterized for use at interbase voltages less than 10 volts and as low as 1.5 volts. The transistor is hermetically sealed in a welded case equivalent to the TO-18, except for lead orientation. Base-two is electrically common to case.

absolute maximum ratings: (25°C)

Power Dissipation*	300	mw
RMS Emitter Current	50	ma
Peak Emitter Current**	2	amps
Emitter Reverse Voltage	30	volts
Interbase Voltage	35	volts
Operating Temperature Range	−65 to +150	°C
Storage Temperature Range	−65 to +175	°C

*Derate 2.4 mw/°C increase in ambient temperature. Maximum power available to the transistor must be limited by external circuitry to be within this rating.

**Capacitor Discharge—10 μfd or less, 30 volts or less.



NOTE 1: Max. diameter leads at a gaging plane .054 + .001 − .000 below base seat to be within .007 of their true location relative to max. width tab and to the max. .230 diameter measured with a suitable gage. When gage is not used, measurement will be made at base seat

NOTE 2: Lead diameter is controlled in the zone between .050 and .250 from the base seat. Between .250 and end of lead a max. of .021 is held

NOTE 3: Calculated by measuring flange diameter, including tab and excluding tab, and subtracting the smaller diameter from the larger diameter

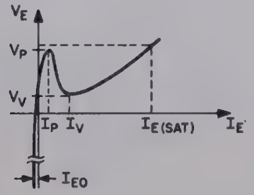
APPROX WEIGHT .015 OZ
ALL DIMENSIONS IN INCHES

.230 MAX
209 MIN
195 MAX
178 MIN
205 MAX
170 MIN
.030 MAX
.500 MIN
3 LEADS
.019 MAX
016 MIN
(NOTE 2)
.100
(NOTE 1)
90°
THIS LEAD GROUNDED TO HOUSING
45°
.278 MAX
.237 MIN
048 MAX
032 MIN
(NOTE 3)
046 MAX
036 MIN
2
4
1
LEAD 1
E
B2
LEAD 4
B1
LEAD 2
EMITTER E
BASE ONE. B1
BASE TWO B2

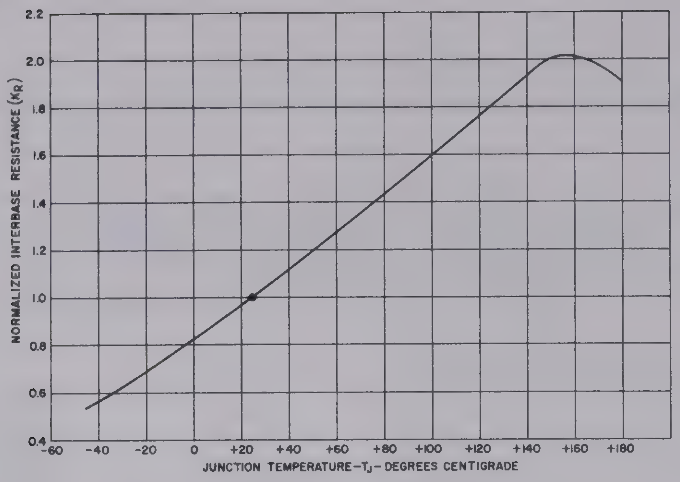
electrical characteristics: (25°C)

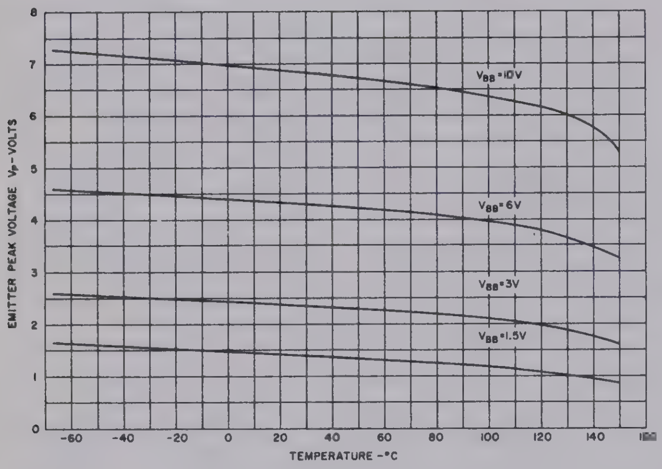
PARAMETER		Min.	Typ.	Max.	
Emitter Peak Point Voltage ($V_{BB} = 1.50V$)	V_P	1.30	1.4	1.50	volts
Emitter Peak Point Current ($V_{BB} = 1.50V$)	I_P		7.5	10	μa
Intrinsic Standoff Ratio ($V_{BB} = 10V$)***	η		.62		
Emitter Valley Point Voltage ($V_{BB} = 1.50V$)	V_V		.95	1.10	volts
Emitter Valley Point Current ($V_{BB} = 1.50V$)	I_V	.20	.40	.70	ma
Emitter Base Saturation Current ($V_{BB} = 1.50V$; $V_{EB1} = 1.50V$)	$I_{E(SAT)}$	20	40		ma
Emitter Reverse Current ($V_{B2E} = 30V$; $I_{B1} = 0$)	I_{EO}		.05	1	μa
Interbase Resistance ($V_{BB} = 1.50V$; $I_E = 0$)	R_{BB}	4.7	7	9.1	KΩ

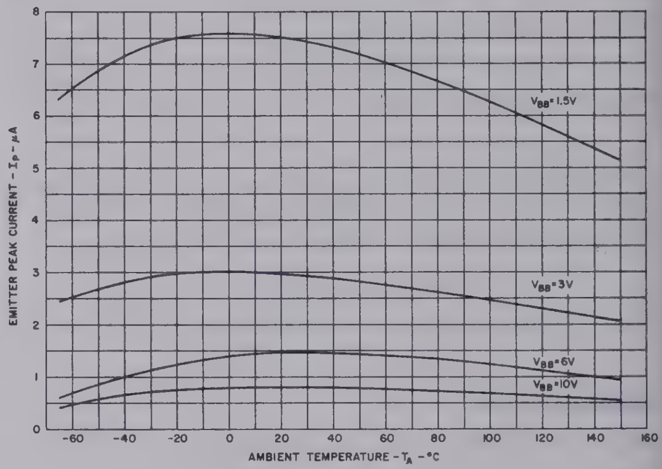
***η is defined by the equation $V_P = \eta V_{BB} + V_D$ where $V_D \sim .5V$.

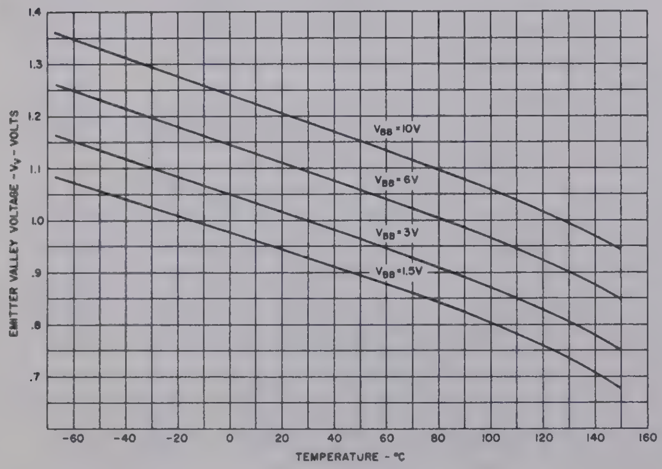


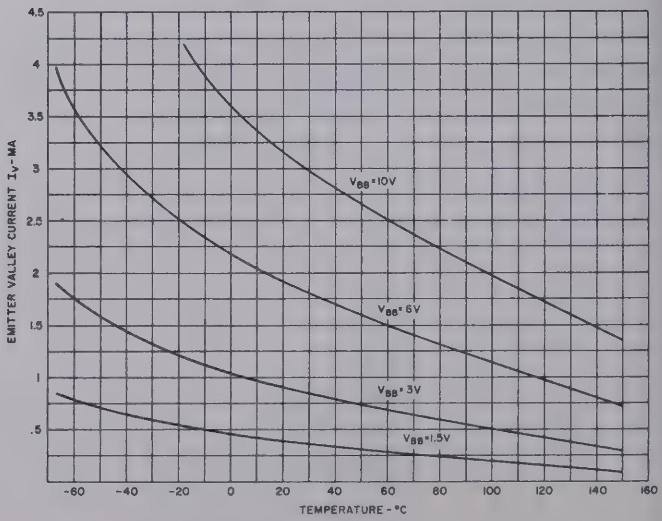
	TEMPERATURE COEFFICIENT, MV/°C		
	10%	MED	90%
V_P	−2.8	−3.4	−4.0
V_B	−1.7	−2.0	−2.4


NORMALIZED INTERBASE RESISTANCE (K_R)
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
-60
-40
-20
0
+20
+40
+60
+80
+100
+120
+140
+160
+180
JUNCTION TEMPERATURE–T_J–DEGREES CENTIGRADE


EMITTER PEAK VOLTAGE V_P–VOLTS
8
7
6
5
4
3
2
1
0
V_{BB}=10V
V_{BB}=6V
V_{BB}=3V
V_{BB}=1.5V
-60
-40
-20
0
20
40
60
80
100
120
140
160
TEMPERATURE –°C


EMITTER PEAK CURRENT – I_P – μA
8
7
6
5
4
3
2
1
0
V_{BB}=1.5V
V_{BB}=3V
V_{BB}=6V
V_{BB}=10V
-60
-40
-20
0
20
40
60
80
100
120
140
160
AMBIENT TEMPERATURE – T_A –°C


EMITTER VALLEY VOLTAGE –V_V– VOLTS
1.4
1.3
1.2
1.1
1.0
.9
.8
.7
V_{BB}=10V
V_{BB}=6V
V_{BB}=3V
V_{BB}=1.5V
-60
-40
-20
0
20
40
60
80
100
120
140
160
TEMPERATURE - °C


EMITTER VALLEY CURRENT I_V–MA
4.5
4
3.5
3
2.5
2
1.5
1
.5
V_{BB}=10V
V_{BB}=6V
V_{BB}=3V
V_{BB}=1.5V
-60
-40
-20
0
20
40
60
80
100
120
140
160
TEMPERATURE –°C

Silicon

Transistor Chips

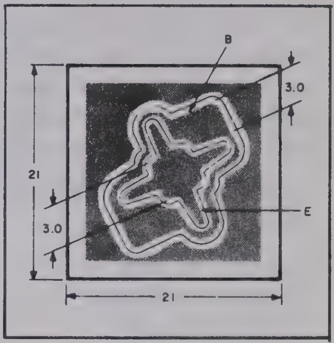
(M67P-X504)

PNP

Electrically Similar To

2N2905-07 (Chips)

These General Electric PNP silicon planar passivated epitaxial transistor chips are designed primarily for amplifier, driver, and general purpose switching applications. The chips feature excellent collector saturation, frequency and Beta characteristics.



General specifications:

- Gold collector contact backing, minimum thickness—3000Å
- Aluminum base and emitter contact metalization
- Maximum conditions for mounting chips—425°C for 5 minutes (Max.) in an inert atmosphere
- Shipping containers: Glass vials sealed with a nitrogen back-fill
  Maximum of 10k chips per vial
  Egg crate containers available at extra cost
- Chip drawing dimensions are in mils
- Chip thickness = 5.0 ±0.5 mils

absolute maximum ratings: ($T_A = 25°C$)

Voltages	Symbol		
Collector to Base	V_{CBO}	−40	V
Collector to Emitter	V_{CEO}	−40	V
Emitter to Base	V_{EBO}	−5	V
Current			
Collector	I_C	0.8	A
Temperature			
Storage	T_{STG}	−65°C to +200°C	
Operating	T_J	−65°C to +200°C	

electrical characteristics: 100% Probe ($T_A = 25°C$)

Tested at outgoing acceptance to a 10% LTPD with a maximum accept number of 3.

	Symbol	Min.	Max.	
Collector Base Breakdown Voltage ($I_C = -10\ \mu A$)	BV_{CBO}	−40	—	V
Collector Emitter Breakdown Voltage ($I_C = -10$ mA)	BV_{CEO}	−40	—	V
Emitter Base Breakdown Voltage ($I_E = -10\ \mu A$)	BV_{EBO}	−5	—	V
Collector Cutoff Current ($V_{CB} = -40V$)	I_{CBO}	—	−100	nA
Forward Current Transfer Ratio ($I_C = -1$ mA, $V_{CE} = -10V$)	h_{FE}	50	—	
Forward Current Transfer Ratio ($I_C = -20$ mA, $V_{CE} = -10V$)	h_{FE}	120	330	

specifications: ($T_A = 25°C$)

Product yield is at least 93% to each of the following parameters:

	Symbol	Min.	Max.	
***Forward Current Transfer Ratio**	h_{FE}			
($I_C = -150$ mA, $V_{CE} = -10V$, Pulsed)		100	300	
($I_C = -500$ mA, $V_{CE} = -10V$, Pulsed)		30	—	
***Collector Saturation Voltage**	$V_{CE(SAT)}$			
($I_C = -500$ mA, $I_B = -50$ mA, Pulsed)		—	−1.6	V
***Base Saturation Voltage**	$V_{BE(SAT)}$			
($I_C = -500$ mA, $I_B = -50$ mA, Pulsed)		—	−2.6	V
Collector Base Capacitance	C_{cb}			
($V_{CB} = -10V$, f = 1 MHz)		—	8	pF
Emitter Base Capacitance	C_{eb}			
($V_{BE} = -2V$, f = 1 MHz)		—	30	pF
Forward Current Transfer Ratio	h_{fe}			
($I_C = -50$ mA, $V_{CE} = -10V$, f = 100 MHz)		2	—	

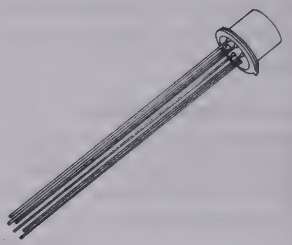
*Pulse conditions: pulse width ≤300 μsec, duty cycle ≤2%.

Silicon
Transistor

NPN

2N2910

The General Electric type **2N2910** is a 6-terminal device containing two completely isolated NPN high gain silicon transistors matched for hFE and VBE over a current range. This device is particularly advantageous for high performance differential amplifier circuits where well matched thermal tracking of hFE and VBE over a temperature range is of prime importance.

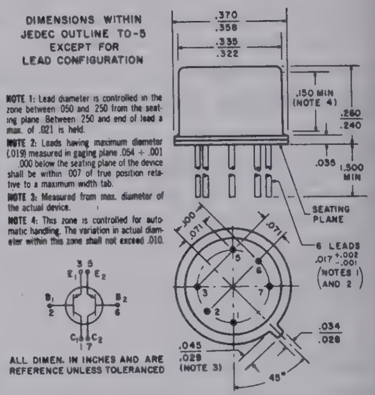


absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Base	V_{CBO}	45 volts	
Collector to Emitter	V_{CBO}	25 volts	
Emitter to Base	V_{CEO}	7 volts	
Dissipation			
Each Transistor (Free air at 25°C)*	P_T	300 mw	
Each Transistor (Case temperature 25°C)**	P_T	600 mw	
Each Transistor (Case temperature 100°C)**	P_T	400 mw	
Temperatures			
Storage	T_{STG}	-65 to +200	°C
Operating Junction	T_J	-65 to +200	°C

* Derate 1.72 mw/°C (Per transistor) increase in ambient temperature above 25°C.

** Derate 5.7 mw/°C (Per transistor) increase in case temperature above 25°C.



DIMENSIONS WITHIN JEDEC OUTLINE TO-5 EXCEPT FOR LEAD CONFIGURATION

NOTE 1: Lead diameter is controlled in the zone between .050 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

NOTE 2: Leads having maximum diameter (.019) measured in gaging plane .054 + .001 .000 below the seating plane of the device shall be within .007 of true position relative to a maximum width tab.

NOTE 3: Measured from max. diameter of the actual device.

NOTE 4: This zone is controlled for automatic handling. The variation in actual diameter within this zone shall not exceed .010.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

electrical characteristics: (25°C) (unless otherwise specified)

MATCHED CHARACTERISTICS		Min.	Max.	
DC Forward Current Transfer Ratio (I_C=100 ua, V_{CE} =5V)	h_{FE1} h_{FE2}	0.8	1.0	
DC Forward Current Transfer Ratio (I_C=1.0 ma, V_{CE} =5 V)	h_{FE1} h_{FE2}	0.8	1.0	
DC Forward Current Transfer Ratio (I_C =1.0 ma, V_{CE} =5V, T_A =0°C to +70°C)	h_{FE1} h_{FE2}	0.75	1.0	
Voltage Differential (I_C=100 ua, V_{CE} =5V)	$\lvert VBE1-VBE2 \rvert$		10	mv
Voltage Differential (I_C=1.0 ma, V_{CE} =5V)	$\lvert VBE1-VBE2 \rvert$		10	mv
Voltage Differential Gradient (I_C=100 ua V_{CE} =5 V, T_A =0°C to 70°C)	$\frac{\Delta(\lvert VBE1-VBE2 \rvert)}{\Delta T}$		20	uv/°C
Voltage Differential Gradient (I_C=1.0 ma, V_{CE} =5 V, T_A =0°C to 70°C)	$\frac{\Delta(\lvert VBE1-VBE2 \rvert)}{\Delta T}$		20	uv/°C

2N2910

electrical characteristics: (25°C)(cont.)

D-C Characteristics

Collector Leakage Current (V_{CB} =20V, I_E=0)	I_{CBO}		10	na
Collector Leakage Current (V_{CE} =20V, I_E=0, T_A=100°C	I_{CBO}		5	ua
Emitter Leakage Current (V_{EB} =5V, I_C=0)	I_{EBO}		10	na
Collector Base Breakdown Voltage (I_C=100 ua)	B_{VCBO}	45		volts
Emitter Base Breakdown Voltage (I_E =100 ua)	B_{VEBO}	7		volts
Collector Emitter Breakdown Voltage (I_C=30 ma, (Pulse)	B_{VCEO}	25		volts
Collector Saturation Voltage (I_C=10 ma, I_B=1 ma)	$V_{CE(SAT)}$		1.0	volts
Base Saturation Voltage (I_C=10 ma, I_B=1 ma)	$V_{BE(SAT)}$		0.9	volts
DC Forward Current Transfer (I_C=100 ua, V_{CE} =5V)	h_{FE}	70		
DC Forward Current Transfer (I_C=1.0 ma, V_{CE} =5V)	h_{FE}	80		
DC Forward Current Transfer (I_C=1.0 ma, V_{CE} =5V, T_A=0°C)	h_{FE}	50		

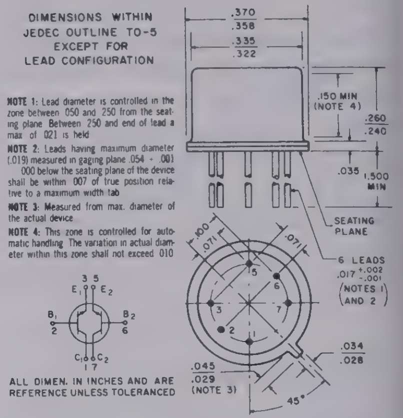
A-C Characteristics

		Min.	Max.	
Input Impedance (L_C=1 ma, V_{CE} =5V, f=1kc)	h_{ib}	20	32	ohms
Gain Band Width Product (I_C=100 ua, V_{CE} =5V, f=20mc)	f_t	11		mc
Gain Band Width Product (I_C=1 ma, V_{CE} =5V, f=20mc)	f_t	55		mc
Collector Capacity (V_{CE} =10V, I_E=0, f=1 mc)	C_{ob}		12	uuf
Input Capacity (V_{EB} =0.5V, I_C=0, f=1mc)	C_{ib}		25	uuf
Noise Figure (I_C=300 ua, V_{CE} =10V, f=1kc, R_G=510 , B.W.=1 cps)	N_F		10	db
Current Transfer Ratio (I_C=1 ma, V_{CE} =5V, f=1kc)	h_{fe}	50		
Output Conductance (I_C=1ma, V_{CE} =5V, f=1kc)	h_{ob}		1.0	umho
Voltage Feedback Ratio (I_C=1 ma, V_{CE} =5V, f=1kc)	h_{rb}		8	X10-4

NPN

2N2913-20

These General Electric Types 2N2913 - 20 are 6-terminal devices containing two completely isolated NPN passivated planar transistors in a hermetically sealed TO-5 package. These devices are designed for use in high performance amplifiers and differential amplifier circuits requiring high gain and low noise at low current.



DIMENSIONS WITHIN JEDEC OUTLINE TO-5 EXCEPT FOR LEAD CONFIGURATION

NOTE 1: Lead diameter is controlled in the zone between 050 and 250 from the seating plane Between 250 and end of lead a max of 021 is held

NOTE 2: Leads having maximum diameter (.019) measured in gaging plane .054 + .001 000 below the seating plane of the device shall be within 007 of true position relative to a maximum width tab

NOTE 3: Measured from max. diameter of the actual device

NOTE 4: This zone is controlled for automatic handling The variation in actual diameter within this zone shall not exceed 010

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

absolute maximum ratings: (25°C) (unless otherwise specified)

Maximum Temperatures	
Storage Temperature	-65 to +200° C
Operating Junction Temperature	200° C
Lead Temperature (Soldering, 60 sec. Time Limit)	300° C

Maximum Power Dissipation	One Side	Both Sides
Total Dissipation		
@ 25° C Case Temperature (Note 1)	0.75 watt	1.5 watts
@ 100° C Case Temperature (Note 2)	0.43 watt	0.86 watt
@ 25° C Ambient Temperature	0.3 watt	0.6 watt

Maximum Voltages and Current for Each Transistor		2N2913 thru 2N918	2N2919, 2N2920
Collector to Base Voltage	V_{CBO}	45 volts	60 volts
Collector to Emitter Voltage	V_{CEO}	45 volts	60 volts
Emitter to Base Voltage	V_{CBO}	6.0 volts	6.0 volts
Collector Current	I_C	30 ma	30 ma

electrical characteristics: (25°C) (unless otherwise specified)

		2N2915 2N2916 2N2919 2N2920		2N2917 2N2918		
		Min	Max	Min	Max	
DC Current Gain Ratio (Note 3) (I_C =100 ua, V_{CE} =5.0 V)	h_{FE1} h_{FE2}	0.9	1.0	0.8	1.0	
Base-Emitter Voltage Differential (I_C =10 ua-1.0 ma, V_{CE} =5.0V)	V_{BE1} -V_{BE2}		5.0		10	mv
Base-Emitter Voltage Differential (I_C =100 ua, V_{CE} =5.0 V)	V_{BE1} -V_{BE2}		3.0		5.0	mv
Base-Emitter Voltage Differential Change (I_C =100 ua, V_{CE} =5.0 V) (T=55°C to 25°C)	(V_{BE1} -V_{BE2})		0.8		1.6	mv
Base-Emitter Voltage Differential Change (I_C =100 ua, V_{CE} =5.0V) (T=25°C to 125°C)	(B_{VE1} -V_{VE2})		1.0		2.0	mv

NOTE 1: Derate 4.3 mw/°C increase in case temperature above 25°C - per transistor.
NOTE 2: Derate 1.71 mw/°C increase in ambient temperature above 25°C - per transistor.
NOTE 3: Lowest of two h_{FE} readings is taken as h_{FE1} for purposes of this ratio.

2N2913-20

electrical characteristics:

		2N2913 2N2915 2N2917 2N2919		2N2914 2N2916 2N2918 2N2920		
		Min	Max	Min.	Max.	
DC Current Gain (I_C=1 ma., V_{CE} =5V)	h_{FE}	150		300		
DC Current Gain (I_C=100ua, V_{CE} =5V)	h_{FE}	100		100		
DC Current Gain (I_C=10ua, V_{CE} =5V)	h_{FE}	60	240	150	600	
DC Current Gain (I_C=0ua, V_{CE} =5V)	$h_{FE(-55°C)}$	15		30		
DC Current Gain (I_C=10ua, V_{CE} =5V)	$h_{FE(-55°C)}$			(2N2920 only) 40		
Collector Saturation Voltage (I_C =1.0ma, I_B =0.1ma)	$V_{CE(SAT)}$		0.35		0.35	volts
Emitter-Base on Voltage (I_C=0.1ma, V_{CE} =5V)	$V_{BE(ON)}$		0.7		0.7	volts
Collector Cutoff Current (I_E = 0, V_{CB} =45V)	I_{CBO}		10		10	na
Collector Cutoff Current (I_E = 0, V_{CB} =45V)	I_{CBO}	(2N2919 only)	2.0	(2N2920 only)	2.0	na
Collector Cutoff Current (I_E = 0, V_{CB} =45V)	$I_{CBO(150°C)}$		10		10	ua
Collector Cutoff Current (I_B = 0, V_{CE} =5V)	I_{CEO}		2.0		2.0	na
Emitter Cutoff Current (I_C =0, V_{EB} =5V)	I_{EBO}		2.0		2.0	na
Output Capacitance (I_E = 0, V_{CB} ,=5V)	C_{ob}		6.0		6.0	pf
High Frequency Current Gain (f=20mc) (I_C =0.5ma, V_{CE} =5V)	h_{fe}	3.0		3.0		
Input Resistance (f=1kc) (I_C =1.0ma, V_{CB} =5V)	h_{ib}	25	32	25	32	ohms
Output Conductance f=1kc) (I_C =1.0ma, V_{CB} =5V)	h_{ob}		1.0		1.0	uohms
Narrow Band Noise Figure (Note 4) (I_C =10ua, V_{CE} =5V)	NF		4.0		3.0	db
Wide Band Noise Figure (Note 5) (I_C =10ua, V_{CE} =5V)	NF		4.0		3.0	db
Collector-Base Breakdown Voltage (I_C =10ua, I_E =0)	BV_{CBO}	45		45		volts
Collector-Base Breakdown Voltage (I_C =10ua, I_E =0)	BV_{CBO}	(2N2919 only) 60		(2N2920 only) 60		volts
Collector-Emitter Sustaining Voltage (I_C =10ma, I_B = 0) (Pulsed, Note 6)	$V_{CEO(SUST)}$	45		45		volts
(I_C =10ma, I_B =0)		60		(2N2920 only) 60		volts
Emitter to Base Breakdown Voltage (I_E =10ua, I_C =0)	BV_{EBO}	6.0		6.0		volts

NOTE 4: Frequency = 1000cps; 200 cycle power bandwidth.

NOTE 5: The amplifier used for this measurement has a power bandwidth of 15.7 kc and a response which rolls off 6 db per octave where the 3 db points are approximately at 25 cps and 10 kc.

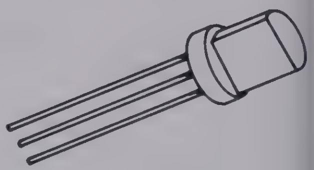
NOTE 6: Pulse conditions: length ≦ 300usec; duty cycle ≦ 1%.

Silicon
Transistors

NPN

2N2923,4,5

The General Electric 2N2923, 2N2924 and 2N2925 are a family of planar passivated NPN silicon transistors intended for general purpose applications. The planar passivated construction assures excellent device stability and life. These high performance, high value devices are made possible by utilizing advanced manufacturing techniques and epoxy encapsulation.



absolute maximum ratings: (25°C) (unless otherwise specified)

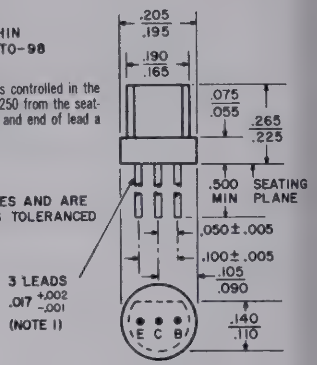
Voltages		
Collector to Emitter	V_{CEO}	25 V
Emitter to Base	V_{EBO}	5 V
Collector to Base	V_{CBO}	25 V
Current		
Collector (Steady State)*	I_C	100 mA
Dissipation		
Total Power (Free air at 25°C)**	P_T	360 mW
Total Power (Free air at 55°C)**	P_T	250 mW
Temperature		
Storage	T_{stg}	–55 to +150°C
Operating	T_j	+125°C

*Determined from power limitations due to saturation voltage at this current.
**Derate 3.6 mW/°C increase in ambient temperature above 25°C.

DIMENSIONS WITHIN JEDEC OUTLINE TO-98

NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED



electrical characteristics: (25°C) (unless otherwise specified)

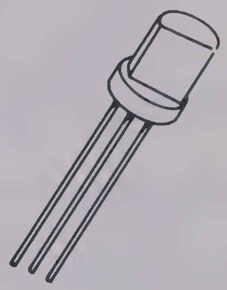
		Min.	Typ.	Max.	
D-C CHARACTERISTICS					
Collector Cutoff Current ($V_{CB} = 25V$)	I_{CBO}			0.1	μA
($V_{CB} = 25V, T_A = 100°C$)	I_{CBO}			15	μA
Emitter Cutoff Current ($V_{EB} = 5V$)	I_{EBO}			0.1	μA
Forward Current Transfer Ratio ($V_{CE} = 4.5V, I_C = 2$ mA)	h_{FE}				
2N2923			115		
2N2924			155		
2N2925			215		
SMALL SIGNAL CHARACTERISTICS					
Forward Current Transfer Ratio ($V_{CE} = 10V, I_C = 2$ mA, f = 1kHz)	h_{fe}				
2N2923		90		180	
2N2924		150		300	
2N2925		235		470	
Input Impedance ($V_{CE} = 10V, I_C = 2$ mA, f = 1kHz)	h_{ib}		15		ohms
HIGH FREQUENCY CHARACTERISTICS					
Collector Capacitance ($V_{CB} = 10V, I_E = 0$, f = 1MHz)	C_{cbo}	4.5	7	10	pF
Gain Bandwidth Product ($I_C = 4$ mA, $V_{CE} = 5V$)	f_T		160		MHz
NOISE					
Noise Figure ($I_C = 100$ μA, $V_{CE} = 5V$, f = 10kHz, BW = 1 Hz, Rg = 2000Ω)	N. F.		2.8 (2N2925 only)		dB

Silicon
Transistor

NPN

2N2926

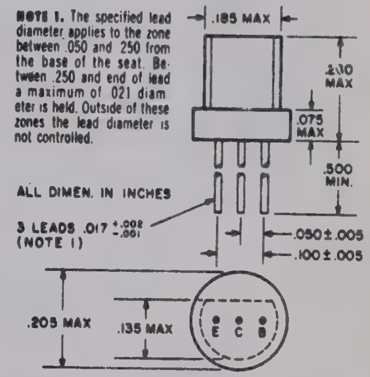
The General Electric 2N2926 is a planar passivated silicon transistor intended for general purpose applications. The planar passivated construction assures excellent device stability and life. This high performance, high value device is made possible by advanced manufacturing techniques, epoxy encapsulation, and utilization of the full line distribution of hfe. This full line distribution is supplied in five beta categories, each with a 2-1 beta spread. Each beta category is color coded and the per cent of the total order shipped in each category is shown below. Significant savings may be realized by designing equipment utilizing all beta categories in proportions compatible with this "full line distribution" type.



absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	25	V
Emitter to Base	V_{EBO}	5	V
Collector to Base	V_{CBO}	25	V
Current			
Collector (Steady State)*	I_C	100	mA
Dissipation			
Total Power (Free air at 25°C)**	P_T	200	mW
Total Power (Free air at 25°C)**	P_T	120	mW
Temperature			
Storage	T_{STG}	-55 to +150°C	
Operating	T_J	+100°C	
Lead Temperature, 1/16" ± 1/32" from case for 10 seconds max.	T_L	+260°C	

*Determined from power limitations due to saturation voltage at this current.
**Derate 2.67 mW/°C increase in ambient temperature above 25°C.



NOTE 1. The specified lead diameter applies to the zone between .050 and 250 from the base of the seat. Between .250 and end of lead a maximum of 021 diameter is held. Outside of these zones the lead diameter is not controlled.

electrical characteristics: (25°C) (unless otherwise specified)

D-C CHARACTERISTICS				
Collector Cutoff Current				
(V_{CB} = 18V)	I_{CBO}		0.5	μa
(V_{CB} = 18V, T_A = 100°C)	I_{CBO}		15	μa
Emitter Cutoff Current				
(V_{EB} = 5V)	I_{EBO}		0.5	μa
SMALL SIGNAL CHARACTERISTICS				
Forward Current Transfer Ratio				
(V_{CE} = 10V, I_C = 2ma, f = 1kc)	h_{fe}	35	470	

Each unit will be branded with the 2N2926 type number and will also be color coded to identify the A-C beta range into which it falls. Segregation of the beta distribution into the following five groups is provided, though it is not a requirement of the JEDEC registration. Typical D-C beta is also shown for guidance purposes.

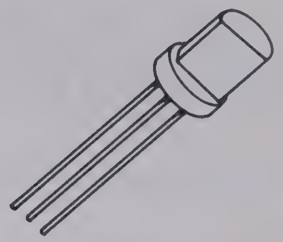
Color Code	(V_{CE} = 10V, I_C = 2ma, f = 1kc)		(V_{CE} = 4.5V, I_C = 2ma)	
	Min.	Max.	Typ.	Content
Brown	35	70	36	0-6%
Red	55	110	62	5-10%
Orange	90	180	115	20-26%
Yellow	150	300	155	35-45%
Green	235	470	215	20-30%

		Min.	Typ.	Max.	
Input Impedance: (V_{CE} = 10V, I_C = 2ma, f = 1kc)	h_{ib}		15		ohm
HIGH FREQUENCY CHARACTERISTICS					
Collector Capacitance (V_{CB} = 10V, I_E = 0, f = 1mc)	C_{ob}	4.5	7	10	pf
Gain Bandwidth Product (I_C = 2ma, V_{CB} = 5V)	f_t		120		mc

Silicon Transistors

NPN
2N3390

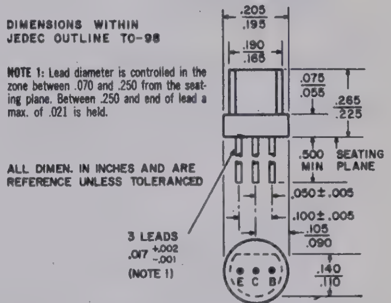
The General Electric 2N3390 is an NPN silicon planar passivated transistor designed as a small signal industrial amplifier. This device features tight beta control at an extremely low price.



absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	18	V
Emitter to Base	V_{EBO}	5	V
Collector to Base	V_{CBO}	18	V
Current			
Collector (Steady State)*	I_C	100	ma
Dissipation			
Total Power (Free air at 25°C)**	P_T	360	mw
Total Power (Free air at 55°C)**	P_T	260	mw
Temperature			
Storage	T_{STG}	-55 to +125°C	
Operating	T_J	+125°C	

*Determined from power limitations due to saturation voltage at this current.
**Derate 2.67 mw/°C increase in ambient temperature above 25°C.


DIMENSIONS WITHIN JEDEC OUTLINE TO-98
NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.
ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED
3 LEADS
.017 +.002 -.001
(NOTE 1)
.205 .195
.190 .165
.075 .055
.265 .225
.500 MIN
SEATING PLANE
.050±.005
.100±.005
.105 .090
.140 .110
E C B

---

electrical characteristics: (25°C) (unless otherwise specified)

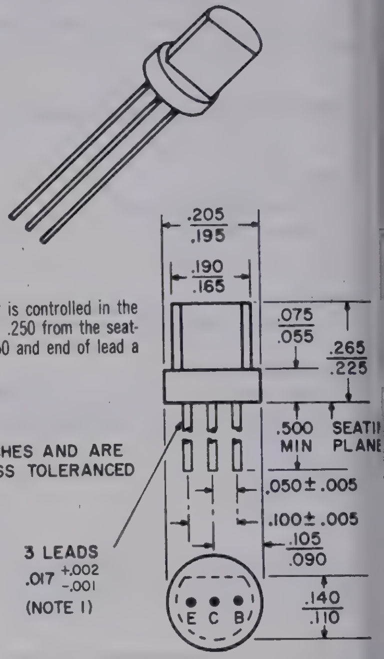
	Sym.	Min.	Max.	Units
STATIC CHARACTERISTICS				
Collector Cutoff Current				
(V_{CB} = 18V)	I_{CBO}		0.1	μA
(V_{CB} = 18V, T_A = 100°C)	I_{CBO}		10.0	μA
Emitter Cutoff Current				
(V_{EB} = 5V)	I_{EBO}		0.1	μA
Collector Cutoff Current				
(V_{CE} = 25V)	I_{CES}		0.1	μA
Forward Current Transfer Ratio				
(V_{CE} = 4.5V, I_C = 2mA)	h_{FE}	400	800	
Collector-Emitter Breakdown Voltage				
(I_C = 1mA)	$V_{(BR)CEO}$	25		V
DYNAMIC CHARACTERISTICS				
Forward Current Transfer Ratio				
(V_{CE} = 4.5V, I_C = 2mA, f = 1kHz)	h_{fe}	400	1250	
Output Capacitance, Common Base				
(V_{CB} = 10V, I_E = 0, f = 1MHz)	C_{cbo}	2	10	pF

Silicon
Transistors

NPN

2N3391,A

The General Electric 2N3391 and 2N3391A are NPN silicon planar passivated devices intended for low noise preamplifier applications. The planar passivated construction assures excellent device stability and life. These high performance, high value transistors are made possible by utilizing advanced manufacturing techniques.



NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED
TO-98

absolute maximum ratings (25°C) unless otherwise specified

Voltages			
Collector to Emitter	V_{CEO}	25	V
Emitter to Base	V_{EBO}	5	V
Collector to Base	V_{CBO}	25	V
Current			
Collector (Steady State)(1)	I_C	100	mA
Dissipation			
Total Power (Free Air @ 25°C)(2)	P_T P_T	360	mW
Temperature			
Storage	T_{stg}	−55 to +150	°C
Operating	T_J	+125	°C
Lead Soldering, 1/16" ± 1/32" from case for 10 seconds max.	T_L	+260	°C

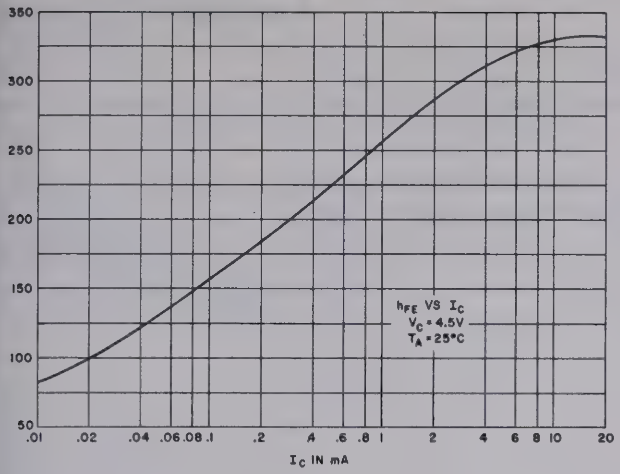
(1) Determined from power limitations due to saturation voltage at this current.
(2) Derate 3.6 mW/°C increase in ambient temperautre above 25°C.

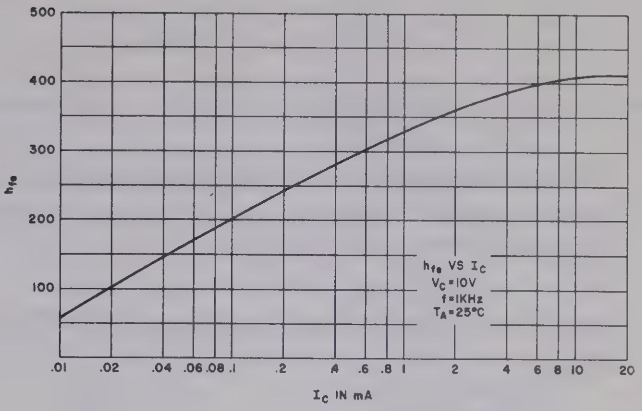
electrical characteristics (25°C) unless otherwise specified

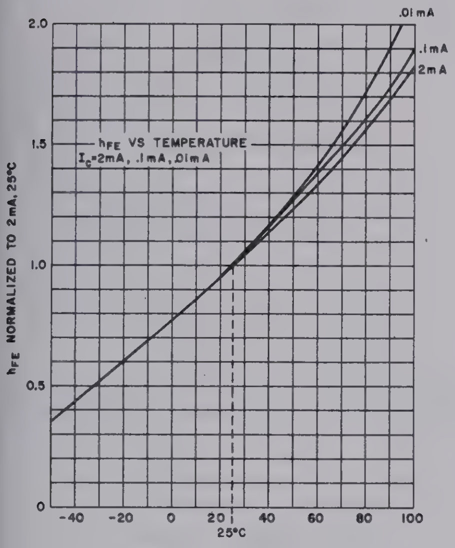
		Min.	Typ.	Max.	
Collector Cutoff Current					
($V_{CB} = 25V$)	I_{CBO}			.1	μA
($V_{CB} = 25V$, $T_A = 100°C$)	I_{CBO}			10	μA
Emitter Cutoff Current ($V_{EB} = 5V$)	I_{EBO}			.1	μA
Forward Current Transfer Ratio ($V_{CE} = 4.5V$, $I_C = 2$ mA)	h_{FE}	250		500	
SMALL SIGNAL CHARACTERISTICS					
Forward Current Transfer Ratio ($V_{CE} = 10V$, $I_C = 100$ μA, f = 1 KHz)	h_{fe}	170(3)	200		
Input Impedance ($V_{CB} = 10V$, $I_C = 2$ mA, f = 1 KHz)	h_{ib}		15		ohms
Output Capacitance ($V_{CB} = 10V$, $I_E = 0$, f = 1 MHz)	C_{cbo}	2.0	7	10	pF
Gain Bandwidth Product ($I_C = 2$ mA, $V_{CE} = 5$ V)	f_t		120		MHz
NOISE (wide band—15 Hz to 10 KHz, Equivalent Noise Bandwidth = 15.7 KHz)					
Noise Figure ($I_C = 100$ μA, $V_{CE} = 4.5V$, $R_g = 5000$ ohms)	NF		1.9	5(4)	db

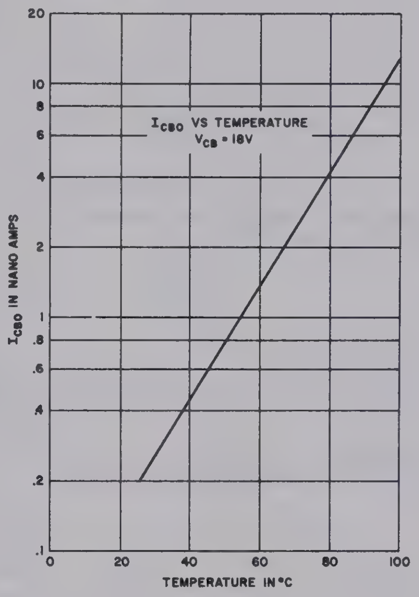
(3) Typically a minimum of 95% of the distribution is above this value.
(4) Type 2N3391A only.

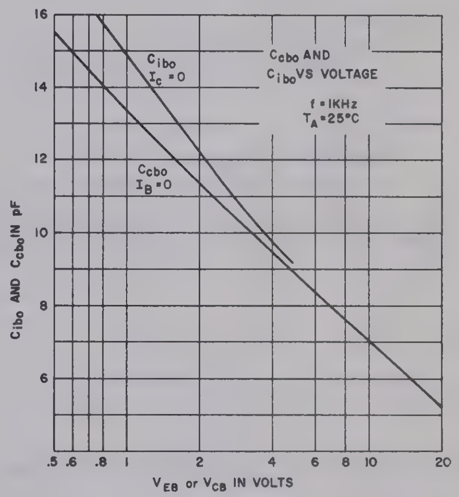
TYPICAL CURVES

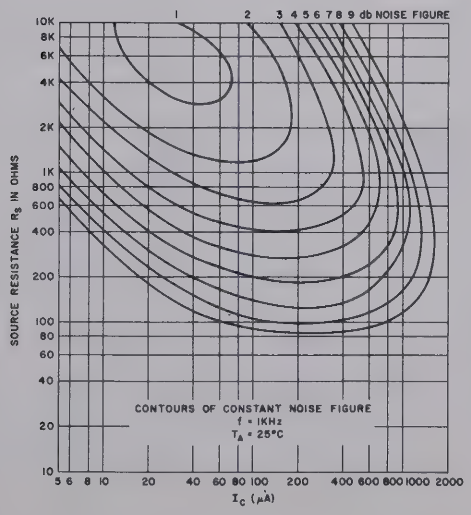


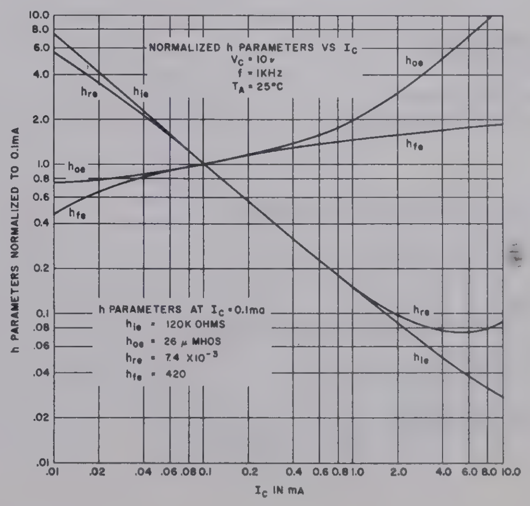










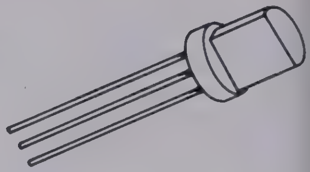


Silicon
Transistors

NPN

2N3392;3,4

The General Electric 2N3392, 2N3393 and 2N3394 are NPN silicon planar passivated transistors designed as small signal amplifiers. These devices feature tight beta control at an extremely low price.



absolute maximum ratings: (25°C) (unless otherwise specified)

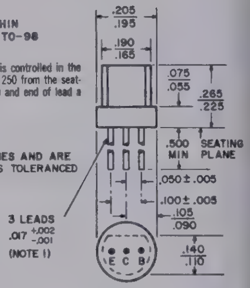
Voltages			
Collector to Emitter	V_{CEO}	25	V
Emitter to Base	V_{EBO}	5	V
Collector to Base	V_{CBO}	25	V
Current			
Collector (Steady State) ⁽¹⁾	I_C	100	mA
Dissipation			
Total Power (free air at 25°C) ⁽²⁾	P_T	360	mW
Total Power (free air at 55°C) ⁽²⁾	P_T	260	mW
Temperature			
Storage	T_{stg}	−55 to +125	°C
Operating	T_J	+125	°C
Lead Temperature, 1/16" ± 1/32" from case for 10 seconds max.	T_L	+260	°C

⁽¹⁾ Determined from power limitations due to saturation voltage at this current.
⁽²⁾ Derate 2.67 mw/°C increase in ambient temperature above 25°C.

DIMENSIONS WITHIN JEDEC OUTLINE TO-98

NOTE 1: Lead diameter is controlled in the zone between 070 and 250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

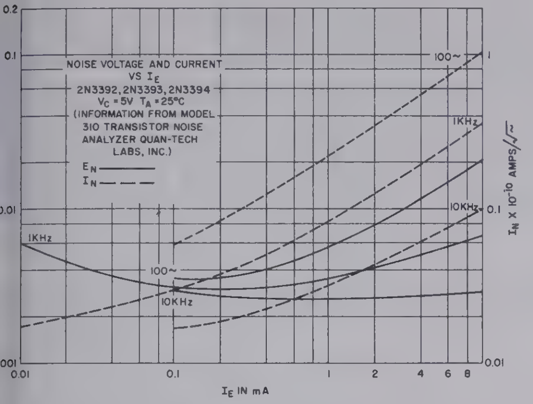


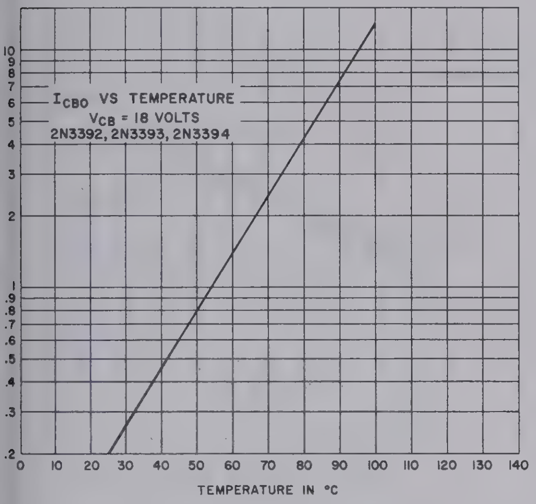
electrical characteristics: (25°C) (unless otherwise specified)

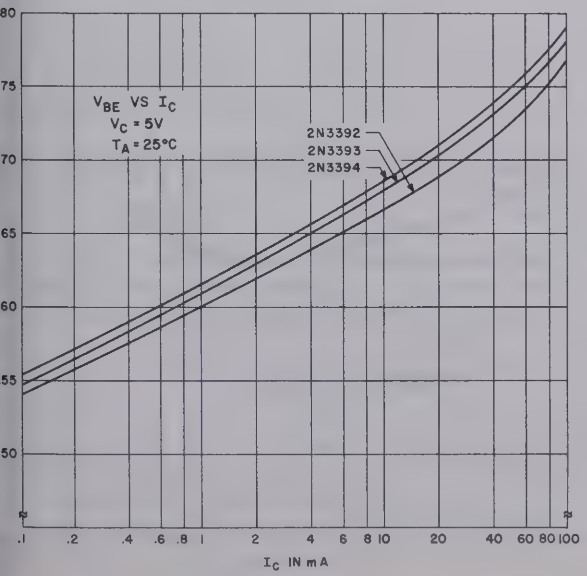
DC CHARACTERISTICS			Min.	Typ.	Max.	
Collector Cutoff Current						
($V_{CB} = 25V$, $I_E = 0$)		I_{CBO}			0.1	μA
($V_{CB} = 25V$, $T_A = 100°C$)		I_{CBO}			10	μA
Emitter Cutoff Current						
($V_{EB} = 5V$, $I_C = 0$)		I_{EBO}			0.1	μA
Collector to Emitter Voltage						
($I_C = 1$ mA)		V_{CEO}	25			volts
Forward Current Transfer Ratio						
($V_{CE} = 4.5V$, $I_C = 2$ mA)	2N3392	h_{FE}	150		300	
	2N3393	h_{FE}	90		180	
	2N3394	h_{FE}	55		110	
SMALL SIGNAL CHARACTERISTICS						
Output Capacitance						
($V_{CB} = 10V$, $I_E = 0$, $f = 1$ MHz)		C_{cb}	4.5	7	10	pf
Input Impedance						
($V_{CB} = 10V$; $I_C = 2$ mA; $f = 1$ KHz)		h_{ib}		15		ohms
Gain Bandwidth Product						
($I_C = 2$ mA; $V_{CB} = 5V$)		f_t		120		MHz
Forward Current Transfer Ratio						
($I_C = 20$ mA; $V_{CB} = 5V$, $f = 20$ MHz)		h_{fe}		15		

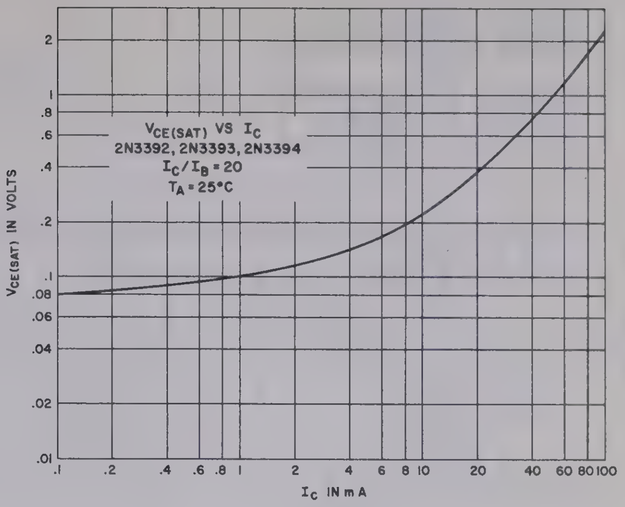
$V_{CE} = 10v$; $I_c = 1mA$; $f = 1KHz$

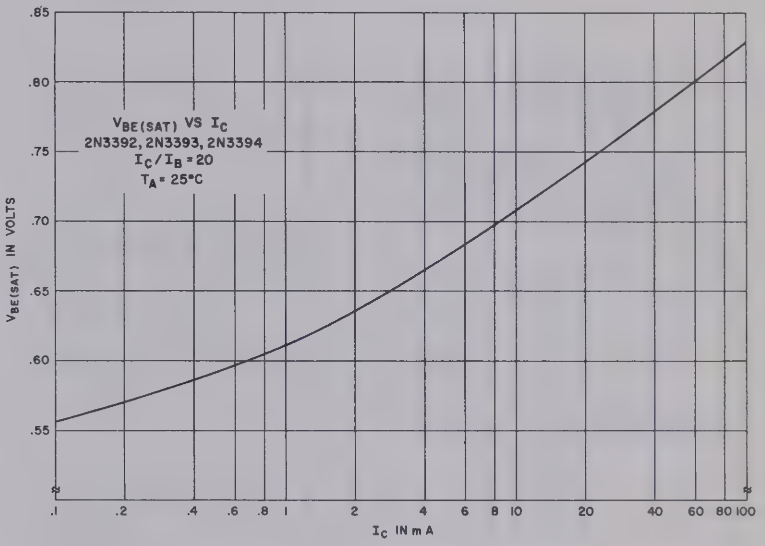
		2N3392	2N3393	2N3394	
Forward Current Transfer Ratio	h_{fe}	208	150	100	
Input Impedance	h_{ie}	6000	3400	2750	ohms
Output Admittance	h_{oe}	14.0	10.0	7.7	μmhos
Voltage Feedback Ratio	h_{re}	.33	.225	.175	$x10^{-3}$

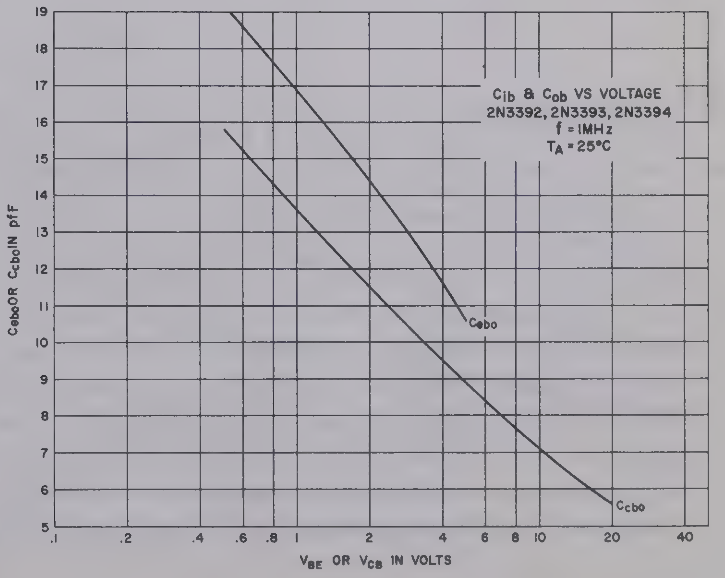


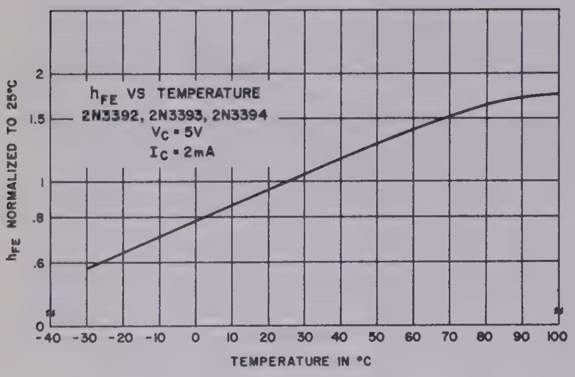




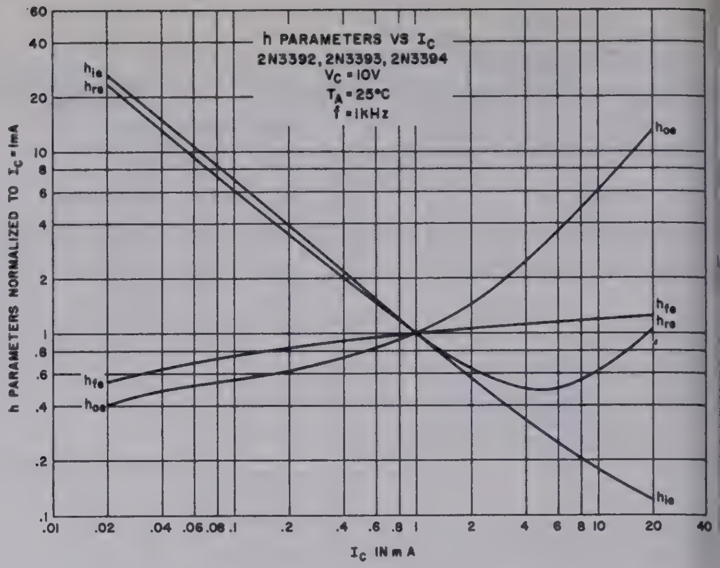




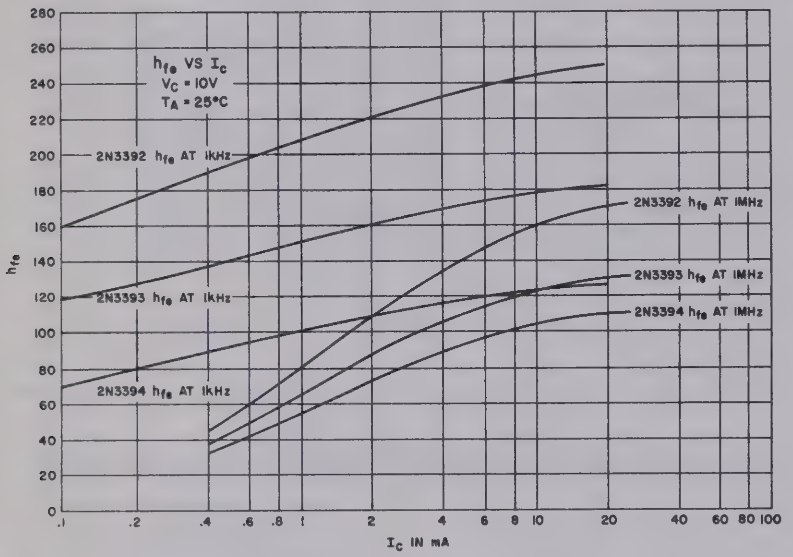




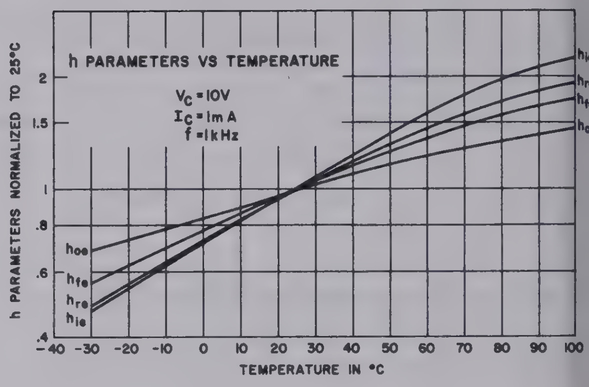
hFE VS TEMPERATURE
2N3392, 2N3393, 2N3394
VC = 5V
IC = 2mA
hFE NORMALIZED TO 25°C
2
1.5
1
.8
.6
0
-40
-30
-20
-10
0
10
20
30
40
50
60
70
80
90
100
TEMPERATURE IN °C



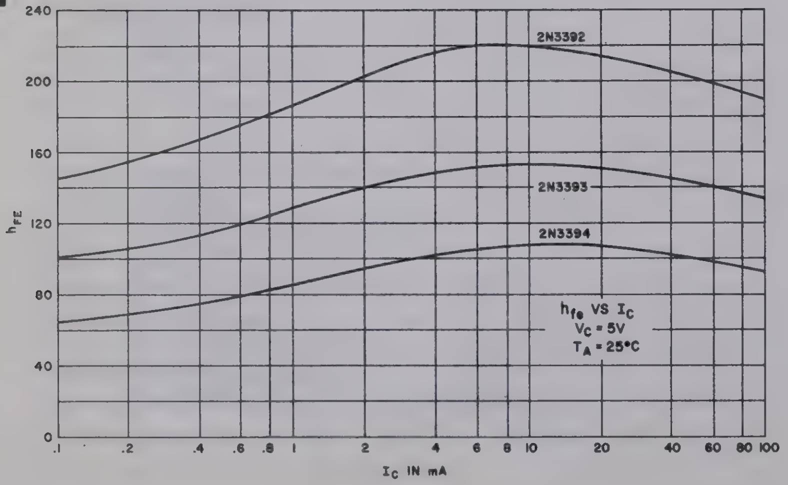
h PARAMETERS VS IC
2N3392, 2N3393, 2N3394
VC = 10V
TA = 25°C
f = 1kHz
h PARAMETERS NORMALIZED TO IC = 1mA
hie
hre
hoe
hfe
hre
hfe
hoe
hie
60
40
20
10
8
6
4
2
1
.8
.6
.4
.2
.1
.01
.02
.04
.06
.08
.1
.2
.4
.6
.8
1
2
4
6
8
10
20
40
IC IN mA



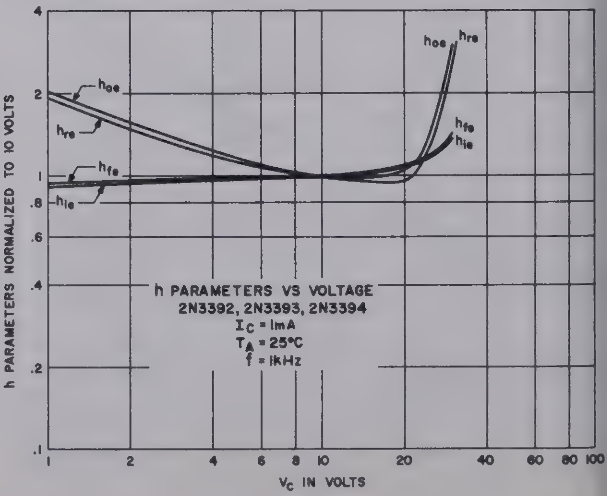
hfe VS IC
VC = 10V
TA = 25°C
2N3392 hfe AT 1kHz
2N3393 hfe AT 1kHz
2N3394 hfe AT 1kHz
2N3392 hfe AT 1MHz
2N3393 hfe AT 1MHz
2N3394 hfe AT 1MHz
hfe
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
.1
.2
.4
.6
.8
1
2
4
6
8
10
20
40
60
80
100
IC IN mA



h PARAMETERS VS TEMPERATURE
VC = 10V
IC = 1mA
f = 1kHz
h PARAMETERS NORMALIZED TO 25°C
hoe
hfe
hre
hie
2
1.5
1
.8
.6
.4
-40
-30
-20
-10
0
10
20
30
40
50
60
70
80
90
100
TEMPERATURE IN °C



2N3392
2N3393
2N3394
hfe VS IC
VC = 5V
TA = 25°C
hFE
240
200
160
120
80
40
0
.1
.2
.4
.6
.8
1
2
4
6
8
10
20
40
60
80
100
IC IN mA



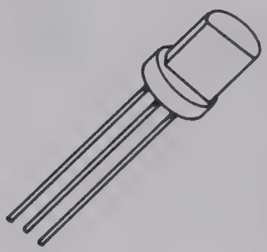
hoe
hre
hfe
hie
hoe
hre
hfe
hie
h PARAMETERS VS VOLTAGE
2N3392, 2N3393, 2N3394
IC = 1mA
TA = 25°C
f = 1kHz
h PARAMETERS NORMALIZED TO 10 VOLTS
4
2
1
.8
.6
.4
.2
.1
1
2
4
6
8
10
20
40
60
80
100
VC IN VOLTS

Silicon
Transistors

NPN

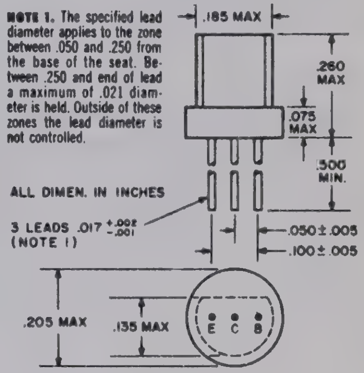
2N3395,6,7,8

The General Electric 2N3395 through 2N3398 are NPN silicon planar passivated transistors designed specifically for application in small signal industrial amplifiers. These devices are spread types which offer tightly controlled beta groups with a guaranteed distribution of groups. Each group is a 2 to 1 beta category and is color coded. The percent of the total order to be shipped in each category is shown on the chart on the back of this specification sheet. Significant savings may be realized by designing equipment using all beta categories in proportions compatible with these spread types.



absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	25	V
Emitter to Base	V_{EBO}	5	V
Collector to Base	V_{CBO}	25	V
Current			
Collector (Steady State)*	I_C	100	ma
Dissipation			
Total Power (Free air at 25°C)**	P_T	360	mw
Total Power (Free air at 55°C)**	P_T	250	mw
Temperature			
Storage	T_{STG}	-55°C to +150°C	
Operating	T_J	+125°C	
Lead Temperature, 1/16" ± 1/32" from case for 10 seconds max.	T_L	+260°C	



NOTE 1. The specified lead diameter applies to the zone between .050 and .250 from the base of the seat. Between .250 and end of lead a maximum of .021 diameter is held. Outside of these zones the lead diameter is not controlled.

* Determined from power limitations due to saturation voltage at this current.
** Derate 3.6 mw/°C increase in ambient temperature above 25°C.

electrical characteristics: (25°C) (unless otherwise specified)

DC Characteristics		Sym.	Min.	Max.	Units
Collector cutoff current (V_{CB} =25V, I_E =0)		I_{CBO}		0.1	ua
Emitter cutoff current (V_{EB} =5V, I_C =0)		I_{EBO}		0.1	ua
Forward current transfer ratio (V_{CE} =4.5V, I_C =2 ma)	2N3395	h_{FE}	150	500	
	2N3396		90	500	
	2N3397		55	500	
	2N3398		55	800	
Grounded-base, open circuit output (V_{CE} =10V) Collector Capacitance (I_E =0, f=1 mc)		C_{ob}	4.5	10	pf

electrical characteristics:

GUARANTEED DISTRIBUTION

h_{FE} Color Code	55-110 Red	90-180 Orange	150-300 Yellow	250-500 White	400-800 Blue
2N3395			35-65%	35-65%	
2N3396		10-60%	10-60%	5-35%	
2N3397	0-15%	10-50%	10-50%	5-35%	
2N3398	0-15%	10-50%	10-50%	5-35%	0-15%

A transistor line generates product with parameter variations. On General Electric Company's economy lines the beta is divided into three to five separate groups from the total line.

On the spread types, General Electric guarantees that a certain percentage of each transistor group will be shipped when you order the type. As an example, suppose you order 1000 pieces of the 2N3396. You may receive 100 orange pieces (h_{FE} =90-180) 600 yellow pieces (h_{FE} =150-300) and 300 white pieces (h_{FE} =250-500). On the other hand, you may receive 600 orange pieces, 300 yellow pieces and 100 white pieces. This flexibility allows us to balance order requirements against actual production types. The savings achieved is passed on to you. If you can't use the spread types, you can still purchase our single line types such as the 2N3391, 2N3392 and 2N3393 at extremely low prices.

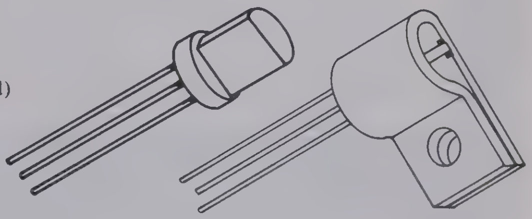
Silicon
Transistor

NPN

2N3402 – 5

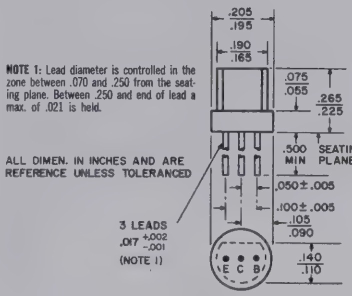
2N3414 – 7

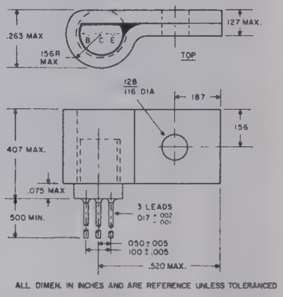
The General Electric Types 2N3402-2N3405 and 2N3414-2N3417 are NPN silicon planar epitaxial passivated transistors intended for general purpose industrial circuits. These transistors are especially suited for high level linear amplifiers or medium speed switching circuits in industrial control applications.



absolute maximum ratings: (25°C) (unless otherwise specified)

		2N3402,3 2N3414,15	2N3404,5 2N3416,17	
Voltages				
Collector to Emitter	V_{CEO}	25	50	V
Emitter to Base	V_{EBO}	5	5	V
Collector to Base	V_{CBO}	25	50	V
Current				
Collector (Steady State)*	I_C	500	500	ma
Dissipation				
Heatsink @ 25°C (2N3402-5)**	P_T	900		mw
Total Power (Free Air @ 25°C)† (2N3402-5)	P_T	560		mw
Total Power (Free Air @ 25°C)‡ (2N3414-17)	P_T	360		mw
Total Power (Free Air @ 65°C)‡ (2N3414-17)	P_T	260		mw
Temperature				
Storage	T_{stg}	−55 to +150		°C
Operating	T_j	+150		°C
Lead Soldering, 1/16" ± 1/32" from case for 10 seconds max.	T_L	+260		°C


.205
.195
.190
.165
NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.
.075
.055
.265
.225
.500 MIN
SEATING PLANE
ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED
.050±.005
.100±.005
.105
.090
3 LEADS
.017 +.002 −.001
(NOTE 1)
E C B
.140
.110


.263 MAX
156R MAX
B C E
127 MAX.
TOP
128
116 DIA
187
156
407 MAX.
.075 MAX
500 MIN.
3 LEADS
017 + 002 − 001
050 ± 005
100 ± .005
.520 MAX.
ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

Determined from power limitations due to saturation voltage at this current.

Derate 7.2 mw/°C increase in case temperature above 25°C.

†Derate 4.47 mw/°C increase in ambient temperature above 25°C.

‡Derate 2.67 mw/°C increase in ambient temperature above 25°C.

electrical characteristics: (25°C)

(unless otherwise specified)

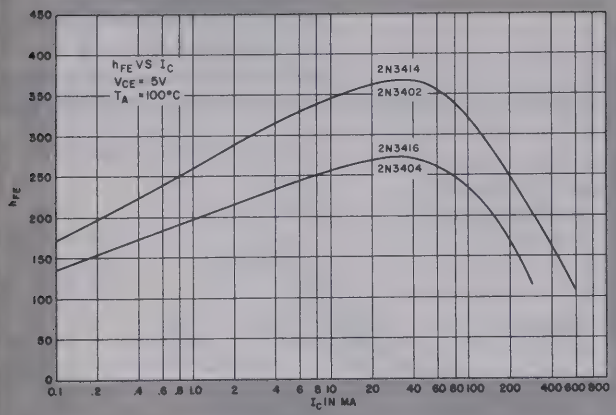
DC CHARACTERISTICS

		2N3402,3 2N3414,5 Min.	 Max.	2N3404,5 2N3416,7 Min.	 Max.	
Collector Cutoff Current ($V_{CB} = 25V$)	I_{CBO}		0.1			μa
($V_{CB} = 25V$, $T_A = 100°C$)	I_{CBO}		15			μa
Collector Cutoff Current ($V_{CB} = 50V$)	I_{CBO}				0.1	μa
($V_{CB} = 50V$, $T_A = 100°C$)	I_{CBO}				15	μa
Emitter Cutoff Current ($V_{EB} = 5V$)	I_{EBO}		0.1		0.1	μa
Collector Saturation Voltage ($I_B = 3$ ma, $I_C = 50$ ma)	$V_{CE(SAT)}$		0.30		0.30	V
Base Saturation Voltage ($I_B = 3$ ma, $I_C = 50$ ma)	$V_{BE(SAT)}$		0.85		0.85	V

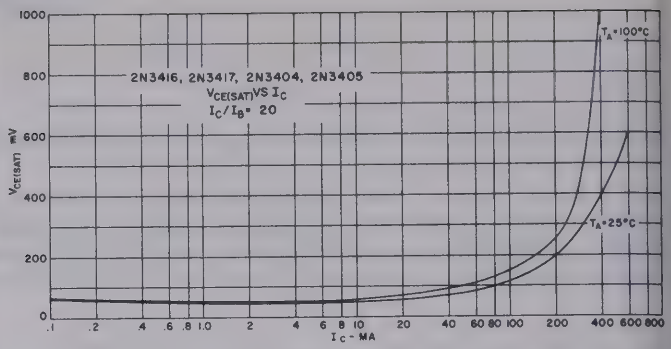
		2N3402,4 2N3414,6 Min.	 Max.	2N3403,5 2N3415,7 Min.	 Max.
Forward Current Transfer Ratio ($V_{CE} = 4.5V$, $I_C = 2$ ma)	h_{FE}	75	225	180	540
SMALL SIGNAL CHARACTERISTICS					
Forward Current Transfer Ratio Collector Voltage, $V_C = 4.5V$, Frequency of measurement = 1000 cps	h_{fe}	75		180	

$V_{CE} = 10V$; $I_C = 1$ ma; f = 1 Kc; $T_A = 25°C$

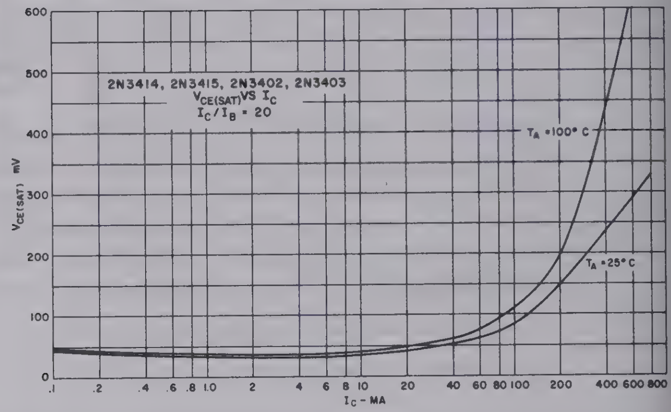
		2N3402 2N3414	2N3403 2N3415	2N3404 2N3416	2N3405 2N3417	
Forward Current Transfer Ratio	h_{fe}	180	330	150	300	
Input Impedance	h_{ie}	5100	9000	4200	8300	ohms
Output Admittance	h_{oe}	14	21	10	20	μmhos
Voltage Feedback Ratio	h_{re}	.27	.45	.2	.4	$\times 10^{-3}$



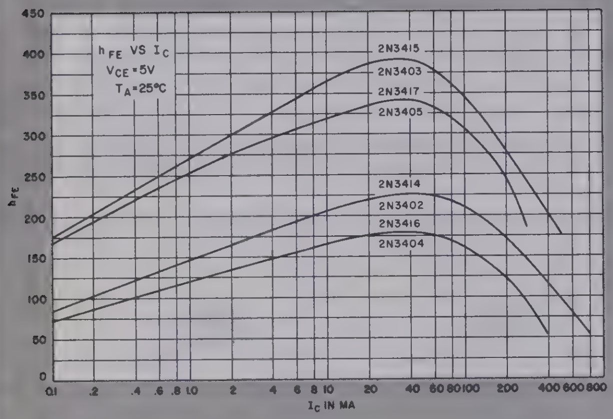
hFE VS IC
VCE = 5V
TA = 100°C
2N3414
2N3402
2N3416
2N3404
hFE
450
400
350
300
250
200
150
100
50
0
0.1 .2 .4 .6 .8 1.0 2 4 6 8 10 20 40 60 80 100 200 400 600 800
IC IN MA



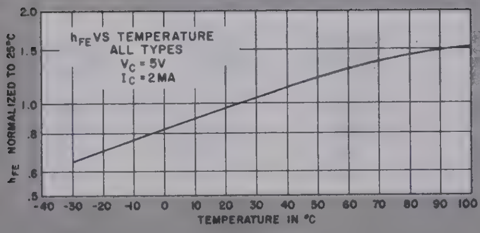
2N3416, 2N3417, 2N3404, 2N3405
VCE(SAT) VS IC
IC/IB = 20
TA = 100°C
TA = 25°C
VCE(SAT) mV
1000
800
600
400
200
0
.1 .2 .4 .6 .8 1.0 2 4 6 8 10 20 40 60 80 100 200 400 600 800
IC - MA



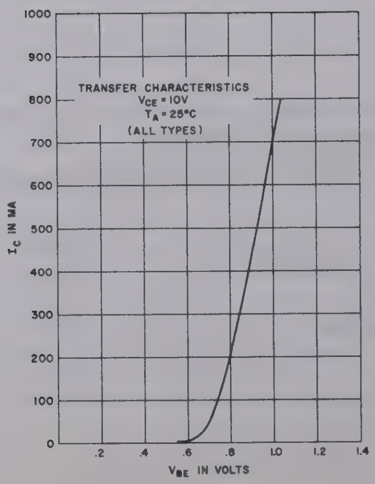
2N3414, 2N3415, 2N3402, 2N3403
VCE(SAT) VS IC
IC/IB = 20
TA = 100° C
TA = 25° C
VCE(SAT) mV
600
500
400
300
200
100
0
.1 .2 .4 .6 .8 1.0 2 4 6 8 10 20 40 60 80 100 200 400 600 800
IC - MA



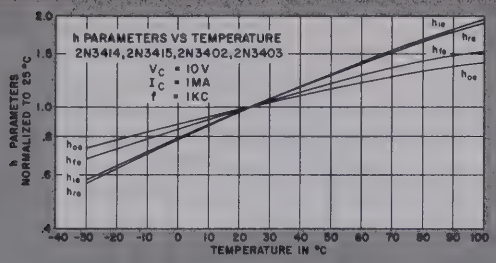
hFE VS IC
VCE = 5V
TA = 25°C
2N3415
2N3403
2N3417
2N3405
2N3414
2N3402
2N3416
2N3404
hFE
450
400
350
300
250
200
150
100
50
0
0.1 .2 .4 .6 .8 1.0 2 4 6 8 10 20 40 60 80 100 200 400 600 800
IC IN MA

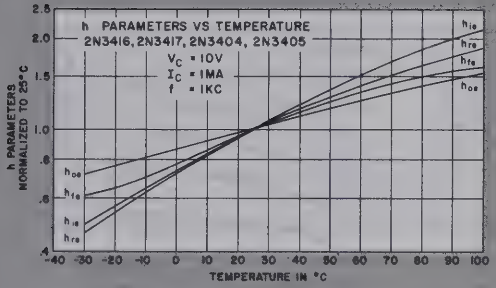


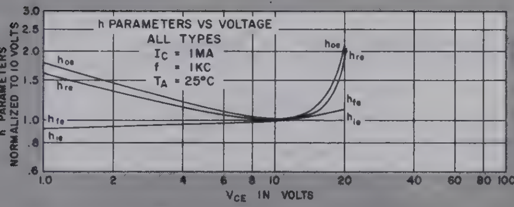
hFE VS TEMPERATURE
ALL TYPES
VC = 5V
IC = 2MA
hFE NORMALIZED TO 25°C
2.0
1.5
1.0
.8
.6
.5
-40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100
TEMPERATURE IN °C

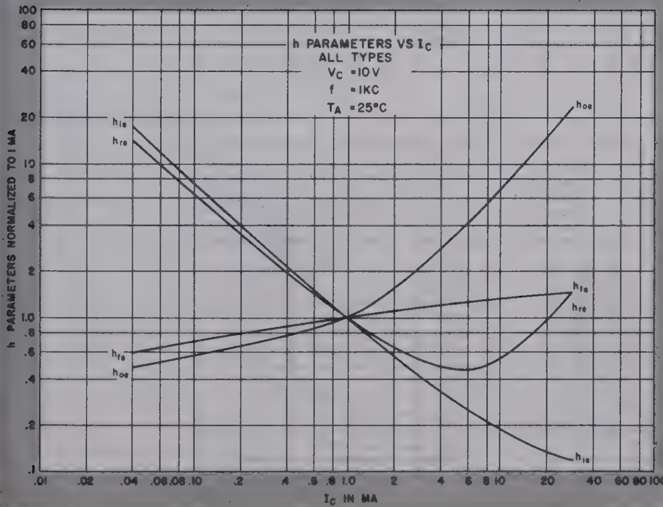


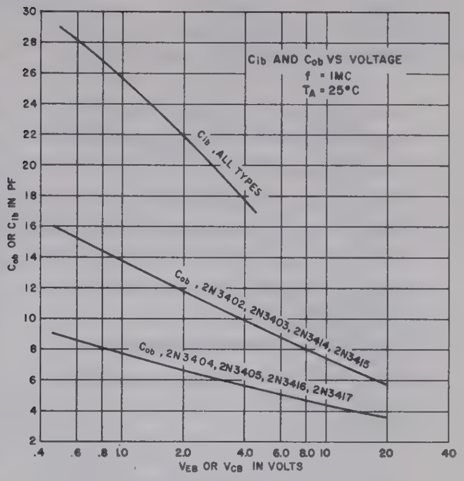
TRANSFER CHARACTERISTICS
VCE = 10V
TA = 25°C
(ALL TYPES)
IC IN MA
1000
900
800
700
600
500
400
300
200
100
0
.2 .4 .6 .8 1.0 1.2 1.4
VBE IN VOLTS

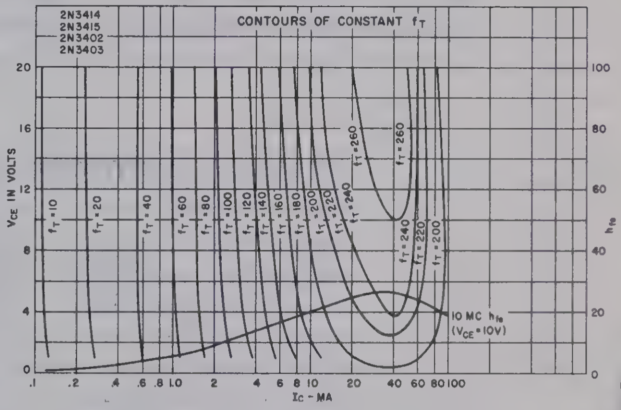

h PARAMETERS VS TEMPERATURE
2N3414, 2N3415, 2N3402, 2N3403
V_C = 10V
I_C = 1MA
f = 1KC
h PARAMETERS NORMALIZED TO 25°C
2.0
1.6
1.0
.8
.6
.4
h_{ie}
h_{re}
h_{fe}
h_{oe}
-40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100
TEMPERATURE IN °C

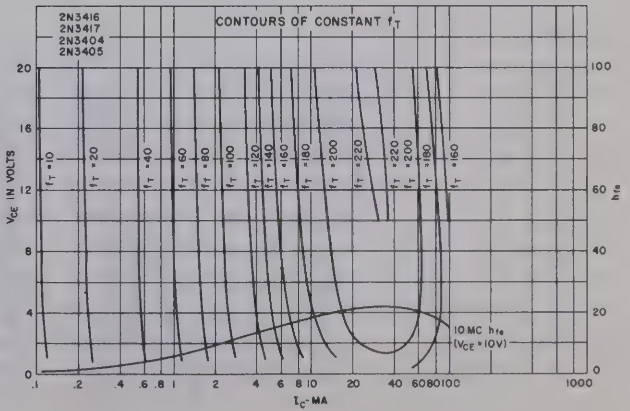

h PARAMETERS VS TEMPERATURE
2N3416, 2N3417, 2N3404, 2N3405
V_C = 10V
I_C = 1MA
f = 1KC
h PARAMETERS NORMALIZED TO 25°C
2.5
2.0
1.5
1.0
.8
.6
.4
h_{ie}
h_{re}
h_{fe}
h_{oe}
-40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100
TEMPERATURE IN °C


h PARAMETERS VS VOLTAGE
ALL TYPES
I_C = 1MA
f = 1KC
T_A = 25°C
h PARAMETERS NORMALIZED TO 10 VOLTS
3.0
2.5
2.0
1.5
1.0
.8
.6
h_{oe}
h_{re}
h_{fe}
h_{ie}
1.0 2 4 6 8 10 20 40 60 80 100
V_{CE} IN VOLTS

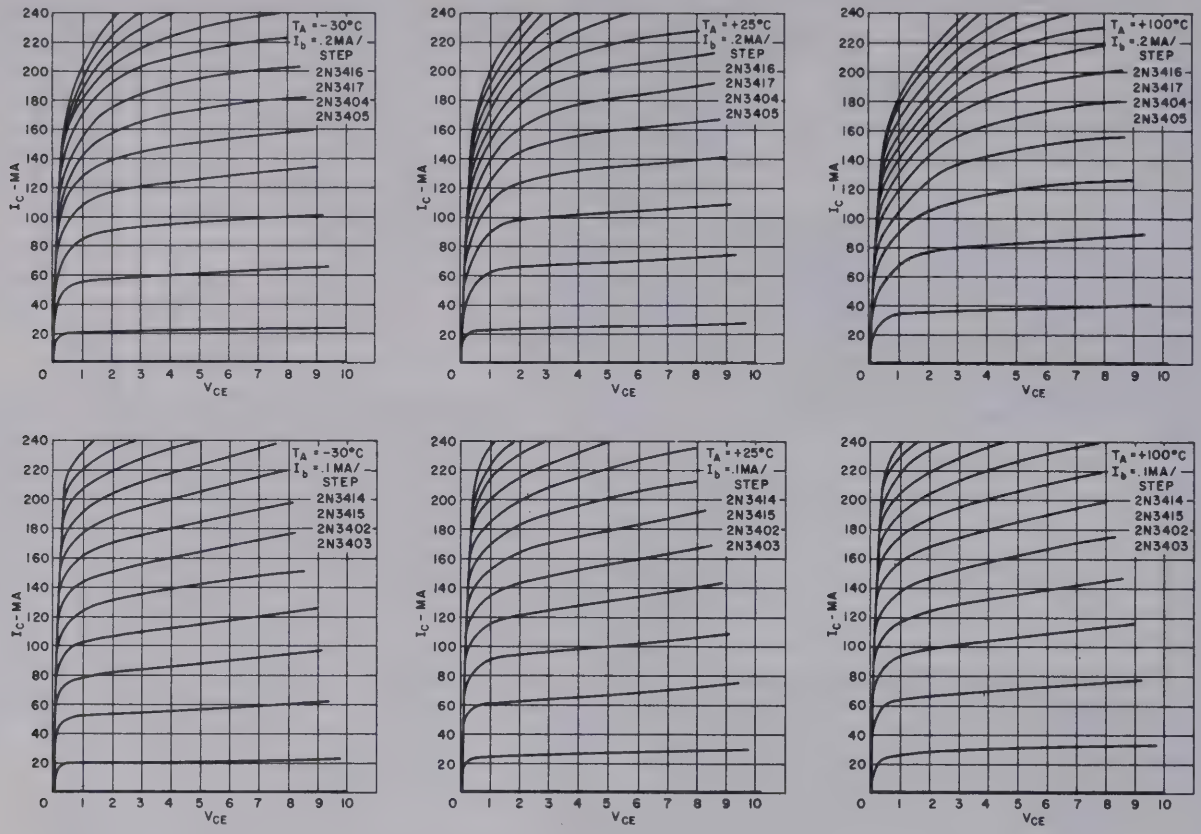

h PARAMETERS VS I_C
ALL TYPES
V_C = 10V
f = 1KC
T_A = 25°C
h PARAMETERS NORMALIZED TO 1 MA
100
80
60
40
20
10
8
6
4
2
1.0
.8
.6
.4
.2
.1
h_{ie}
h_{re}
h_{fe}
h_{oe}
.01 .02 .04 .06 .08 .10 .2 .4 .6 .8 1.0 2 4 6 8 10 20 40 60 80 100
I_C IN MA


C_{ib} AND C_{ob} VS VOLTAGE
f = 1MC
T_A = 25°C
C_{ob} OR C_{ib} IN PF
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
C_{ib}, ALL TYPES
C_{ob}, 2N3402, 2N3403, 2N3414, 2N3415
C_{ob}, 2N3404, 2N3405, 2N3416, 2N3417
.4 .6 .8 1.0 2.0 4.0 6.0 8.0 10 20 40
V_{EB} OR V_{CB} IN VOLTS

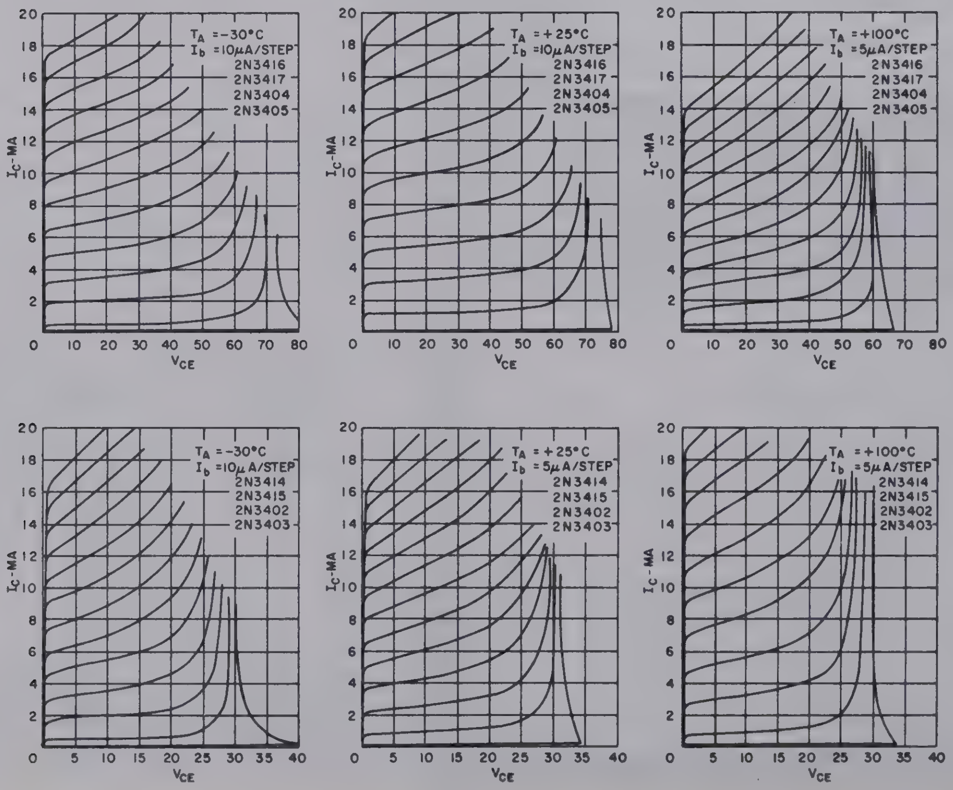

2N3414
2N3415
2N3402
2N3403
CONTOURS OF CONSTANT f_T
V_{CE} IN VOLTS
20
16
12
8
4
0
h_{fe}
100
80
60
40
20
0
f_T = 10
f_T = 20
f_T = 40
f_T = 60
f_T = 80
f_T = 100
f_T = 120
f_T = 140
f_T = 160
f_T = 180
f_T = 200
f_T = 220
f_T = 240
f_T = 260
f_T = 260
f_T = 240
f_T = 220
f_T = 200
10 MC h_{fe}
(V_{CE} = 10V)
.1 .2 .4 .6 .8 1.0 2 4 6 8 10 20 40 60 80 100
I_C - MA


2N3416
2N3417
2N3404
2N3405
CONTOURS OF CONSTANT f_T
V_{CE} IN VOLTS
20
16
12
8
4
0
h_{fe}
100
80
60
40
20
0
f_T = 10
f_T = 20
f_T = 40
f_T = 60
f_T = 80
f_T = 100
f_T = 120
f_T = 140
f_T = 160
f_T = 180
f_T = 200
f_T = 220
f_T = 220
f_T = 200
f_T = 180
f_T = 160
10 MC h_{fe}
(V_{CE} = 10V)
.1 .2 .4 .6 .8 1 2 4 6 8 10 20 40 60 80 100 1000
I_C - MA

Typical Common Emitter Collector Current Characteristic Curves



Typical Common Emitter Characteristic Curves



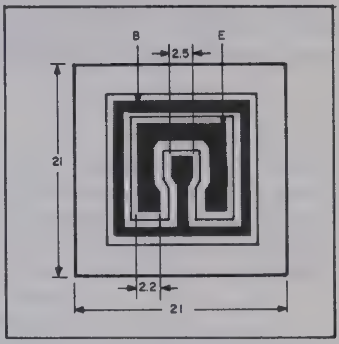
Silicon
Transistor Chips

NPN

2N3414 (Chip)

(M32P-X503)

This General Electric NPN silicon planar passivated epitaxial transistor chip is designed for general purpose circuits. The chip is especially suited for high-level linear amplifiers or medium-speed switching circuits in control applications.



General specifications:

- Gold collector contact backing, minimum thickness—3000Å
- Aluminum base and emitter contact metalization
- Maximum conditions for mounting chips—425°C for 5 minutes (Max.) in an inert atmosphere
- Shipping containers: Glass vials sealed with a nitrogen back-fill
  Maximum of 10k chips per vial
  Egg crate containers available at extra cost
- Chip drawing dimensions are in mils
- Chip thickness = 5.4 $^{+0.8}_{-0.9}$ mils

absolute maximum ratings: ($T_A = 25°C$)

	Symbol		
Voltages			
Collector to Base	V_{CBO}	25	V
Collector to Emitter	V_{CEO}	25	V
Emitter to Base	V_{EBO}	5	V
Current			
Collector	I_C	500	mA
Temperature			
Storage	T_{STG}	−65°C to +200°C	
Operating	T_J	−65°C to +200°C	

electrical characteristics: 100% Probe ($T_A = 25°C$)

Tested at outgoing acceptance to a 10% LTPD with a maximum accept number of 3.

	Symbol	Min.	Max.	
Collector Base Breakdown Voltage ($I_C = 0.1\ \mu A$)	BV_{CBO}	25	—	V
Collector Emitter Breakdown Voltage ($I_C = 10$ mA)	BV_{CEO}	25	—	V
Emitter Base Breakdown Voltage ($I_E = 0.1\ \mu A$)	BV_{EBO}	5	—	V
Forward Current Transfer Ratio ($I_C = 2$ mA, $V_{CE} = 4.5V$)	h_{FE}	75	225	

specifications: ($T_A = 25°C$)

Product yield is at least 93% to each of the following parameters:

	Symbol	Min.	Max.	
Collector Saturation Voltage ($I_C = 50$ mA, $I_B = 3$ mA)	$V_{CE(SAT)}$	—	0.3	V
Base Saturation Voltage ($I_C = 50$ mA, $I_B = 3$ mA)	$V_{BE(SAT)}$	—	1.3	V
Forward Current Transfer Ratio ($I_C = 2$ mA, $V_{CE} = 4.5V$, f = 1 KHz)	h_{fe}	75	340	

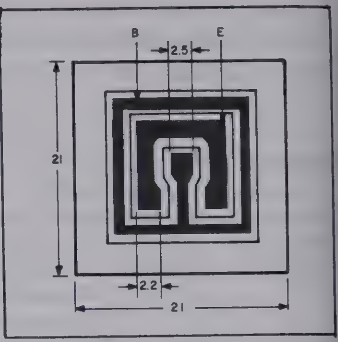
Silicon
Transistor Chips

NPN

2N3415 (Chip)

(M32P-X509)

This General Electric NPN silicon planar passivated epitaxial transistor chip is designed for general purpose circuits. The chip is especially suited for high-level linear amplifiers or medium-speed switching circuits in control applications.



General specifications:
- Gold collector contact backing, minimum thickness—3000Å
- Aluminum base and emitter contact metalization
- Maximum conditions for mounting chips—425°C for 5 minutes (Max.) in an inert atmosphere
- Shipping containers: Glass vials sealed with a nitrogen back-fill
  Maximum of 10k chips per vial
  Egg crate containers available at extra cost
- Chip drawing dimensions are in mils
- Chip thickness = $5.4 \begin{smallmatrix} +0.8 \\ -0.9 \end{smallmatrix}$ mils

absolute maximum ratings: ($T_A = 25°C$)

	Symbol		
Voltages			
Collector to Base	V_{CBO}	25	V
Collector to Emitter	V_{CEO}	25	V
Emitter to Base	V_{EBO}	5	V
Current			
Collector	I_C	500	m
Temperature			
Storage	T_{STG}	−65°C to +200°C	
Operating	T_J	−65°C to +200°C	

electrical characteristics: 100% Probe ($T_A = 25°C$)

Tested at outgoing acceptance to a 10% LTPD with a maximum accept number of 3.

	Symbol	Min.	Max.	
Collector Base Breakdown Voltage ($I_C = 0.1\ \mu A$)	BV_{CBO}	25	—	V
Collector Emitter Breakdown Voltage ($I_C = 10$ mA)	BV_{CEO}	25	—	V
Emitter Base Breakdown Voltage ($I_E = 0.1\ \mu A$)	BV_{EBO}	5	—	V
Forward Current Transfer Ratio ($I_C = 2$ mA, $V_{CE} = 4.5V$)	h_{FE}	180	540	

specifications: ($T_A = 25°C$)

Product yield is at least 93% to each of the following parameters:

	Symbol	Min.	Max.	
Collector Saturation Voltage ($I_C = 50$ mA, $I_B = 3$ mA)	$V_{CE(SAT)}$	—	0.3	V
Base Saturation Voltage ($I_C = 50$ mA, $I_B = 3$ mA)	$V_{BE(SAT)}$	—	1.3	V
Forward Current Transfer Ratio ($I_C = 2$ mA, $V_{CE} = 4.5V$, f = 1 KHz)	h_{fe}	180	800	

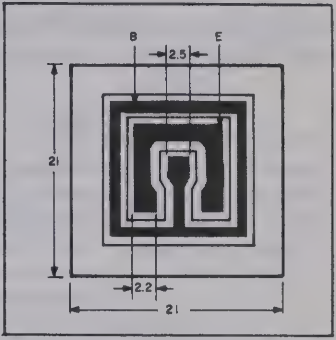
Silicon
Transistor Chips

NPN

2N3416 (Chip)

(M32P-X506)

This General Electric NPN silicon planar passivated epitaxial transistor chip is designed primarily for general purpose circuits. The chip is especially suited for high-level linear amplifiers or medium-speed switching circuits in control applications.



General specifications:

- Gold collector contact backing, minimum thickness—3000Å
- Aluminum base and emitter contact metalization
- Maximum conditions for mounting chips—425°C for 5 minutes (Max.) in an inert atmosphere
- Shipping containers: Glass vials sealed with a nitrogen back-fill
  Maximum of 10k chips per vial
  Egg crate containers available at extra cost
- Chip drawing dimensions are in mils
- Chip thickness = 5.4 $^{+0.8}_{-0.9}$ mils

absolute maximum ratings: ($T_A = 25°C$)

	Symbol		
Voltages			
Collector to Base	V_{CBO}	50	V
Collector to Emitter	V_{CEO}	50	V
Emitter to Base	V_{EBO}	5	V
Current			
Collector	I_C	500	mA
Temperature			
Storage	T_{STG}	−65°C to +200°C	
Operating	T_J	−65°C to +200°C	

electrical characteristics: 100% Probe ($T_A = 25°C$)

Tested at outgoing acceptance to a 10% LTPD with a maximum accept number of 3.

	Symbol	Min.	Max.	
Collector Base Breakdown Voltage ($I_C = 100\ \mu A$)	BV_{CBO}	55	—	V
Collector Emitter Breakdown Voltage ($I_C = 10$ mA)	BV_{CEO}	50	—	V
Emitter Base Breakdown Voltage ($I_E = 100\ \mu A$)	BV_{EBO}	5	—	V
Collector Cutoff Current ($V_{CB} = 50V$)	I_{CBO}	—	0.1	μA
Forward Current Transfer Ratio ($I_C = 2$ mA, $V_{CE} = 4.5V$)	h_{FE}	75	225	

specifications: ($T_A = 25°C$)

Product yield is at least 93% to each of the following parameters:

	Symbol	Min.	Max.	
Collector Saturation Voltage ($I_C = 50$ mA, $I_B = 3$ mA)	$V_{CE(SAT)}$	—	0.3	V
Base Saturation Voltage ($I_C = 50$ mA, $I_B = 3$ mA)	$V_{BE(SAT)}$	—	1.3	V
Forward Current Transfer Ratio ($I_C = 2$ mA, $V_{CE} = 4.5V$, f = 1 KHz)	h_{fe}	75	340	

Silicon

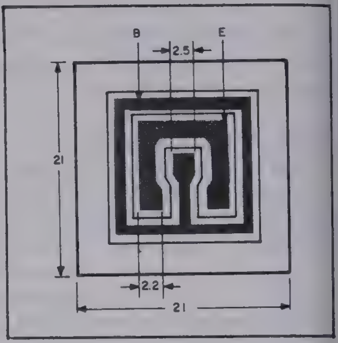
Transistor Chips

NPN

2N3417 (Chip)

(M32P-X508)

This General Electric NPN silicon planar passivated epitaxial transistor chip is designed primarily for general purpose circuits. The chip is suited for high-level linear amplifiers or medium-speed switching circuits in control applications.



General specifications:

- Gold collector contact backing, minimum thickness—3000Å
- Aluminum base and emitter contact metalization
- Maximum conditions for mounting chips—425°C for 5 minutes (Max.) in an inert atmosphere
- Shipping containers: Glass vials sealed with a nitrogen back-fill
  Maximum of 10k chips per vial
  Egg crate containers available at extra cost
- Chip drawing dimensions are in mils
- Chip thickness = 5.4 $^{+0.8}_{-0.9}$ mils

absolute maximum ratings: (T$_A$ = 25°C)

	Symbol		
Voltages			
Collector to Base	V_{CBO}	50	V
Collector to Emitter	V_{CEO}	50	V
Emitter to Base	V_{EBO}	5	V
Current			
Collector	I_C	500	mA
Temperature			
Storage	T_{STG}	−65°C to +200°C	
Operating	T_J	−65°C to +200°C	

electrical characteristics: 100% Probe (T$_A$ = 25°C)

Tested at outgoing acceptance to a 10% LTPD with a maximum accept number of 3.

	Symbol	Min.	Max.	
Collector Base Breakdown Voltage ($I_C = 100\ \mu A$)	BV_{CBO}	55	—	V
Collector Emitter Breakdown Voltage ($I_C = 1$ mA)	BV_{CEO}	50	—	V
Emitter Base Breakdown Voltage ($I_E = 100\ \mu A$)	BV_{EBO}	5	—	V
Collector Cutoff Current ($V_{CB} = 50V$)	I_{CBO}	—	100	nA
Forward Current Transfer Ratio ($I_C = 2$ mA, $V_{CE} = 4.5V$)	h_{FE}	180	540	

specifications: (T$_A$ = 25°C)

Product yield is at least 93% to each of the following parameters:

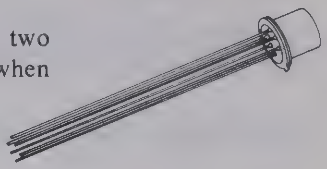
	Symbol	Min.	Max.	
Collector Saturation Voltage ($I_C = 50$ mA, $I_B = 3$ mA)	$V_{CE}{}^{(SAT)}$	—	0.3	V
Base Saturation Voltage ($I_C = 50$ mA, $I_B = 3$ mA)	$V_{BE}{}^{(SAT)}$	—	1.3	V
Forward Current Transfer Ratio ($I_C = 2$ mA, $V_{CE} = 4.5V$; f = KHz)	h_{fe}	180	800	

Silicon
Transistor

NPN

2N3521

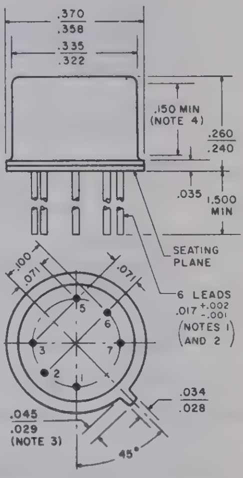
The General Electric type 2N3521 is a NPN planar passivated 6-terminal device containing two completely isolated transistors in a TO-5 package. This device is particularly advantageous when used as a differential amplifier where extremely high gain at low current levels is required.



absolute maximum ratings: (25°C)

		2N3521	
Package		TO-5	
Voltages			
Collector to Base	V_{CBO}	60	volts
Collector to Emitter	V_{CEO}	45	volts
Emitter to Base	V_{EBO}	7	volts
Dissipation (Free air @ 25°C Amb.)			
Each Transistor	P_T	300	mw
Derate		1.72	mw/°C
Both Transistors	P_T	600	mw
Derate		3.43	mw/°C
Dissipation (Case Temp. @ 25°C)			
Each Transistor	P_T	750	mw
Derate		4.28	mw/°C
Both Transistors	P_T	1500	mw
Derate		8.56	mw/°C
Temperatures			
Storage	T_{STG}	−65 to +200	°C
Operating Junction	T_J	200	°C

DIMENSIONS WITHIN JEDEC OUTLINE TO-5 EXCEPT FOR LEAD CONFIGURATION

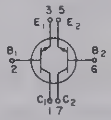


NOTE 1: Lead diameter is controlled in the zone between .050 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

NOTE 2: Leads having maximum diameter (.019) measured in gaging plane .054 + .001 .000 below the seating plane of the device shall be within .007 of true position relative to a maximum width tab.

NOTE 3: Measured from max. diameter of the actual device.

NOTE 4: This zone is controlled for automatic handling. The variation in actual diameter within this zone shall not exceed .010.



ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

electrical characteristics: (25°C) (unless otherwise specified)

		Min.	Max.	
DC CHARACTERISTICS				
Forward Current Transfer Ratio				
$V_{CE} = 5V, I_C = 10\ \mu a$)	h_{FE1}	100	300	
$V_{CE} = 5V, I_C = 500\ \mu a$)	h_{FE2}	155	500	
$V_{CE} = 5V, I_C = 10\ ma$)	h_{FE3}*	200	600	
Collector Base Voltage ($I_C = 100\ \mu a, I_E = 0$)	BV_{CBO}	60		volts
Collector-Emitter Voltage ($I_C = 10\ ma, I_B = 0$)	BV_{CEO}*	45		volts
Emitter-Base Voltage ($I_E = 10\ \mu a, I_C = 0$)	BV_{EBO}	7		volts
Collector Leakage Current ($V_{CB} = 50V, I_E = 0$)	I_{CBO}		10	na
Collector Leakage Current ($V_{CE} = 35V, I_B = 0$)	I_{CEO}		50	na
Collector Leakage Current ($V_{CE} = 35V, V_{BE} = 0$)	I_{CES}		10	na
Collector Leakage Current ($V_{CE} = 35V, V_{BE} = 0$, 125°C)	I_{CES}		10	μa
Emitter Leakage Current ($V_{EB} = 5V, I_C = 0$)	I_{EBO}		10	na
MATCHING CHARACTERISTICS				
DC Beta Match ($V_{CE} = 5V, I_C = 10\ \mu a$)	$\frac{h_{FE1}^{**}}{h_{FE2}}$	.8	1.0	
($V_{CE} = 5V, I_C = 1\ ma$)	$\frac{h_{FE1}^{**}}{h_{FE2}}$	.8	1.0	
Input Voltage Match ($V_{CE} = 5V, I_C = 10\ \mu a$)	$\lvert V_{BE1} - V_{BE2} \rvert$		5	mv
($V_{CE} = 5V, I_C = 1.0\ ma$)	$\lvert V_{BE1} - V_{BE2} \rvert$		10	mv
Voltage Differential Gradient				
($V_{CE} = 5V, I_C = 10\ \mu a, T_A = -40$ to $+100°C$)	$\frac{\Delta \lvert V_{BE1} - V_{BE2} \rvert}{\Delta T}$		10	$\mu v/°C$
($V_{CE} = 5V, I_C = 1\ ma, T_A = -40$ to $+100°C$)	$\frac{\Delta \lvert V_{BE1} - V_{BE2} \rvert}{\Delta T}$		10	$\mu v/°C$
SMALL SIGNAL CHARACTERISTICS				
Saturation Voltage ($I_C = 10\ ma, I_B = 1\ ma$)	$V_{CE(SAT)}$		1.0	volts
Input Voltage ($V_{CE} = 10V, I_C = 5\ ma$)	V_{BE}	.55	.9	volts
Forward Current Transfer Ratio ($V_{CE} = 5V, I_C = 1\ ma, f = 30\ mc$)	h_{fe}	1		
HIGH FREQUENCY CHARACTERISTICS				
Capacitance ($V_{CB} = 5V, I_E = 0, f = 1\ mc$)	C_{ob}		8	pf

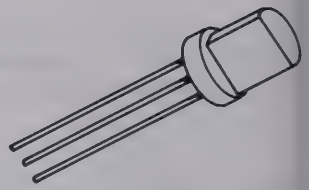
*Pulse width ≦ 300 μsec. Duty cycle ≦ 2%.
**Lowest of two h_{FE} readings is taken as h_{FE1} for purposes of this ratio.

Silicon
Transistors

NPN

2N3662,3

The General Electric 2N3662 and 2N3663 are NPN silicon planar epitaxial transistors designed specifically for high frequency applications. The units are suitable for use as oscillators in UHF television tuners. The units feature a typical circuit power gain of 19 db at 200 MHz.



absolute maximum ratings: (25°C) (unless otherwise specified)

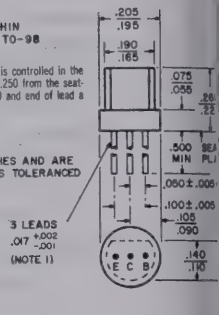
		2N3662	2N3663	
Voltages				
Collector to Base	V_{CBO}	18	30	volts
Emitter to Base	V_{EBO}	3	3	volts
Collector to Emitter	V_{CEO}	12	12	volts
Current				
Collector (Steady State)*	I_C	25	25	mA
Dissipation				
Total Power (Free air @ 55°C)*	P_T	120	120	mW
Total Power (Free air @ 25°C)*	P_T	200	200	mW
Temperature				
Storage Temp.	T_{stg}	−55 to +125°C		
Soldering Temp. 10 sec. $\frac{1}{16} \pm \frac{1}{32}''$ from case		260	260	°C
Operating Junction	T_J	100	100	°C

*Derate 2.67 mW/°C for ambient above 25°C.

DIMENSIONS WITHIN
JEDEC OUTLINE TO-98

NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE
REFERENCE UNLESS TOLERANCED



electrical characteristics: (25°C) (unless otherwise specified)

Static Characteristics

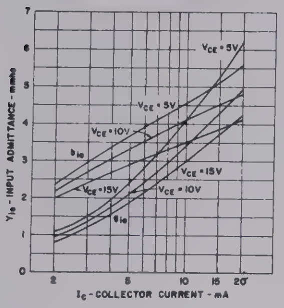
		Min.	Typ.	Max.	
Collector Cutoff Current ($I_E = 0$, $V_{CB} = 15V$)	I_{CBO}			0.5	μA
($I_E = 0$, $V_{CB} = 18V$, $T_A = 85°C$)	I_{CBO}			5.0	μA
Emitter Cutoff Current ($I_C = 0$, $V_{EB} = 2V$)	I_{EBO}			0.5	μA
Forward Current Transfer Ratio ($I_C = 8$ mA, $V_{CE} = 10V$)	h_{FE}	20	75		
Collector Saturation Voltage ($I_C = 10$ mA, $I_B = 1.0$ mA)	$V_{CE(SAT)}$			0.6	volts
Breakdown Voltage, Emitter to Base, Collector Open ($I_E = 100$ μA)	BV_{EBO}	3			volts
Breakdown Voltage, Collector to Emitter Base Open ($I_{CEO} = 3$ mA pulsed, pulse width = 1 μsec., 1% duty cycle)	BV_{CEO}	12			volts
Breakdown Voltage, Collector to Base, emitter open ($I_C = 100$ μA) 2N3662	BV_{CBO}	18			volts
2N3663	BV_{CBO}	30			volts
Dynamic Characteristics					
Output Capacitance ($I_E = 0$, $V_{CB} = 10$, $f = 1$ MHz)	C_{ob}	0.8		1.5	pF
($I_E = 0$, $V_{CB} = 0$, $f = 1$ MHz)	C_{ob}			3.0	pF
Input Capacitance ($I_C = 0$, $V_{EB} = 0.5V$, $f = 1$ MHz)	C_{ib}			2	pF
Forward Current Transfer Ratio ($I_C = 5$ mA, $V_{CE} = 10V$, $f = 100$ MHz)	h_{fe}	7.0	10	21	
Power Gain (See Fig. 2) ($I_C = 6$ mA, $V_{CE} = 12V$, $f = 200$ MHz) 2N3662	A_p	12	16		db
2N3663	A_p	15	19		db
Power Output (See Fig. 1) ($I_C = 10$ mA, $V_{CE} = 12V$, $f = 500$ MHz)	P_o		30		mW
Power Output (See Fig. 3) ($I_C \approx 10$ mA, $V_{CE} = 12V$, $f \approx 940$ MHz)	V_o		5.5		mV
Noise Figure ($I_C = 1$ mA, $V_{CE} = 6V$, $f = 60$ MHz) ($Rg = 400\ \Omega$)	N.F.		4	6.5	db

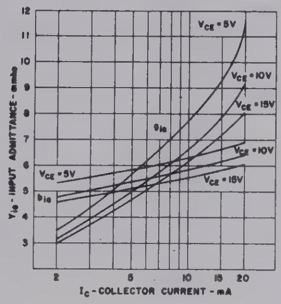
TYPICAL COMMON EMITTER "y" PARAMETERS

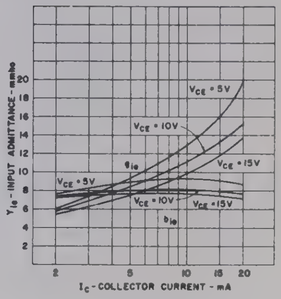
2N3662, 2N3663

f=45 MHz | **f=100 MHz** | **f=200 MHz**

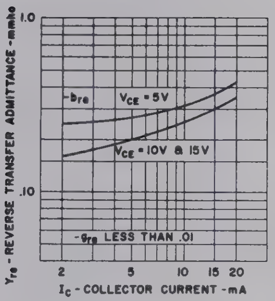
y_{ie}
Input
Admittance
vs.
Collector Current

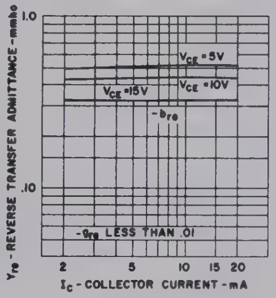


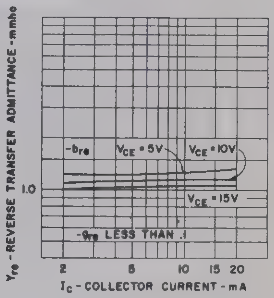




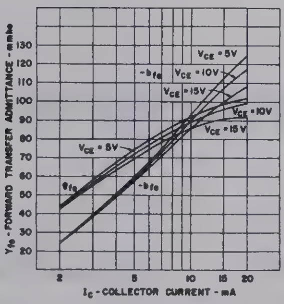
y_{re}
Reverse
Transfer
Admittance
vs.
Collector Current

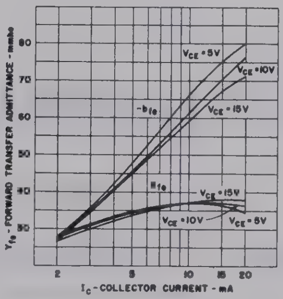


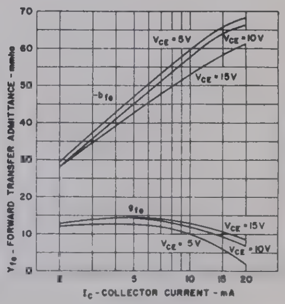




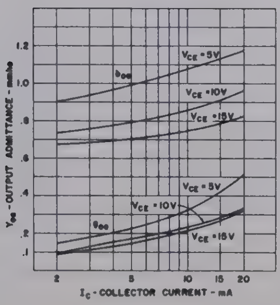
y_{fe}
Forward
Transfer
Admittance
vs.
Collector Current

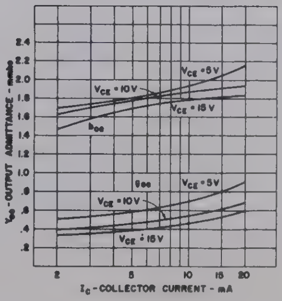


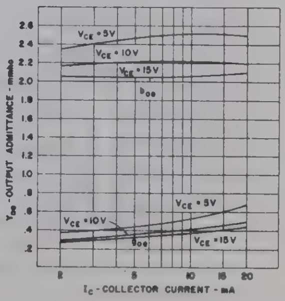




y_{oe}
Output
Admittance
vs.
Collector Current



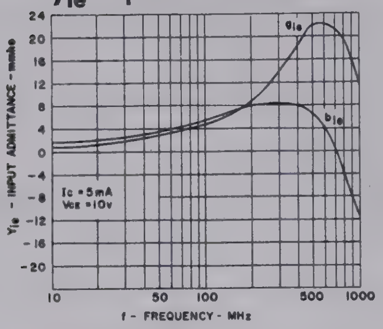




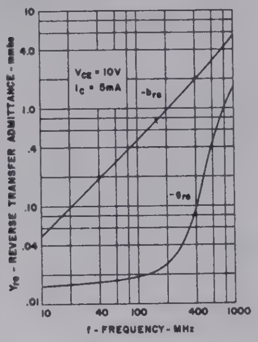
TYPICAL COMMON EMITTER "y" PARAMETERS VERSUS FREQUENCY

2N3662, 2N3663

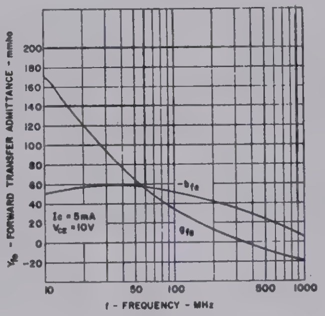
y_{ie} Input Admittance



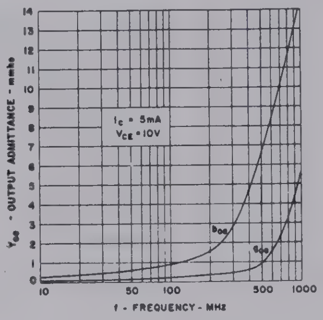
y_{re} Reverse Transfer Admittance



y_{fe} Forward Transfer Admittance

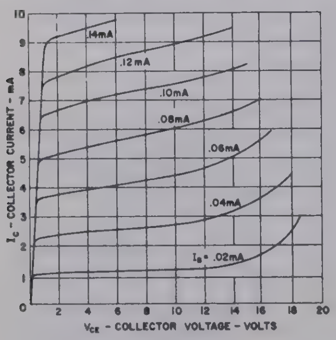


y_{oe} Output Admittance

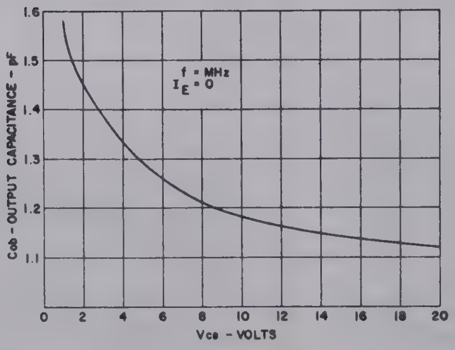


TYPICAL ELECTRICAL CHARACTERISTICS

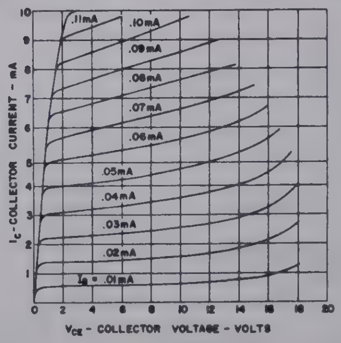
Collector Characteristics $T_A = 25°C$



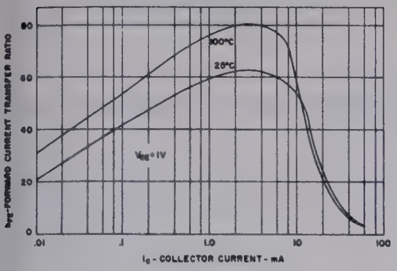
Output Capacity vs. Reverse Voltage Bias



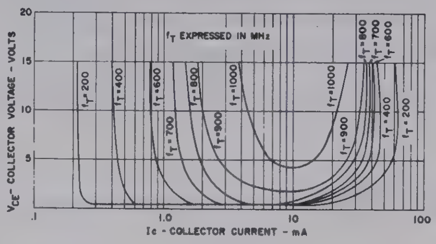
Collector Characteristics T_A = 100



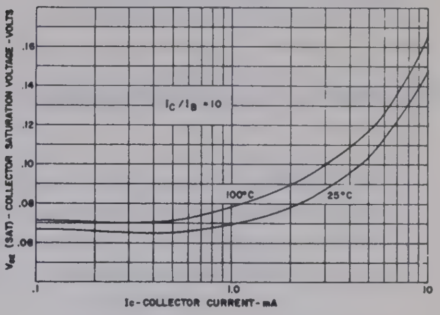
h_{FE} vs. Collector Current



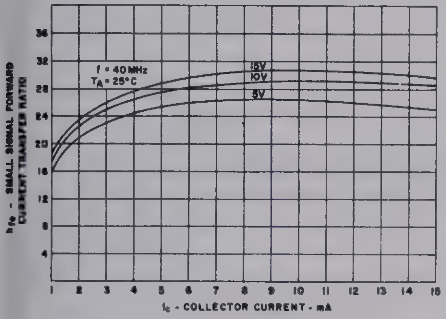
Contours of Gain Bandwidth Product, f_T vs. Collector Current



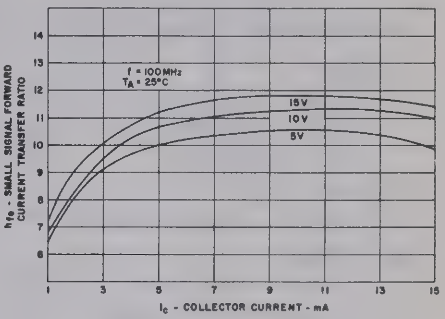
$V_{CE(SAT)}$ vs. Collector Current



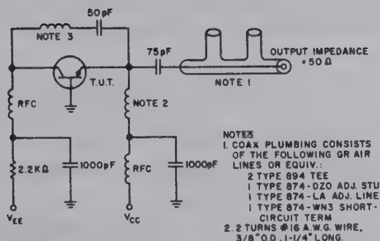
fe vs. Collector Current, f = 40 MHz



h_{fe} vs. Collector Current, f = 100 MHz



TEST CIRCUITS


50pF
NOTE 3
75pF
OUTPUT IMPEDANCE = 50 Ω
T.U.T.
NOTE 1
RFC
NOTE 2
2.2KΩ
1000pF
RFC
1000pF
V_{EE}
V_{CC}

NOTES
1. COAX PLUMBING CONSISTS OF THE FOLLOWING GR AIR LINES OR EQUIV.:
   - 2 TYPE 894 TEE
   - 1 TYPE 874-DZO ADJ. STUB
   - 1 TYPE 874-LA ADJ. LINE
   - 1 TYPE 874-WN3 SHORT-CIRCUIT TERM
2. 2 TURNS #16 A.W.G. WIRE, 3/8" O.D., 1-1/4" LONG.
3. 9 TURNS # 22 A.W.G. WIRE, 3/16" O.D., 1/2" LONG.

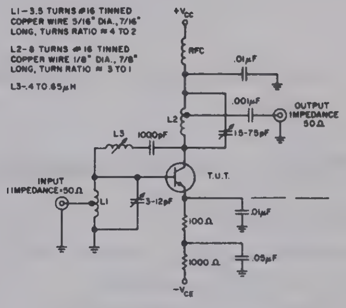
500 MHz OSCILLATOR TEST CIRCUIT (P_O)

Figure 1

L1 – 3.5 TURNS #16 TINNED COPPER WIRE 5/16" DIA., 7/16" LONG, TURNS RATIO ≈ 4 TO 2

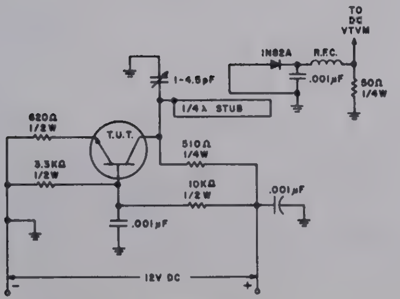
L2 – 8 TURNS #16 TINNED COPPER WIRE 1/8" DIA., 7/8" LONG, TURN RATIO ≈ 3 TO 1

L3 – .4 TO .65μH


+V_{CC}
RFC
.01μF
.001μF
OUTPUT IMPEDANCE 50Ω
L2
1.5-7.5pF
L3
1000pF
T.U.T.
INPUT IMPEDANCE=50Ω
L1
3-12pF
.01μF
100Ω
1000Ω
.05μF
-V_{CE}

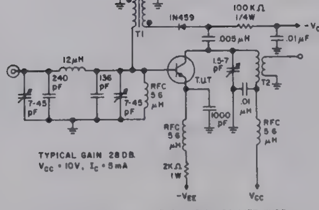
NEUTRALIZED 200 MHz POWER GAIN AMPLIFIER TEST CIRCUIT (G_{PE})

Figure 2


TO DC VTVM
1N82A
R.F.C.
.001μF
50Ω 1/4W
1-4.5pF
1/4λ STUB
620Ω 1/2W
T.U.T.
3.3KΩ 1/2W
510Ω 1/4W
10KΩ 1/2W
.001μF
.001μF
12V DC
-
+

940MHz OSCILLATOR TEST CIRCUIT

Figure 3


T1
1N459
100KΩ 1/4W
-V_{CN}
.01μF
.005μH
12μH
240 pF
136 pF
7-45 pF
7-45 pF
RFC 56 μH
T.U.T
1.5-7 pF
T2
.01 μH
1000 pF
RFC 56 μH
RFC 56 μH
2KΩ 1W
-V_{EE}
V_{CC}

TYPICAL GAIN 28DB
V_{CC} = 10V, I_C = 5mA

T1, EACH WINDING 10 TURNS #150-50 LITZ WIRE ON Q_2 TOROID (μ_0=115) BIFILAR WOUND

T2, PRIMARY 10 TURNS #28 ENAMELED, SECONDARY CLOSE COUPLED 2 TURNS #28 ENAMELED WOUND ON Q_3 TOROID (SIZE CF) 102, GENERAL CERAMICS

45MHz I F POWER GAIN

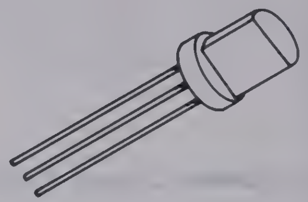
Figure 4

Silicon Transistor

NPN

2N3721

The General Electric 2N3721 is a NPN silicon transistor intended for general purpose applications. The planar passivated construction assures excellent device stability and life. This high performance, high value device is made possible by utilizing advanced manufacturing techniques and epoxy encapsulation.

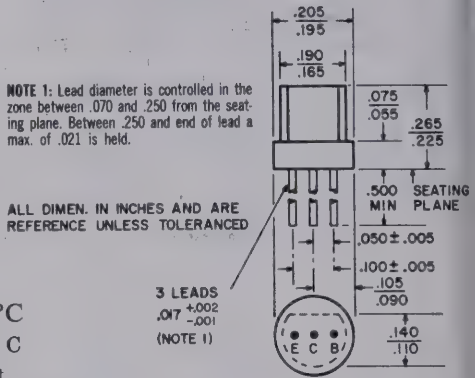


absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to emitter	V_{CEO}	18	V
Emitter to base	V_{EBO}	5	V
Collector to base	V_{CBO}	18	V
Current			
Collector (steady state)	I_{C*}	100	mA
Dissipation			
Total Power (Free air @ 25°C)	P_{T**}	360	mW
Total Power (Free air @ 55°C)	P_{T**}	260	mW
Temperature			
Storage	T_{STG}	-55 to	+125°C
Operating	T_J		+125° C

* Determined from power limitations due to saturation voltage at this current.

** Derate 2.67 mW/°C increase in ambient temperature above 25°C.



NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

electrical characteristics: (25°C) (unless otherwise specified)

DC Characteristics		Min.	Typ.	Max.	Units
Collector cutoff current: (VCB = 18V)	I_{CBO}			0.5	μA
(VCB = 18V, TA=100°C)	I_{CBO}			15	μA
Emitter cutoff current: (VEB=5V)	I_{EBO}			0.5	μA
Small Signal Characteristics					
Forward current transfer ratio: (VCE=10V, IC = 2 ma, f = lk Hz†)	h_{FE}	60		660	
Input impedance: (VCE=10V,IC=2mA, f=lk Hz)	h_{IB}		15		ohms
High Frequency Characteristics					
Collector capacitance: (VCB=10V, IE=O, f=l MHz)	C_{cb}	4.5	7	10	pF
Gain bandwidth product: (IC=4mA, VCB=5V)	f_t		120		MHz

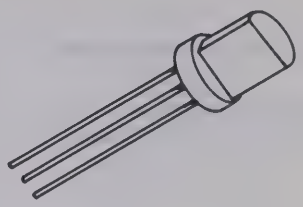
† Hz=Hertz, equivalent to cycles per second.

Silicon Transistors

NPN

2N3843A,4A,5A

The General Electric 2N3843,4,5, and 2N3843A, 4A, 5A are NPN silicon planar, epitaxial passivated transistors designed primarily for RF and converter applications in high performance A.M. radios. The A versions feature high signal to noise ratio in RF amplifier service.



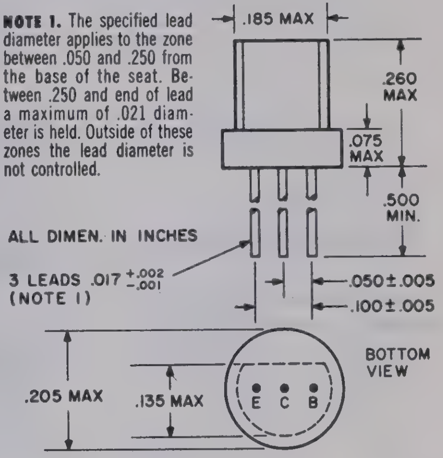
absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	30	volts
Emitter to Base	V_{EBO}	4	volts
Collector to Base	V_{CBO}	30	volts
Current			
Collector (Steady State)*	I_C	100	mA
Dissipation			
Total Power (25°C Ambient)**	P_T	200	mW
Total Power (55°C Ambient)**	P_T	120	mW
Temperature			
Storage	T_{STG}	−30 to 125	°C
Operating	T_J	100	°C
Lead Soldering 1/16" ± 1/32" from case for 10 seconds maximum	T_L	260	°C

*Determined from power limitation due to saturation voltage at this current.

**Derate 2.67mW/°C increase in ambient temperature above 25°C.

NOTE 1. The specified lead diameter applies to the zone between .050 and .250 from the base of the seat. Between .250 and end of lead a maximum of .021 diameter is held. Outside of these zones the lead diameter is not controlled.



electrical characteristics: (25°C) (unless otherwise specified).

		Min.	Typ.	Max.	
Collector Cutoff Current ($V_{CB} = 18V$)	I_{CBO}			0.5	μA
($V_{CB} = 18V, T_A = 100°C$)	I_{CBO}			15	μA
Collector-Emitter Breakdown Voltage ($I_C = 1mA$)	BV_{CEO}	30			volts
Emitter-Base Breakdown Voltage ($I_E = 500\ \mu A$)	BV_{EBO}	4			volts
Forward Current Transfer Ratio ($V_{CE} = 4.5V, I_C = 2mA$)					
2N3843,A	h_{FE}	20		40	
2N3844,A	h_{FE}	35		70	
2N3845,A	h_{FE}	60		120	
Collector Saturation Voltage ($I_C = 10mA, I_B = 1mA$)	$V_{CE(SAT)}$			1	volt
Output Capacitance ($V_{CB} = 10V, I_E = 0, f = 1Mc$)	C_{ob}	2.0	3	4.0	pF
Input Capacitance ($V_{EB} = 0.5V, I_E = 0, f = 1Mc$)	C_{ib}		15		pF
Case Capacitance			.66		pF
Gain Band-Width Product ($V_{CE} = 10V, I_C = 2mA$)					
2N3843,A	f_T	60		230	Mc
2N3844,A	f_T	90		250	Mc
2N3845,A	f_T	120		290	Mc
Collector Base Time Constant	$r_b' C_c$			150	psec
Noise Figure ($f = 2Mc, I_C = 1mA, V_{CE} = 12V, R_g = 20\Omega$)					
2N3843A, 2N3844A, 2N3845A,	N.F.		6.0	8.5	db
2N3843, 2N3844, 2N3845	N.F.			10.2	db
($f = 2Mc, I_C = 1mA, V_{CE} = 12V, R_g = 50\Omega$)					
2N3843A, 2N3844A, 2N3845A	N.F.		5.5		db

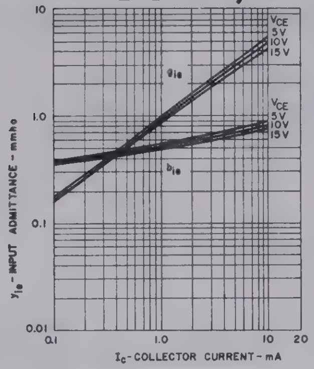
TYPICAL COMMON EMITTER "Y" PARAMETERS

1.6 Mc

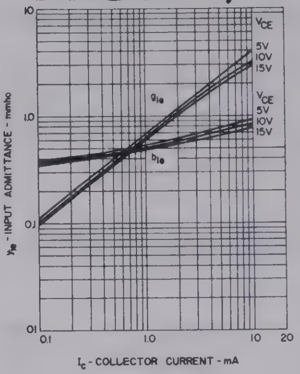
$T_A = 25°$ C

Y_{ie}
Input Admittance
vs.
Collector Current
(OUTPUT SHORT CIRCUIT)

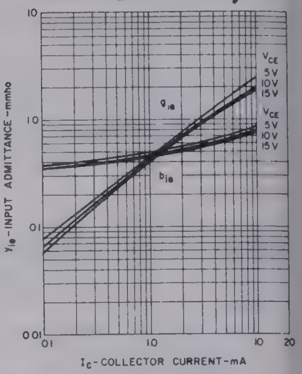
2N3843,A



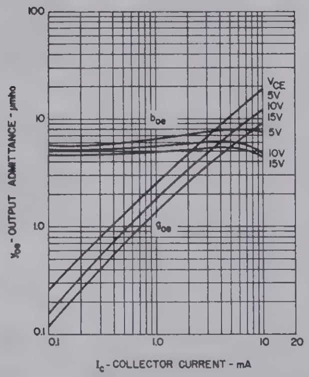
2N3844,A

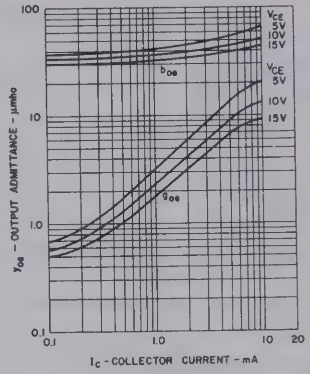


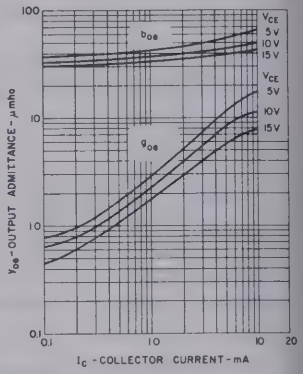
2N3845,A



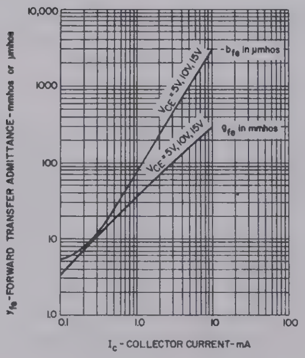
Y_{oe}
Output Admittance
VS
Collector Current
(INPUT SHORT CIRCUIT)

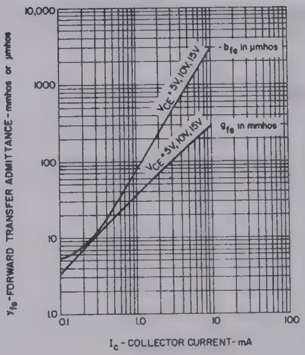


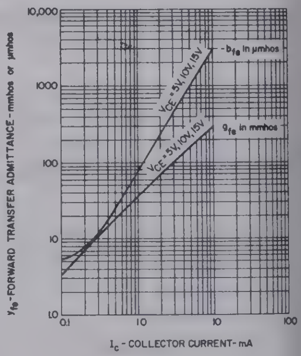




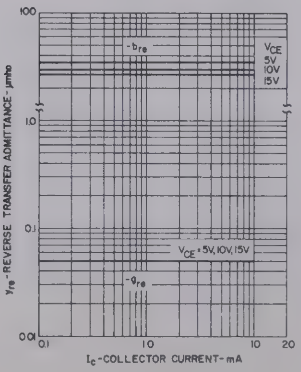
Y_{fe}
Forward Transfer
Admittance
VS
Collector Current
(OUTPUT SHORT CIRCUIT)

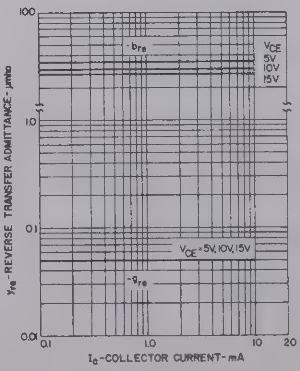


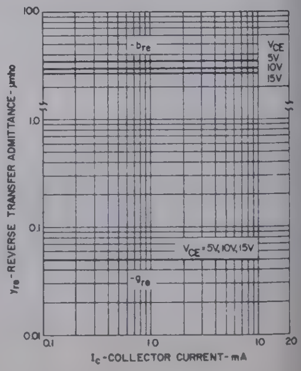




Y_{re}
Reverse
Transfer Admittance
VS
Collector Current
(INPUT SHORT CIRCUIT)







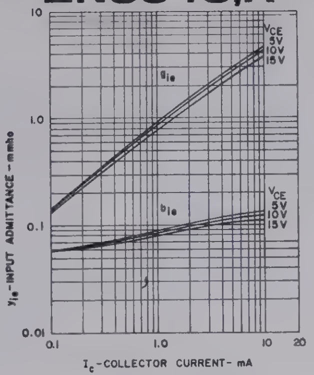
TYPICAL COMMON EMITTER "Y" PARAMETERS

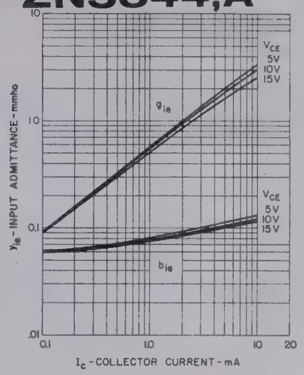
262.5 Kc

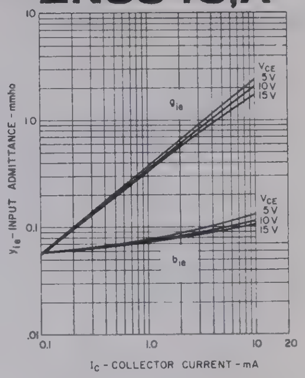
$T_A = 25°$ C

2N3843,A **2N3844,A** **2N3845,A**

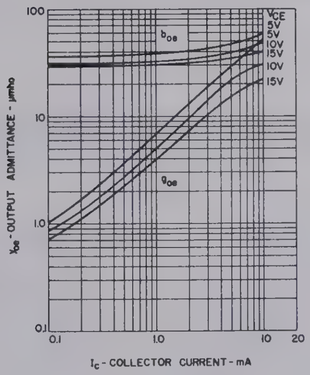
Y_{ie}
Input Admittance
vs.
Collector Current
OUTPUT SHORT CIRCUIT)

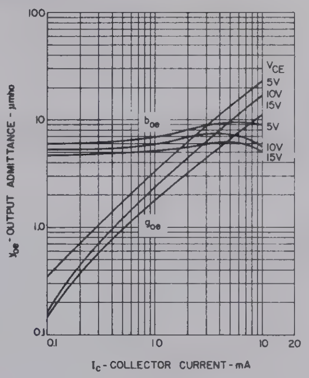


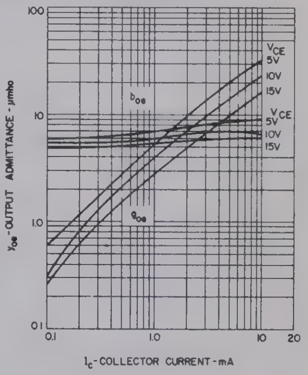




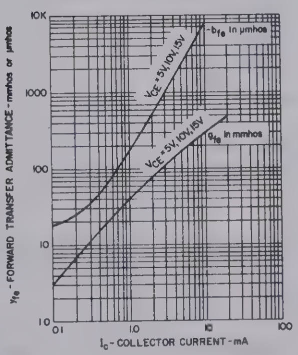
Y_{oe}
Output Admittance
vs
Collector Current
INPUT SHORT CIRCUIT)

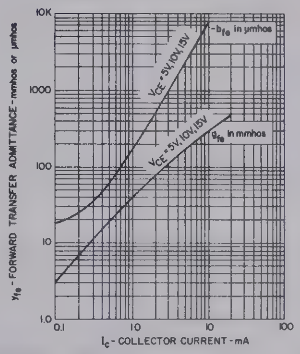


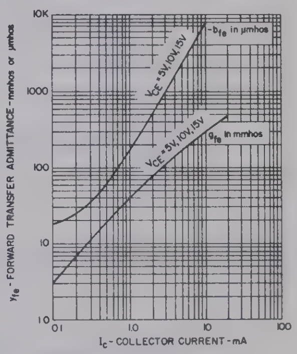




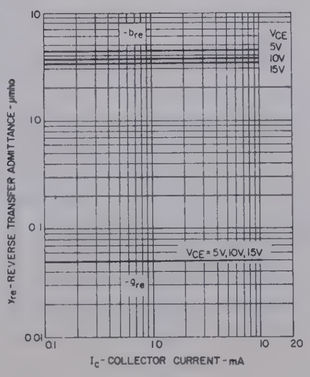
Y_{fe}
Forward Transfer
Admittance
vs
Collector Current
OUTPUT SHORT CIRCUIT)

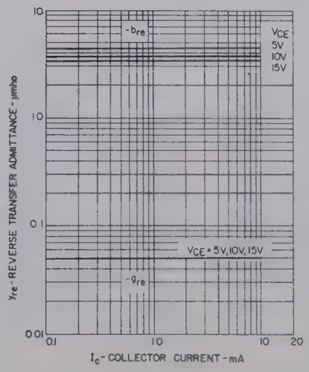


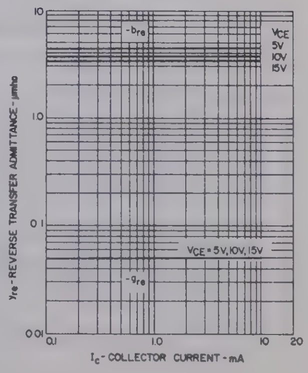




Y_{re}
Reverse
ransfer Admittance
vs
Collector Current
INPUT SHORT CIRCUIT)

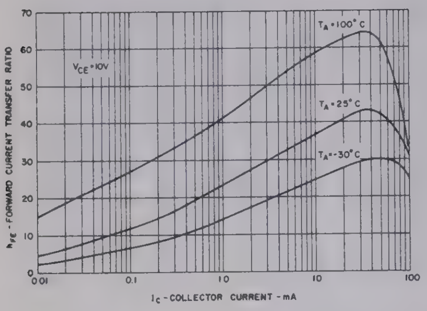




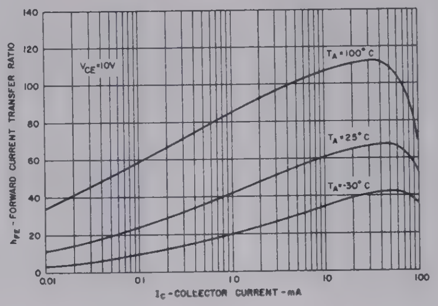


TYPICAL ELECTRICAL CHARACTERISTICS

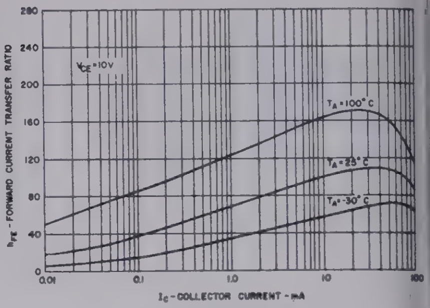
FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT



2N3843,A

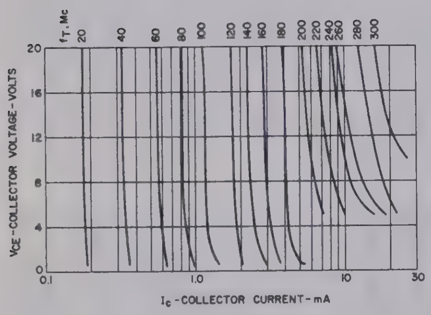


2N3844,A

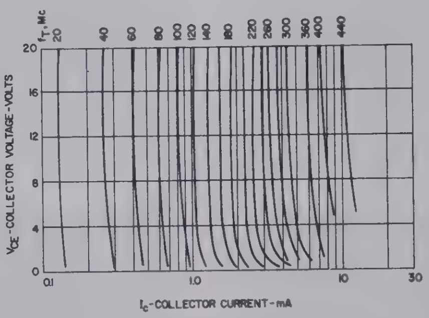


2N3845,A

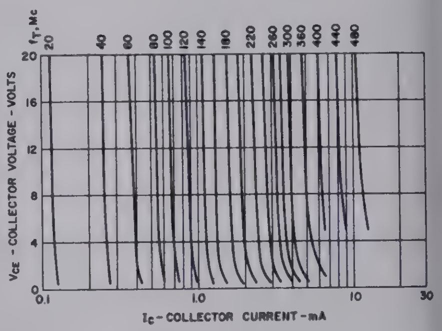
GAIN BAND-WIDTH PRODUCT(f_T)VS. COLLECTOR CURRENT



2N3843,A

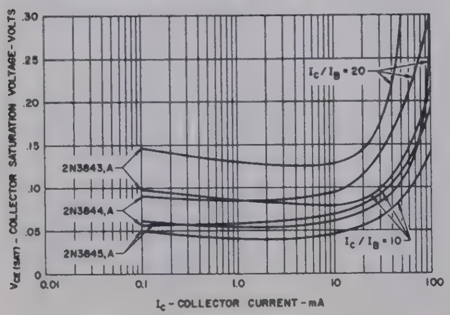


2N3844,A

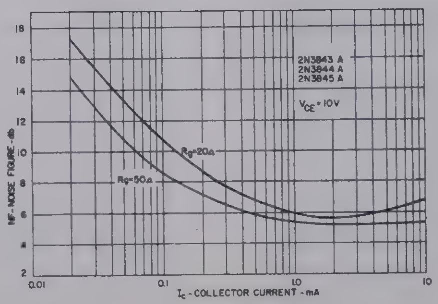


2N3845,A

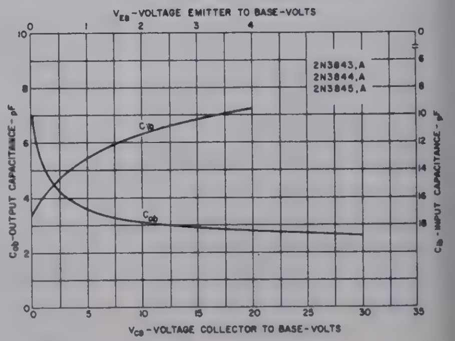
COLLECTOR SATURATION VOLTAGE



2Mc NOISE FIGURE



INPUT & OUTPUT CAPACITANCE



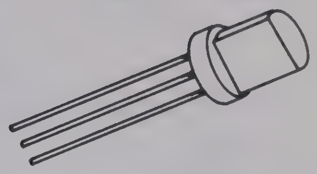
Silicon Transistors

NPN

2N3854,5,6

2N3854A,5A,6A

The General Electric 2N3854,A, 2N3885,A, 2N3856,A, are NPN silicon planar epitaxial passivated transistors designed primarily for RF, IF and converter applications in AM and FM receivers. Selected high voltage units are available for TV video amplifiers. (See typical BVceo)



- FM-IF STAGE GAIN OF 25 dB
- 30 dB GAIN AT 4.5 MHz
- FM-RF GAIN OF 15 dB
- TV VIDEO IF GAIN OF 21 dB

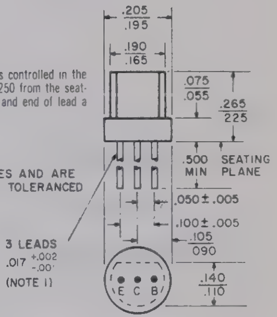
absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages				
Collector to Emitter	2N3854, 5, 6	V_{CEO}	18	volts
	2N3854A, 5A, 6A	V_{CEO}	30	volts
Emitter to Base		V_{EBO}	4	volts
Collector to Base	2N3854, 5, 6,	V_{CBO}	18	volts
	2N3854A, 5A, 6A	V_{CBO}	30	volts
Current				
Collector (Steady State)†		I_C	100	mA
Dissipation				
Total Power (Free air at 25°C)‡		P_T	200	mW
Total Power (Free air at 55°C)‡		P_T	120	mW
Temperature				
Storage		T_S	−30 to 150°C	
Operating		T_J	100°C	
Lead soldering, 1/16 ± 1/32" from case for 10 sec. max.		T_L	260°C	

†Determined from power limitations due to saturation voltage at this point.
‡Derate 2.67 mW/°C increase in ambient temperature above 25°C.

NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED



electrical characteristics: (25°C) (unless otherwise specified)

		Min.	Typ.	Max.	Units
Static Characteristics					
Collector Cutoff Current ($V_{CB} = 18V$)	I_{CBO}			0.5	μA
($V_{CB} = 18V$, $T_A = 100°C$)	I_{CBO}			15	μA
Forward Current Transfer Ratio ($V_{CE} = 4.5V$, $I_C = 2mA$)					
2N3854, 2N3854A	h_{FE}	35		70	
2N3855, 2N3855A	h_{FE}	60		120	
2N3856, 2N3856A	h_{FE}	100		200	
Emitter—Base Breakdown Voltage ($I_E = 500\mu A$)	BV_{EBO}	4			volts
Collector—Emitter Breakdown Voltage ($I_C = 1mA$)					
2N3854, 2N3855, 2N3856	BV_{CEO}	18	70		volts
2N3854A, 2N3855A, 2N3856A	BV_{CEO}	30	70		volts
Collector—Base Breakdown Voltage ($I_C = 0.1mA$)					
2N3854, 2N3855, 2N3856	BV_{CBO}	18			volts
2N3854A, 2N3855A, 2N3856A	BV_{CBO}	30			volts
Collector Saturation Voltage ($I_C = 10mA$, $I_B = 1mA$)	$V_{CE(SAT)}$			0.200	volts
Dynamic Characteristics					
Gain Bandwidth Product ($V_{CE} = 10V$, $I_C = 5mA$)					
2N3854, 2N3854A	f_T	100		350	MHz
2N3855, 2N3855A	f_T	130		450	MHz
2N3856, 2N3856A	f_T	140		500	MHz
Collector—Base Time Constant ($V_{CE} = 10V$, $I_C = 5mA$)					
2N3854, 2N3854A	$r_b' C_c$		25	90	psec.
2N3855, 2N3855A	$r_b' C_c$		35	90	psec.
2N3856, 2N3856A	$r_b' C_c$		40	90	psec.
Output Capacitance ($V_{CB} = 10V$, $I_E = 0$, $f = 1$ MHz)	C_{ob}			3.5	pF
Input Capacitance ($V_{EB} = 0.5V$, $I_E = 0$, $f = 1$ MHz)	C_{ib}		16		pF
Case Capacitance			0.66		pF

TYPICAL
COMMON EMITTER "y" PARAMETERS

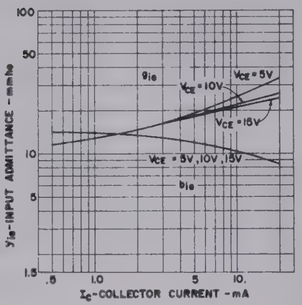
f = 100 MHz

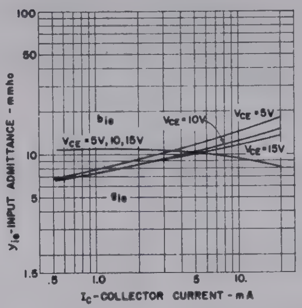
2N3854, A

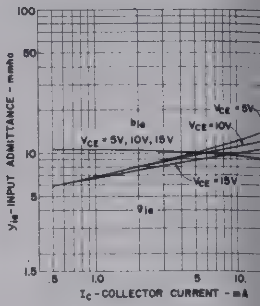
2N3855, A

2N3856, A

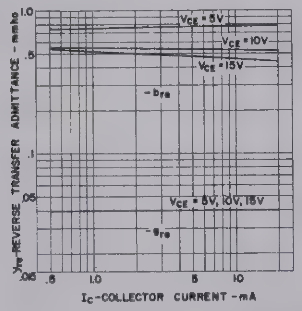
y_{ie}
Input
Admittance
vs.
Collector Current

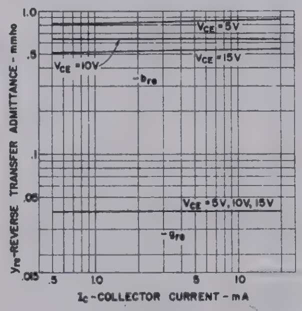


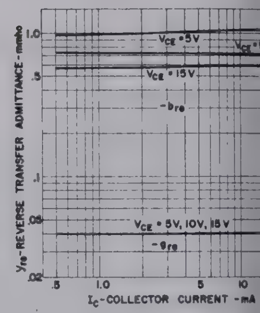




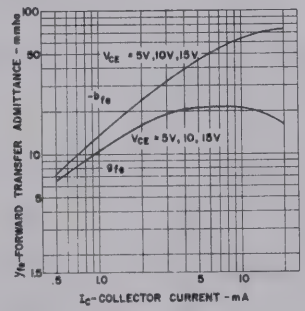
y_{re}
Reverse
Transfer
Admittance
vs.
Collector Current

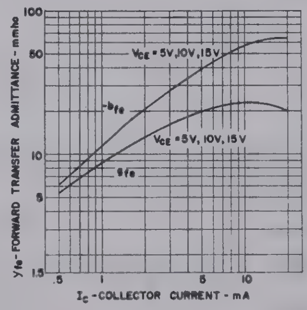


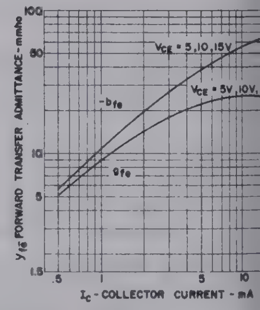




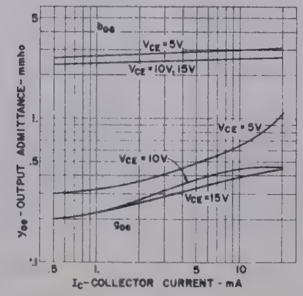
y_{fe}
Forward
Transfer
Admittance
vs.
Collector Current

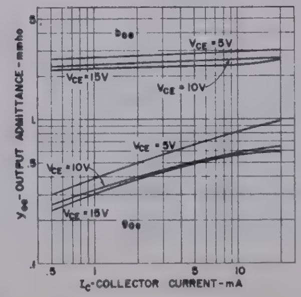


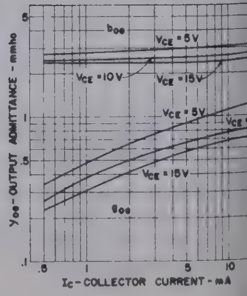




y_{oe}
Output
Admittance
vs.
Collector Current





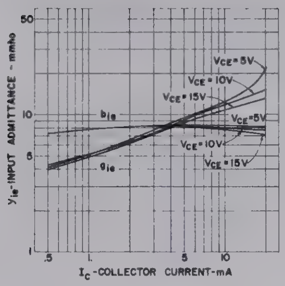


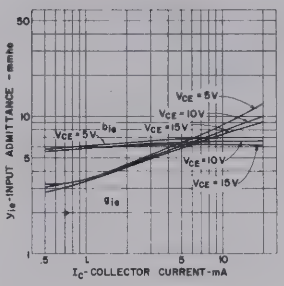
TYPICAL
COMMON EMITTER "y" PARAMETERS

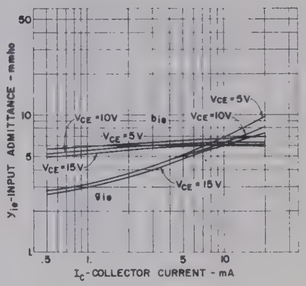
f = 45 MHz

	2N3854, A	**2N3855, A**	**2N3856, A**

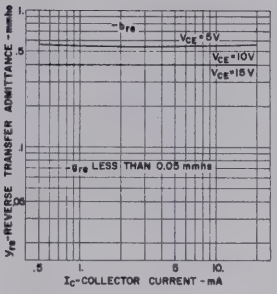
y_{ie} Input Admittance vs. Collector Current

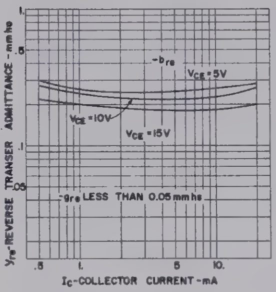


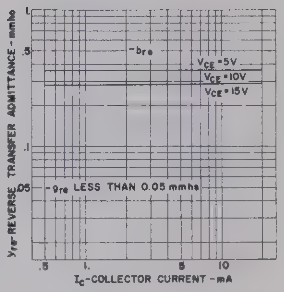




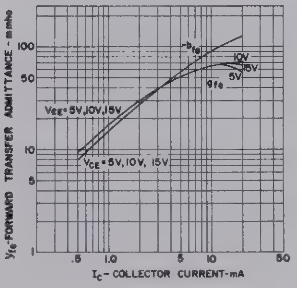
y_{re} Reverse Transfer Admittance vs. Collector Current

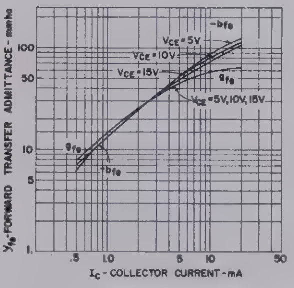


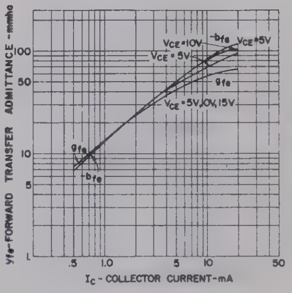




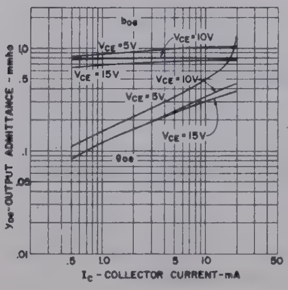
y_{fe} Forward Transfer Admittance vs. Collector Current

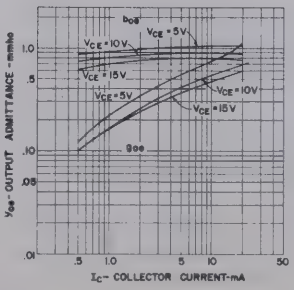


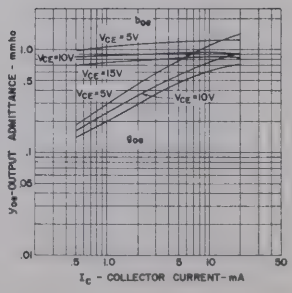




y_{oe} Output Admittance vs. Collector Current







TYPICAL
COMMON EMITTER "y" PARAMETERS

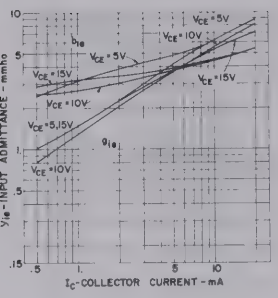
f = 10.7 MHz

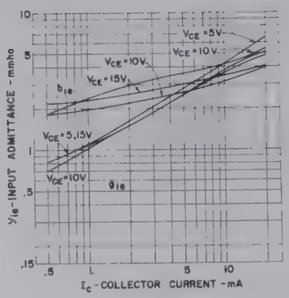
2N3854, A

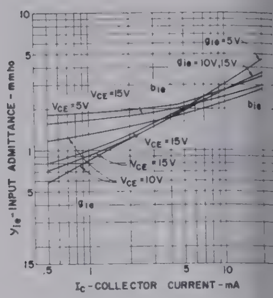
2N3855, A

2N3856, A

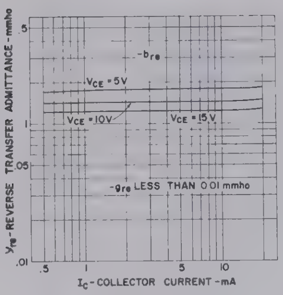
y_{ie}
Input
Admittance
vs.
Collector Current

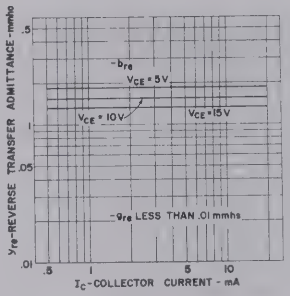


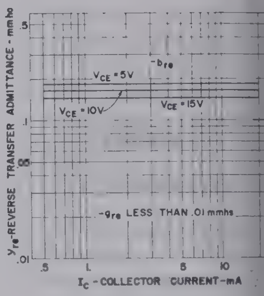




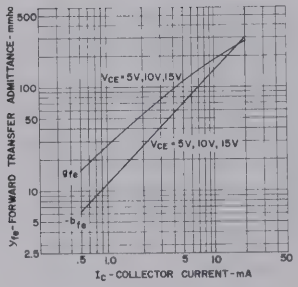
y_{re}
Reverse
Transfer
Admittance
vs.
Collector Current

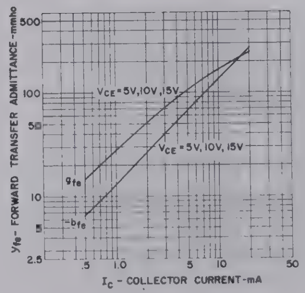


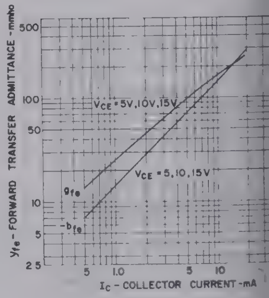




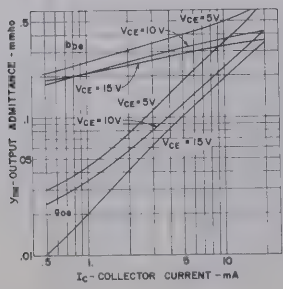
y_{fe}
Forward
Transfer
Admittance
vs.
Collector Current

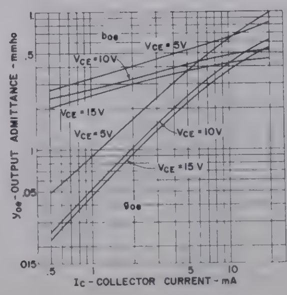


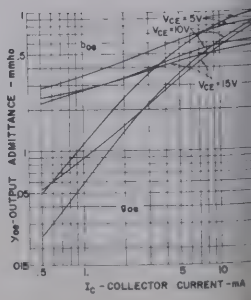




y_{oe}
Output
Admittance
vs.
Collector Current





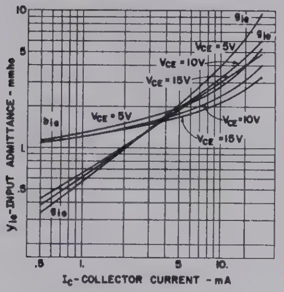


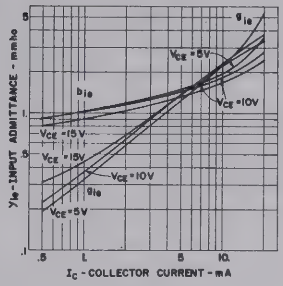
TYPICAL
COMMON EMITTER "y" PARAMETERS

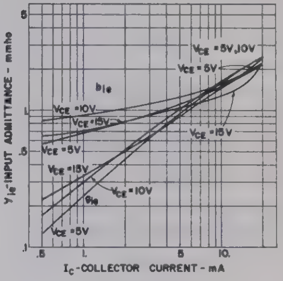
f = 4.5 MHz

2N3854, A | **2N3855, A** | **2N3856, A**

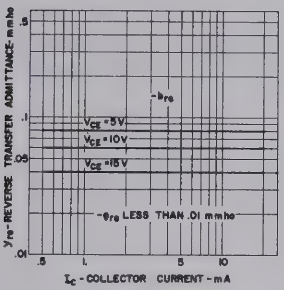
y_{ie} Input Admittance vs. Collector Current

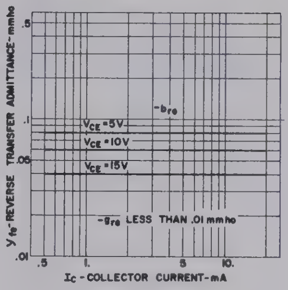


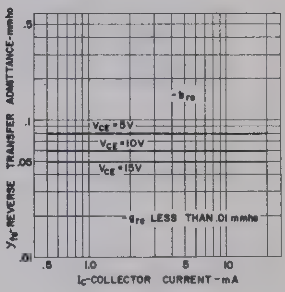




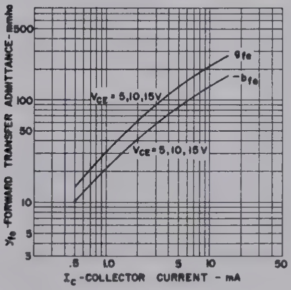
y_{re} Reverse Transfer Admittance vs. Collector Current

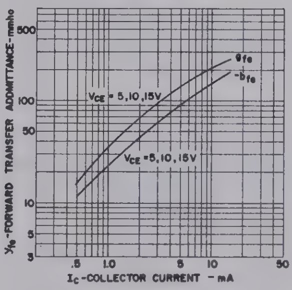


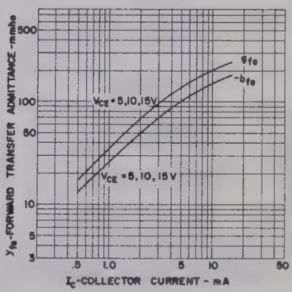




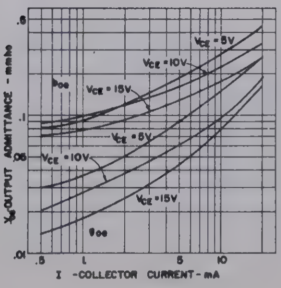
y_{fe} Forward Transfer Admittance vs. Collector Current

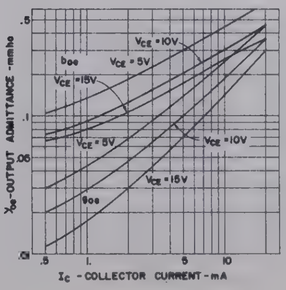


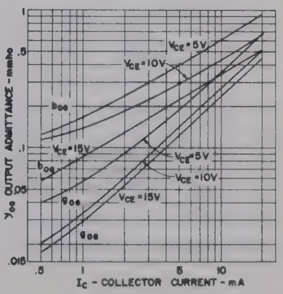




y_{oe} Output Admittance vs. Collector Current





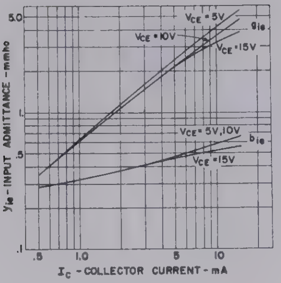


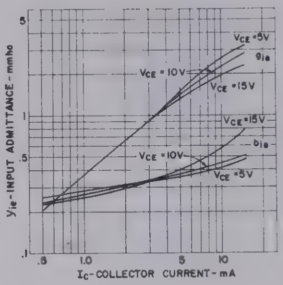
TYPICAL
COMMON EMITTER "y" PARAMETERS

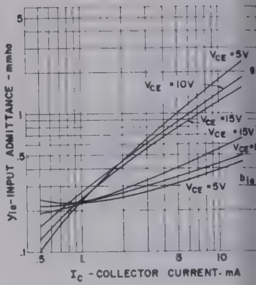
f = 1.0 MHz

2N3854, A **2N3855, A** **2N3856, A**

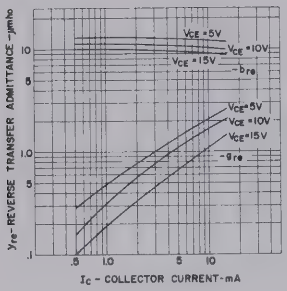
y_{ie}
Input
Admittance
vs.
Collector Current

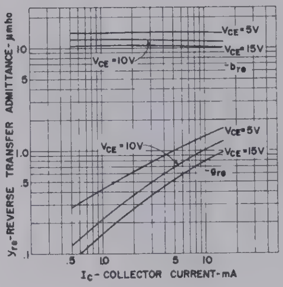


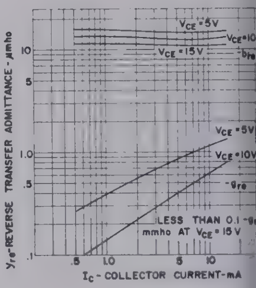




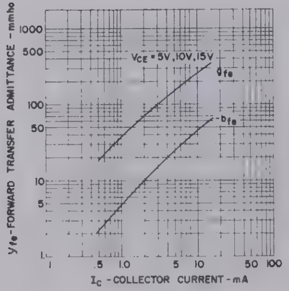
y_{re}
Reverse
Transfer
Admittance
vs.
Collector Current

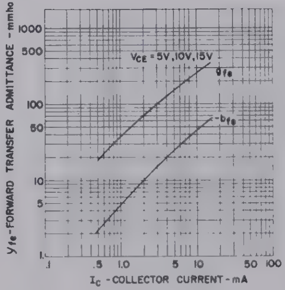


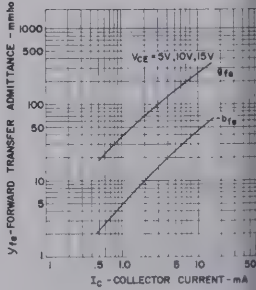




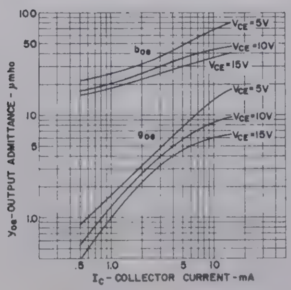
y_{fe}
Forward
Transfer
Admittance
vs.
Collector Current

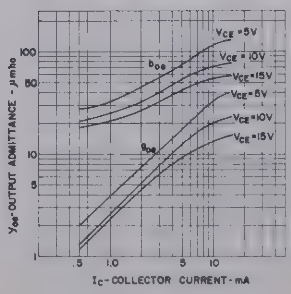


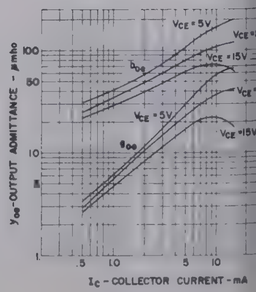




y_{oe}
Output
Admittance
vs.
Collector Current





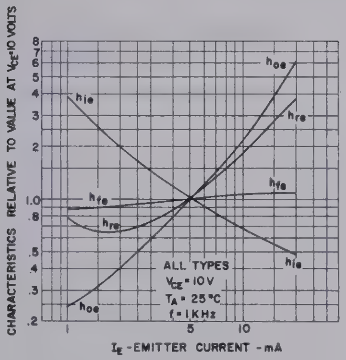


TYPICAL SMALL SIGNAL CHARACTERISTICS

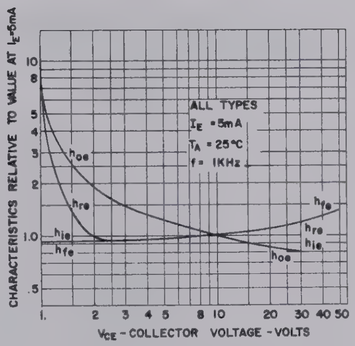
f = 1 kHz, V_{CE} = 10V, I_E = 5mA

Symbol	Characteristic	2N3854 2N3854A	2N3855 2N3855A	2N3856 2N3856A	Units
h_{ie}	Input resistance	454	741	1140	ohms
h_{oe}	Output conductance	10.4	16.2	23.1	μmhos
h_{fe}	Forward current transfer ratio	65.5	113	173	
h_{re}	Reverse voltage feedback ratio	10.5	11.3	11.8	$X10^{-5}$

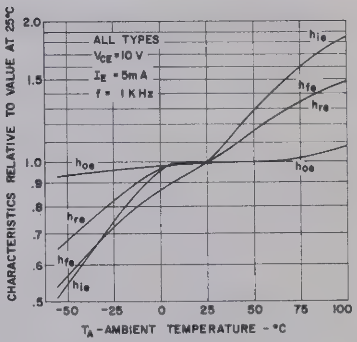
SMALL SIGNAL CHARACTERISTICS VS. EMITTER CURRENT



SMALL SIGNAL CHARACTERISTICS VS. COLLECTOR VOLTAGE



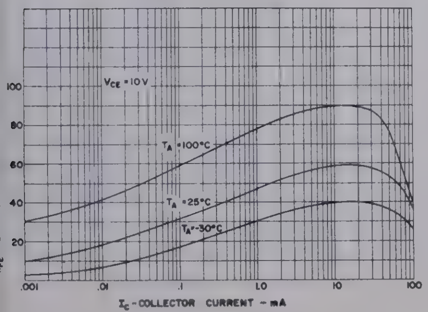
SMALL SIGNAL CHARACTERISTICS VS. AMBIENT TEMPERATURE



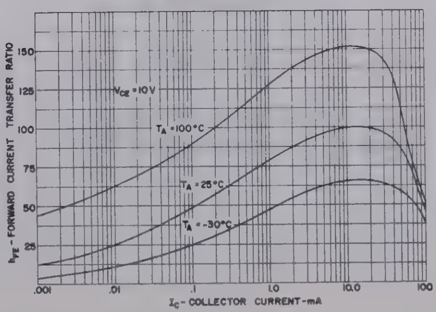
TYPICAL ELECTRICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO, h_{FE}, vs. COLLECTOR CURRENT

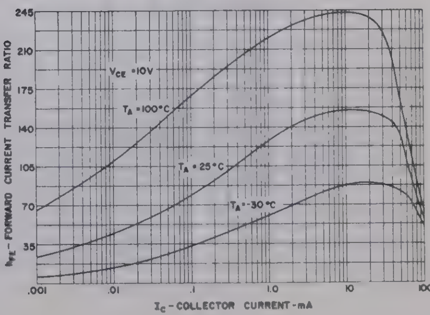
2N3854, A



2N3855, A



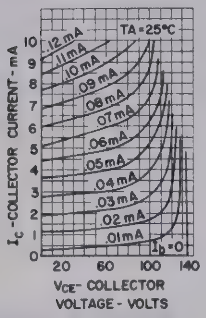
2N3856, A



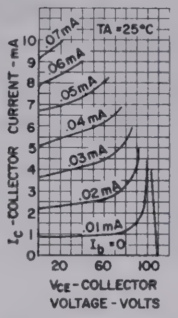
TYPICAL ELECTRICAL CHARACTERISTICS

COLLECTOR CHARACTERISTICS

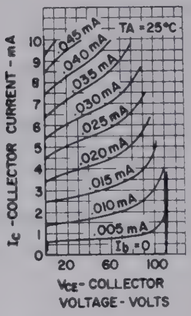
2N3854, A



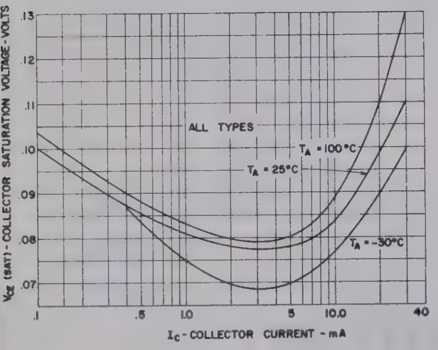
2N3855, A



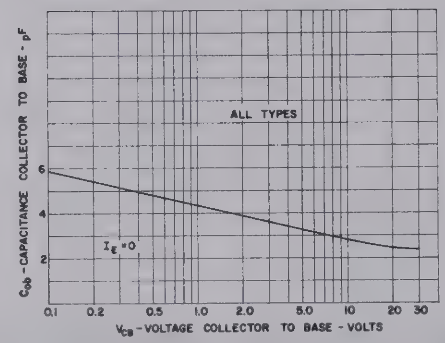
2N3856, A



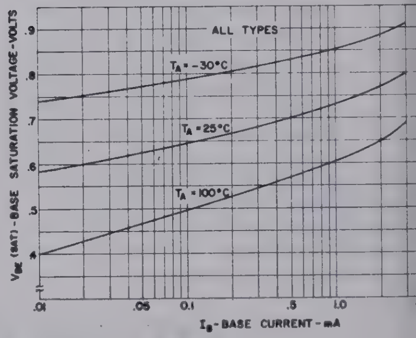
COLLECTOR SATURATION VOLTAGE VS. COLLECTOR CURRENT



OUTPUT CAPACITY VS. REVERSE VOLTAGE BIAS

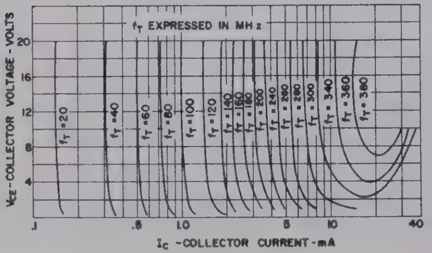


BASE SATURATION VOLTAGE VS. BASE CURRENT

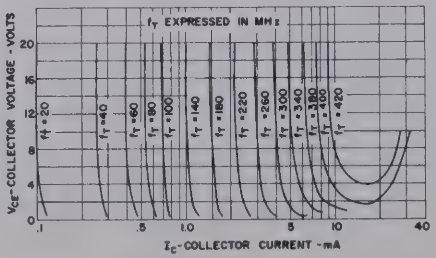


CONTOURS OF GAIN BANDWIDTH PRODUCT, f_T, vs. COLLECTOR CURREN

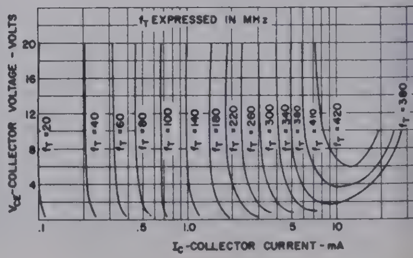
2N3854, A



2N3855, A



2N3856, A

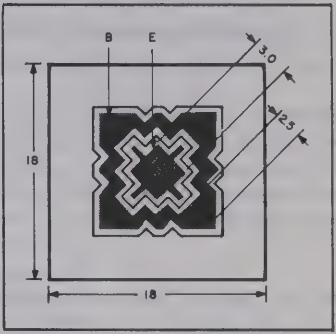


Silicon
Transistor Chips

NPN
2N3855A (Chip)

(M28P-X507)

This General Electric NPN silicon planar epitaxial passivated transistor chip is designed primarily for RF, IF and converter applications in AM and FM radio receivers and TV video amplifiers.



General specifications:

- Gold collector contact backing, minimum thickness—3000Å
- Aluminum base and emitter contact metalization
- Maximum conditions for mounting chips—425°C for 5 minutes (Max.) in an inert atmosphere
- Shipping containers: Glass vials sealed with a nitrogen back-fill
  Maximum of 10k chips per vial
  Egg crate containers available at extra cost
- Chip drawing dimensions are in mils
- Chip thickness = $5.4^{+0.8}_{-0.9}$ mils

absolute maximum ratings: ($T_A = 25°C$)

	Symbol		
Voltages			
Collector to Base	V_{CBO}	30	V
Collector to Emitter	V_{CEO}	30	V
Emitter to Base	V_{EBO}	4	V
Current			
Collector	I_C	100	mA
Temperature			
Storage	T_{STG}	−65°C to +200°C	
Operating	T_J	−65°C to +200°C	

electrical characteristics: 100% Probe ($T_A = 25°C$)

Tested at outgoing acceptance to a 10% LTPD with a maximum accept number of 3.

	Symbol	Min.	Max.	
Collector Base Breakdown Voltage ($I_C = 0.1$ mA)	BV_{CBO}	30	—	V
Collector Emitter Breakdown Voltage ($I_C = 1$ mA)	BV_{CEO}	30	—	V
Emitter Base Breakdown Voltage ($I_E = 500\ \mu A$)	BV_{EBO}	4	—	V
Collector Cutoff Current ($V_{CB} = 18V$)	I_{CBO}	—	50	nA
Forward Current Transfer Ratio ($I_C = 2$ mA, $V_{CE} = 4.5V$)	h_{FE}	60	120	

specifications: ($T_A = 25°C$)

Product yield is at least 93% to each of the following parameters:

	Symbol	Min.	Max.	
Collector Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)	$V_{CE(SAT)}$	—	0.2	V
Base Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)	$V_{BE(SAT)}$	—	0.82	V
Forward Current Transfer Ratio ($I_C = 5$ mA, $V_{CE} = 10V$, f = 100 MHz)	$\lvert h_{fe} \rvert$	2.3	13.2	dB
Gain Bandwidth Product ($I_C = 5$ mA, $V_{CE} = 10V$, f = 100 MHz)	f_t	130	450	MHz
Collector Base Capacitance ($V_{CB} = 10V$, f = 1 MHz)	C_{cb}	1.5	3.5	pF

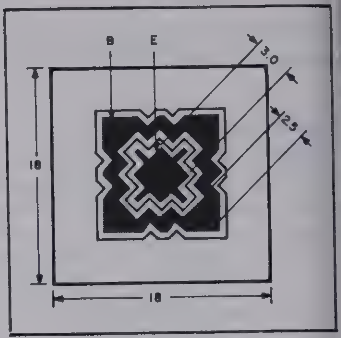
Silicon
Transistor Chips

NPN

2N3856A (Chip)

(M28P-X508)

This General Electric NPN silicon planar passivated epitaxial transistor chip is designed primarily for RF, IF and converter applications in AM and FM radio receivers and TV video amplifiers.



General specifications:

- Gold collector contact backing, minimum thickness—3000Å
- Aluminum base and emitter contact metalization
- Maximum conditions for mounting chips—425°C for 5 minutes (Max.) in an inert atmosphere
- Shipping containers: Glass vials sealed with a nitrogen back-fill
  Maximum of 10k chips per vial
  Egg crate containers available at extra cost
- Chip drawing dimensions are in mils
- Chip thickness = 5.4 $^{+0.8}_{-0.9}$ mils

absolute maximum ratings: ($T_A = 25°C$)

	Symbol		
Voltages			
Collector to Base	V_{CBO}	30	V
Collector to Emitter	V_{CEO}	30	V
Emitter to Base	V_{EBO}	4	V
Current			
Collector	I_C	100	mA
Temperature			
Storage	T_{STG}	−65°C to +200°C	
Operating	T_J	−65°C to +200°C	

electrical characteristics: 100% Probe ($T_A = 25°C$)

Tested at outgoing acceptance to a 10% LTPD with a maximum accept number of 3.

	Symbol	Min.	Max.	
Collector Base Breakdown Voltage ($I_C = 0.1$ mA)	BV_{CBO}	30	—	V
Collector Emitter Breakdown Voltage ($I_C = 1$ mA)	BV_{CEO}	30	—	V
Emitter Base Breakdown Voltage ($I_E = 500\ \mu A$)	BV_{EBO}	4	—	V
Collector Cutoff Current ($V_{CB} = 18V$)	I_{CBO}	—	50	nA
Forward Current Transfer Ratio ($I_C = 2$ mA, $V_{CE} = 4.5V$)	h_{FE}	100	200	

specifications: ($T_A = 25°C$)

Product yield is at least 93% to each of the following parameters:

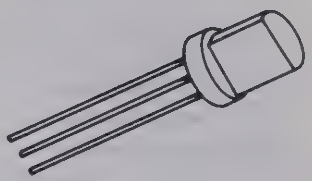
	Symbol	Min.	Max.	
Collector Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)	$V_{CE(SAT)}$	—	0.2	V
Base Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)	$V_{BE(SAT)}$	—	0.82	V
Forward Current Transfer Ratio ($I_C = 5$ mA, $V_{CE} = 10V$, f = 100 MHz)	$\lvert h_{fe} \rvert$	2.9	14	dB
Gain Bandwidth Product ($I_C = 5$ mA, $V_{CE} = 10V$, f = 100 MHz)	f_t	140	500	MHz
Collector Base Capacitance ($V_{CB} = 10V$, f = 1 MHz)	C_{cb}	1.5	3.5	pF

Silicon Transistors

NPN

2N3858,9,60

The General Electric 2N3858, 2N3859 and 2N3860 are NPN silicon, planar, epitaxial, passivated transistors designed primarily for AM radio I.F. and converter applications.

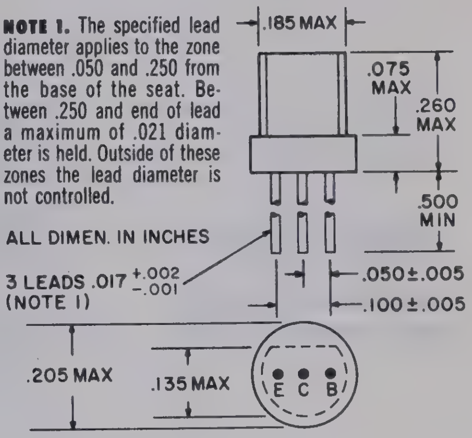


absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages		
Collector to Emitter	V_{CEO}	30 volts
Emitter to Base	V_{EBO}	4 volts
Collector to Base	V_{CBO}	30 volts
Current		
Collector (Steady State)*	I_C	100 mA
Dissipation		
Total Power (Free air at 25°C)†	P_T	360 mW
Temperature		
Storage	T_{STG}	−55 to 150°C
Operating	T_J	125°C
Lead Soldering, 1/16" ± 1/32" from case for 10 seconds max.	T_L	260°C

*Determined from power limitations due to saturation voltage at this current.

†Derate 3.6 mW/°C increase in ambient temperature above 25°C.



NOTE 1. The specified lead diameter applies to the zone between .050 and .250 from the base of the seat. Between .250 and end of lead a maximum of .021 diameter is held. Outside of these zones the lead diameter is not controlled.

electrical characteristics: (25°C) (unless otherwise specified)

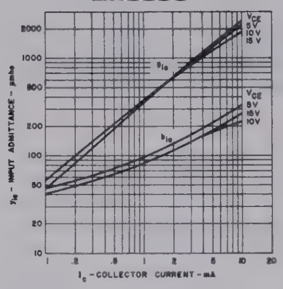
STATIC CHARACTERISTICS	Sym.	Min.	Typ.	Max.	Units
Collector Cutoff Current ($V_{CB} = 40V$)	I_{CBO}			50	NA
($T_A = 100°C$)	I_{CBO}			10	μA
Emitter Cutoff Current ($V_{EB} = 5V$)	I_{EBO}			100	NA
Forward Current Transfer Ratio ($V_{CE} = 4.5V$, $I_C = 2mA$)					
2N3858	h_{FE}	60		120	
2N3859	h_{FE}	100		200	
2N3860	h_{FE}	150		300	
Collector—Base Breakdown Voltage ($I_C = 0.1mA$)	BV_{CBO}	40			volts
Emitter—Base Breakdown Voltage ($I_E = 0.1mA$)	BV_{EBO}	5			volts
Collector—Emitter Breakdown Voltage ($I_C = 1mA$)	BV_{CEO}	40			volts
Collector Saturation Voltage ($I_C = 10mA$, $I_B = 1mA$)	$V_{CE(SAT)}$			0.125	volts
DYNAMIC CHARACTERISTICS					
Gain Bandwidth Product ($V_{CE} = 10V$, $I_C = 2mA$)					
2N3858	f_T	90	125	250	Mc
2N3859	f_T	90	140	250	Mc
2N3860	f_T	90	170	250	Mc
Collector—Base Time Constant ($V_{CE} = 10V$, $I_C = 2mA$)	$r_b'C_c$		65	150	psec.
Output Capacitance, Common Base ($V_{CB} = 10V$, $I_E = 0$, $f = 1Mc$)	C_{obo}	2.0	2.7	4.0	pF
Input Capacitance, Common Base ($V_{EB} = 0.5V$, $I_E = 0$, $f = 1Mc$)	C_{ibo}		10		pF
Case Capacitance			0.66		pF

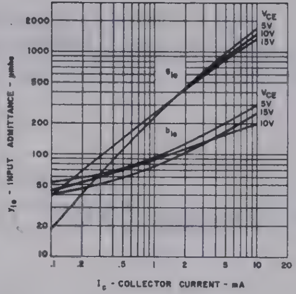
TYPICAL COMMON EMITTER "y" PARAMETERS vs. Ic

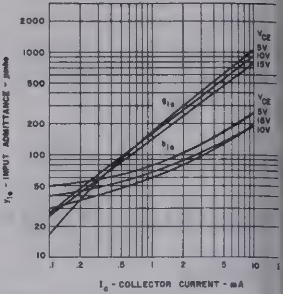
f=262.5 Kc TA=25°C

2N3858 2N3859 2N3860

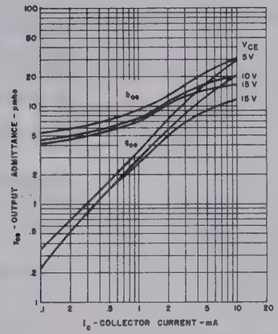
y_{ie}
Input Admittance vs. Collector Current
(OUTPUT SHORT CIRCUIT)

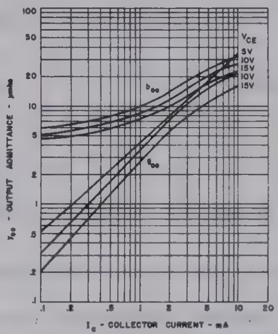


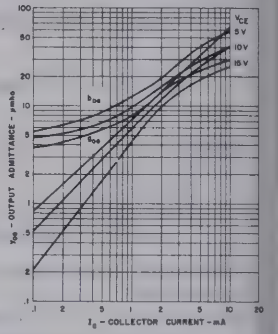




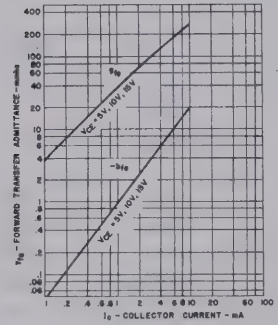
y_{oe}
Output Admittance vs. Collector Current
(INPUT SHORT CIRCUIT)

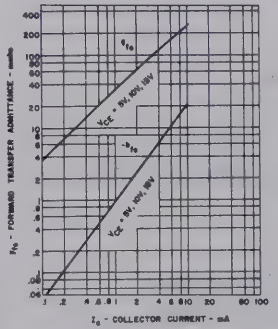


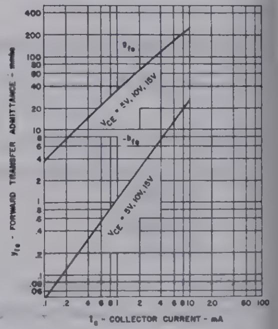




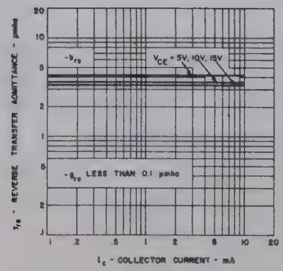
y_{fe}
Forward Transfer Admittance vs. Collector Current
(OUTPUT SHORT CIRCUIT)

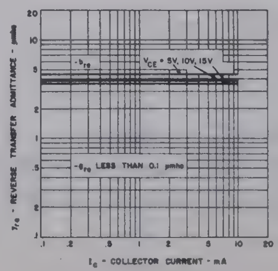


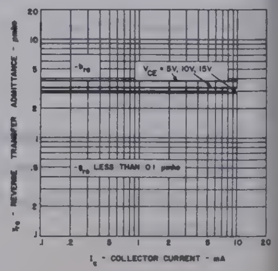




y_{re}
Reverse Transfer Admittance vs. Collector Current
(INPUT SHORT CIRCUIT)





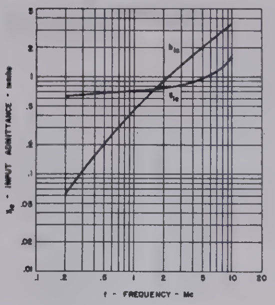


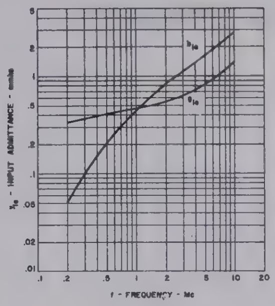
TYPICAL COMMON EMITTER "y" PARAMETERS vs. f

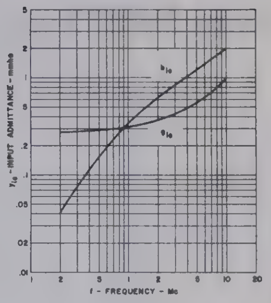
V_{CE}=10V, I_C=2mA, T_A=25°C

2N3858 **2N3859** **2N3860**

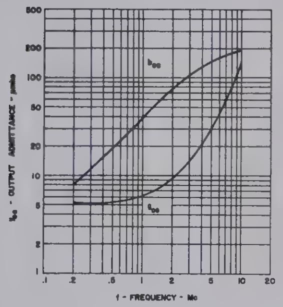
y_{ie}
Input Admittance
vs.
Frequency
(OUTPUT SHORT CIRCUIT)

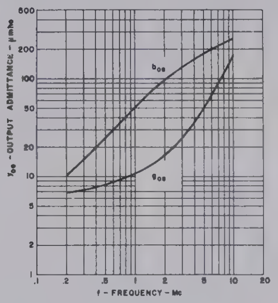


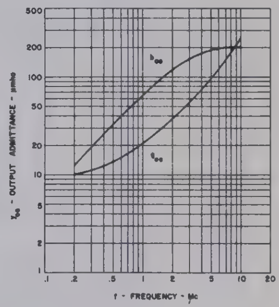




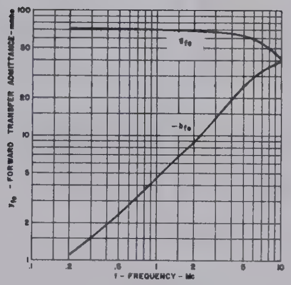
y_{oe}
Output Admittance
vs.
Frequency
(INPUT SHORT CIRCUIT)

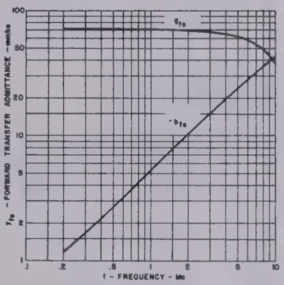


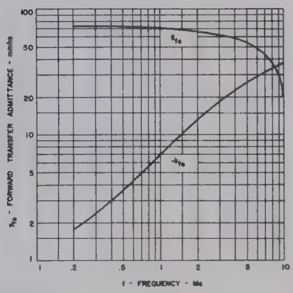




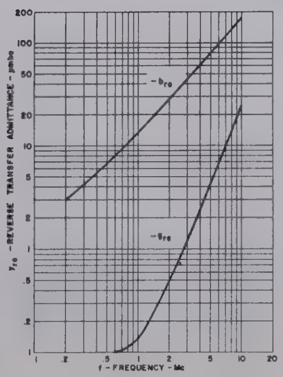
y_{fe}
Forward Transfer
Admittance
vs.
Frequency
(OUTPUT SHORT CIRCUIT)

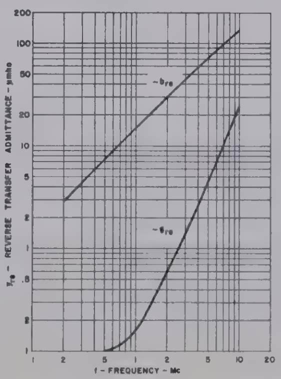


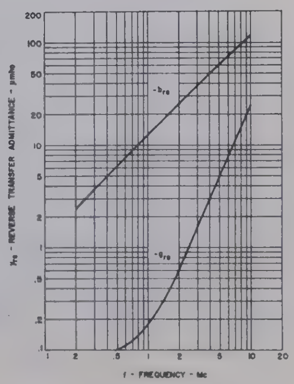




y_{re}
Reverse
Transfer Admittance
vs.
Frequency
(INPUT SHORT CIRCUIT)

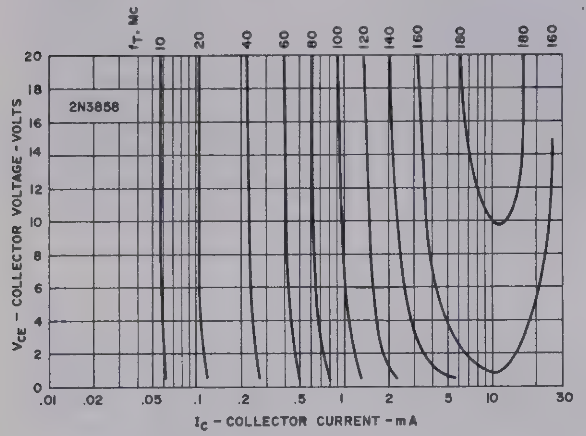




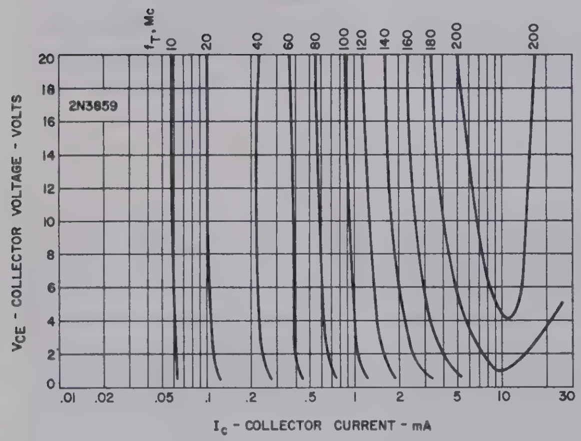


GAIN BAND-WIDTH PRODUCT vs. COLLECTOR CURRENT

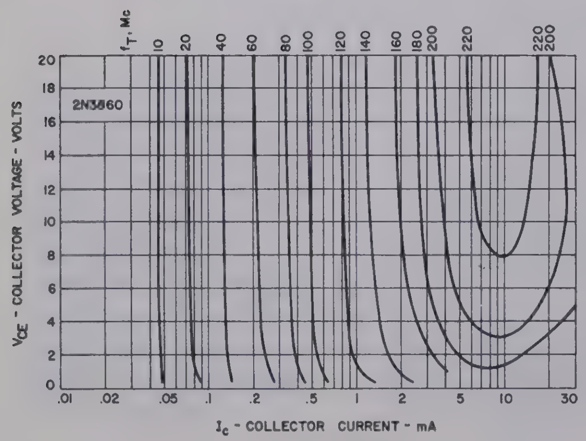
2N3858



2N3859

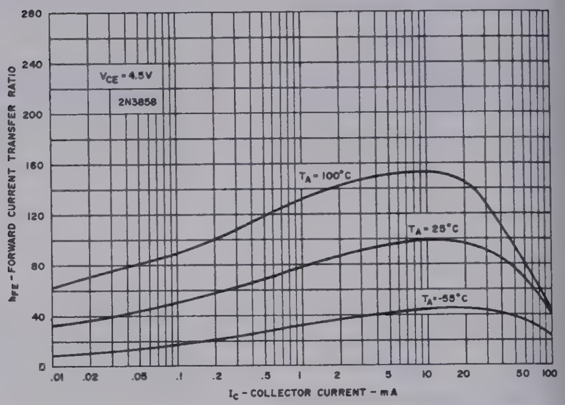


2N3860

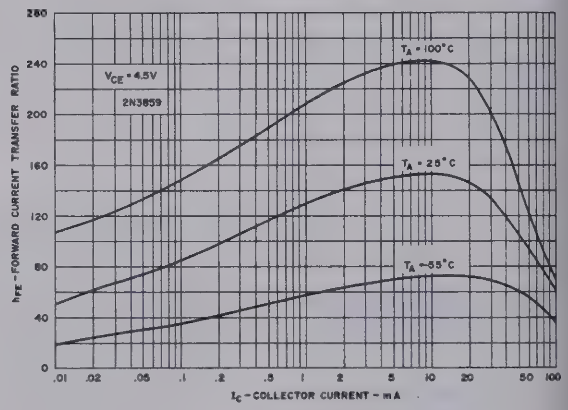


FORWARD CURRENT TRANSFER RATIO vs. COLLECTOR CURRENT

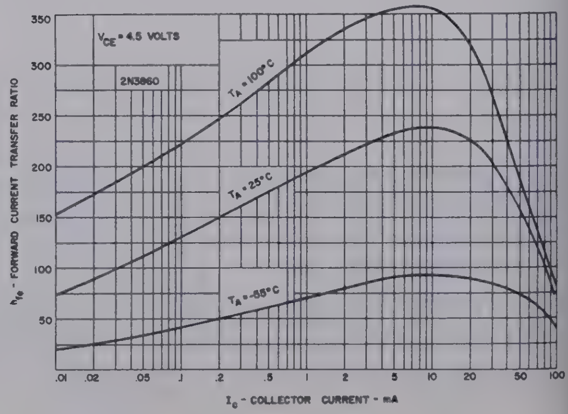
2N3858



2N3859

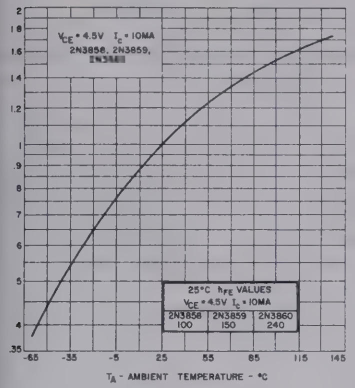


2N3860

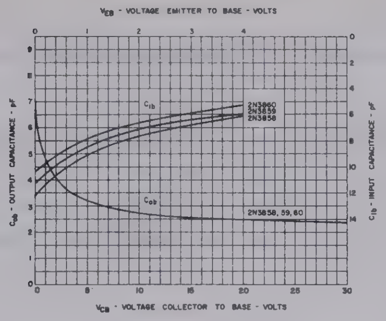


TYPICAL ELECTRICAL CHARACTERISTICS

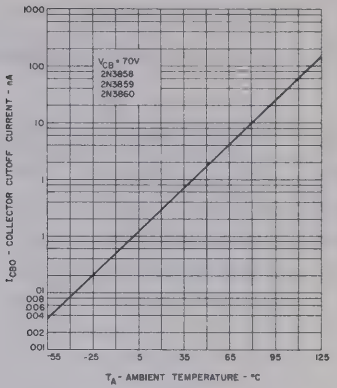
h_{FE} VS. TEMPERATURE



INPUT AND OUTPUT CAPACITANCE

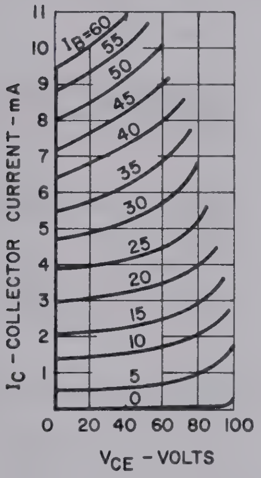


I_{CBO} VS. TEMPERATURE

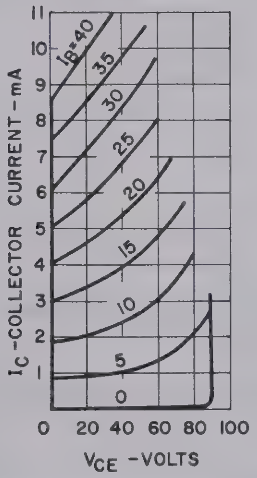


COLLECTOR CHARACTERISTICS

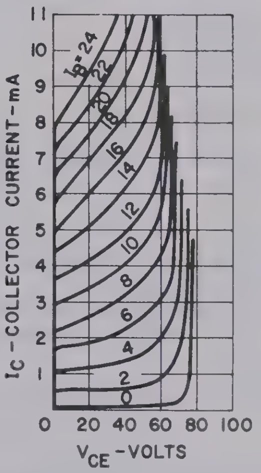
2N3858



2N3859



2N3860

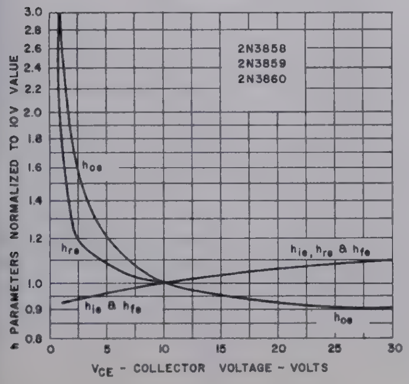


TYPICAL SMALL SIGNAL CHARACTERISTICS

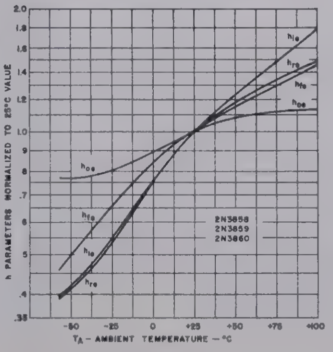
f=1 Kc, V_{CE}=10V, I_E=2mA, T_A=25°C

Symbol	Characteristics	2N3858	2N3859	2N3860	Units
h_{ie}	Input Resistance	1680	2480	3660	ohms
h_{oe}	Output Conductance	8.2	11	17	μmhos
h_{fe}	Forward Current Transfer Ratio	110	175	275	
h_{re}	Voltage Feedback Ratio	8.2	10.5	14.6	X10^{-5}

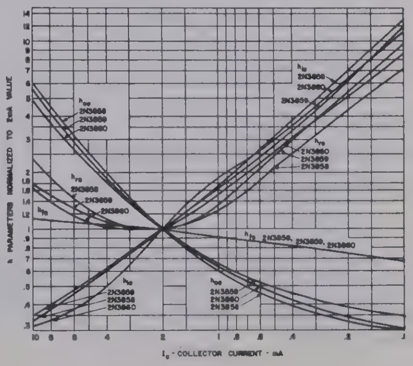
h PARAMETERS vs. V_{CE}



h PARAMETERS vs. TEMPERATURE



h PARAMETERS vs. I_C

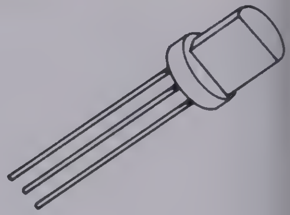


Silicon Transistors

NPN

2N3858A,9A

The General Electric 2N3858A and 2N3859A are NPN silicon, planar, epitaxial, passivated transistors. They are well suited as high voltage, high gain amplifiers and switches. Useful applications include drivers for audio output stages, high level video amplifiers and output stages of operational amplifiers. Selected higher voltage units are available.



absolute maximum ratings: (25°C) (unless otherwise specified)

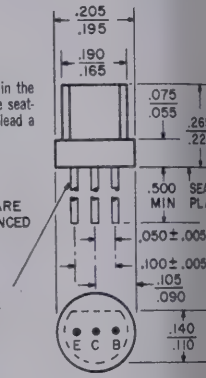
Voltages			
Collector to Emitter	V_{CEO}	60	volts
Emitter to Base	V_{EBO}	6	volts
Collector to Base	V_{CBO}	60	volts
Current			
Collector (Steady State)*	I_C	100	mA
Dissipation			
Total Power (Free air at 25°C)**	P_T	360	mW
Temperature			
Storage	T_{STG}	−55 to 150	°C
Operating	T_J	125	°C
Lead Soldering, 1/16" ± 1/32" from case for 10 seconds max.	T_L	260	°C

*Determined from power limitations due to saturation voltage at this current.

**Derate 3.6 mW/°C increase in ambient temperature above 25°C.

NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED



electrical characteristics: (25°C) (unless otherwise specified)

STATIC CHARACTERISTICS

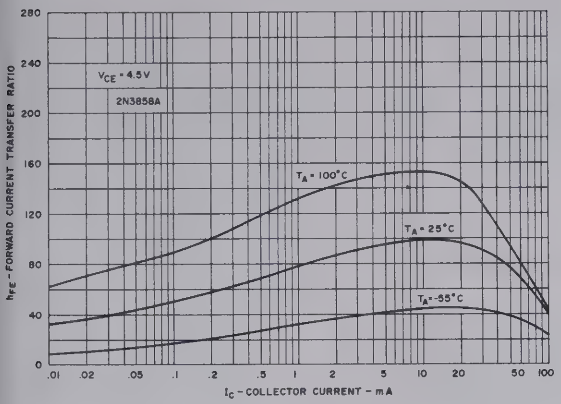
	Sym.	Min.	Typ.	Max.	Units
Collector Cutoff Current ($V_{CB} = 60V$)	I_{CBO}			50	NA
($T_A = 100°C$)	I_{CBO}			10	μA
Emitter Cutoff Current ($V_{EB} = 6V$)	I_{EBO}			0.1	μA
Forward Current Transfer Ratio					
2N3858A ($V_{CE} = 1V, I_C = 10\text{ mA}$)	h_{FE}	60			
2N3859A ($V_{CE} = 1V, I_C = 10\text{ mA}$)	h_{FE}	100			
2N3858A ($V_{CE} = 4.5V, I_C = 2mA$)	h_{FE}	60		120	
2N3859A ($V_{CE} = 4.5V, I_C = 2mA$)	h_{FE}	100		200	
Collector—Base Breakdown Voltage ($I_C = 0.1\text{ mA}$)	BV_{CBO}	60			volts
Emitter—Base Breakdown Voltage ($I_E = 0.1\text{ mA}$)	BV_{EBO}	6			volts
Collector—Emitter Breakdown Voltage ($I_C = 1\text{ mA}$)	BV_{CEO}	60			volts
Collector Saturation Voltage ($I_C = 10\text{ mA}, I_B = 1\text{ mA}$)	$V_{CE(SAT)}$			0.125	volts
Base—Emitter Voltage ($I_C = 10\text{ mA}, V_{CE} = 1\text{ volt}$)	$V_{BE(Drive)}$		.68		volts
Base—Emitter Voltage ($I_C = 10\text{ mA}, I_B = 1\text{ mA}$)	$V_{BE(SAT)}$		.70	.78	volts

DYNAMIC CHARACTERISTICS

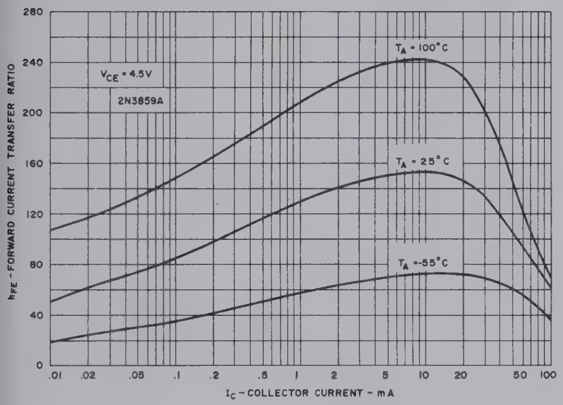
	Sym.	Min.	Typ.	Max.	Units
Gain Bandwidth Product ($V_{CE} = 10V, I_C = 2\text{ mA}$)					
2N3858A	f_T	90	125	250	MHz
2N3859A	f_T	90	140	250	MHz
Collector—Base Time Constant ($V_{CE} = 10V, I_C = 2\text{ mA}$)	$r_b'C_c$		65	150	psec.
Output Capacitance, Common Base ($V_{CB} = 10V, I_E = 0, f = 1\text{ MHz}$)	C_{cbo}	2.0	2.7	4.0	pF
Input Capacitance, Common Base ($V_{EB} = 0.5V, I_E = 0, f = 1\text{ MHz}$)	C_{ibo}		10		pF
Case Capacitance			0.66		pF

FORWARD CURRENT TRANSFER RATIO
vs.
COLLECTOR CURRENT

2N3858A

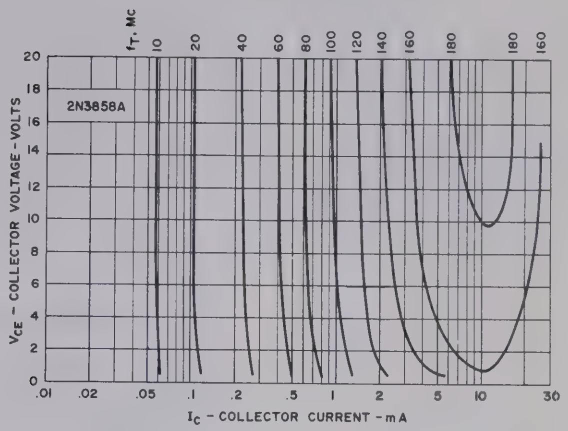


2N3859A

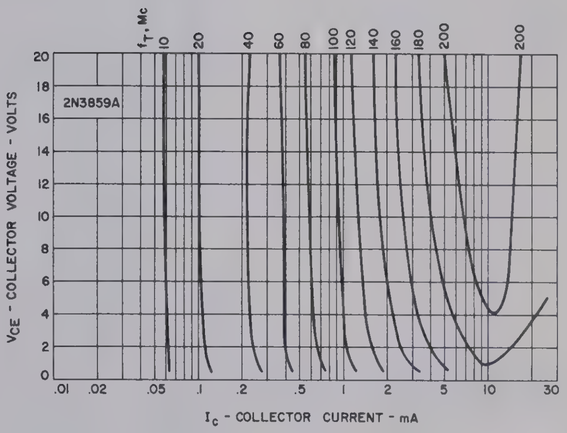


GAIN BAND-WIDTH
PRODUCT
vs.
COLLECTOR CURRENT

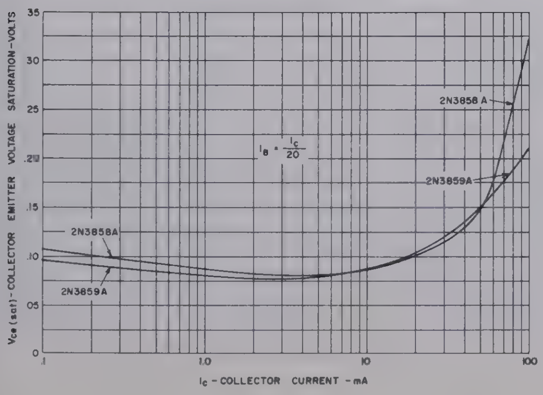
2N3858A



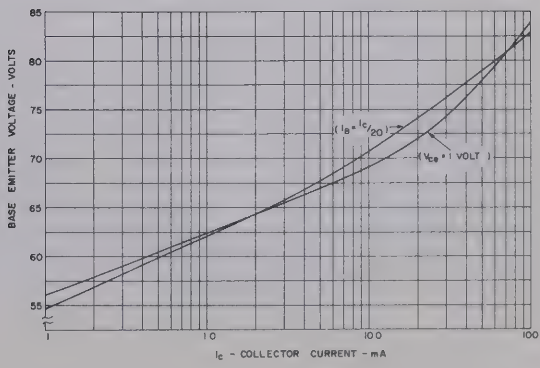
2N3859A



$V_{CE(SAT)}$
vs.
Collector Current

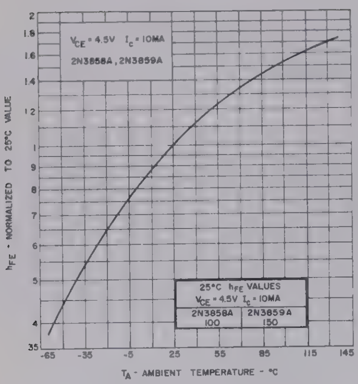


$V_{BE(SAT)}$, $V_{BE(DRIVE)}$
vs.
Collector Current

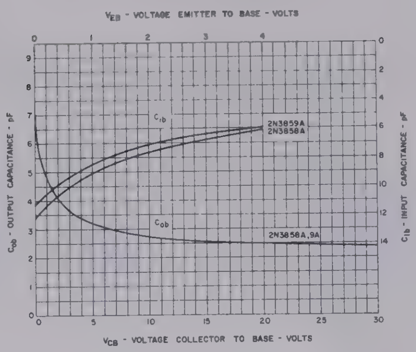


TYPICAL ELECTRICAL CHARACTERISTICS

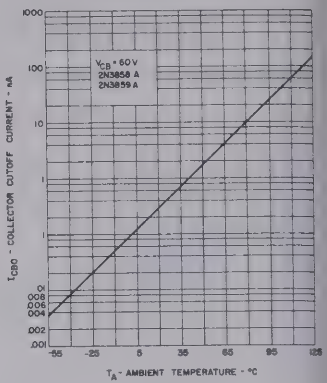
h_{FE} vs. TEMPERATURE



INPUT AND OUTPUT CAPACITANCE

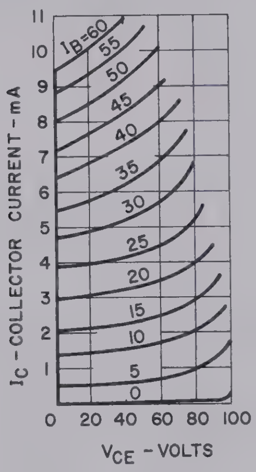


I_{CBO} vs. TEMPERATURE

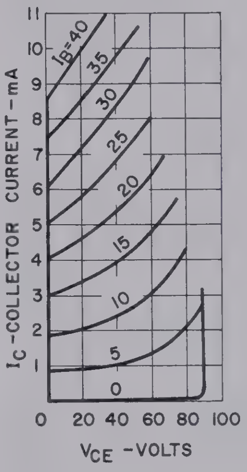


COLLECTOR CHARACTERISTICS

2N3858A



2N3859A

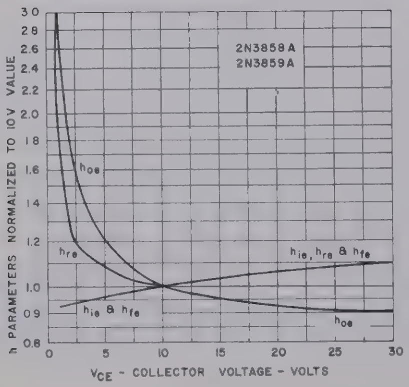


TYPICAL SMALL SIGNAL CHARACTERISTICS

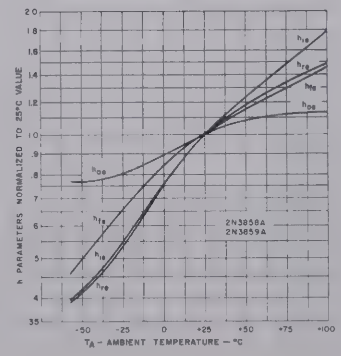
f = 1 Kc, V_{CE} = 10V, I_E = 2mA, T_A = 25°C

Symbol	Characteristics	2N3858A	2N3859A	Units
h_{ie}	Input Resistance	1680	2480	ohms
h_{oe}	Output Conductance	8.2	11	μmhos
h_{fe}	Forward Current Transfer Ratio	110	175	
h_{re}	Voltage Feedback Ratio	8.2	10.5	X10^{-5}

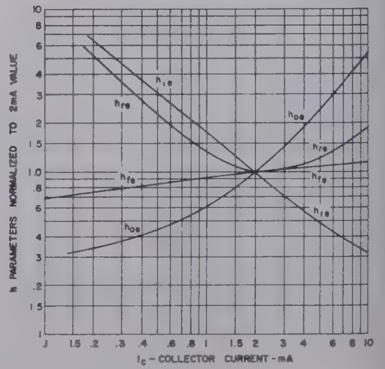
h PARAMETERS vs. V_{CE}



h PARAMETERS vs. TEMPERATURE



h PARAMETERS vs. I_C



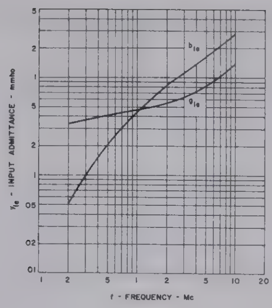
TYPICAL COMMON EMITTER "y" PARAMETERS

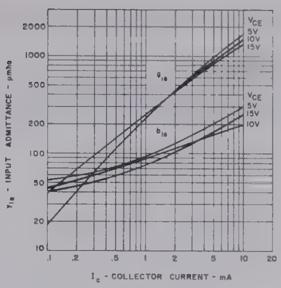
$V_{CE} = 10V$

$I_C = 2$ mA

f = 250 KHz

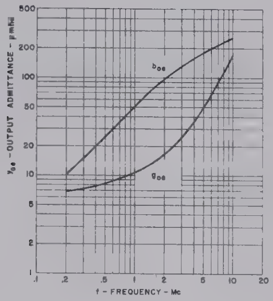
y_{ie}
Input Admittance
vs.
Frequency
(OUTPUT SHORT CIRCUIT)

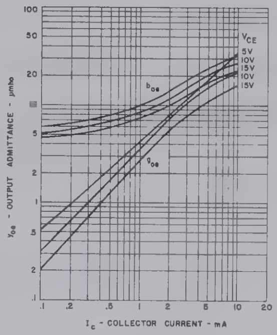




y_{ie}
Input Admittance
vs.
Collector Current
(OUTPUT SHORT CIRCUIT)

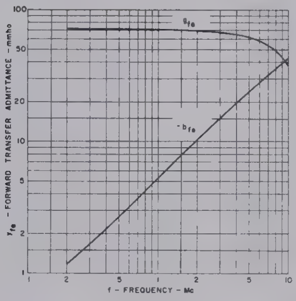
y_{oe}
Output Admittance
vs.
Frequency
(INPUT SHORT CIRCUIT)

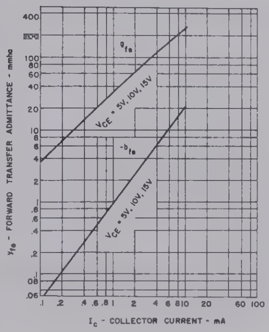




y_{oe}
Output Admittance
vs.
Collector Current
(INPUT SHORT CIRCUIT)

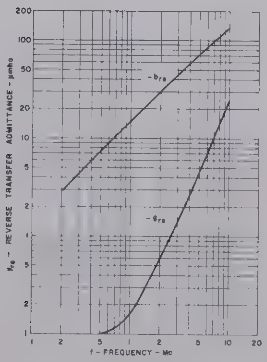
y_{fe}
Forward Transfer
Admittance
vs.
Frequency
(OUTPUT SHORT CIRCUIT)

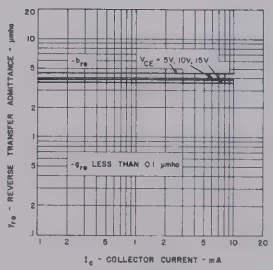




y_{fe}
Forward Transfer
Admittance
vs.
Collector Current
(OUTPUT SHORT CIRCUIT)

y_{re}
Reverse
Transfer Admittance
vs.
Frequency
(INPUT SHORT CIRCUIT)





y_{re}
Reverse
Transfer Admittance
vs.
Collector Current
(INPUT SHORT CIRCUIT)

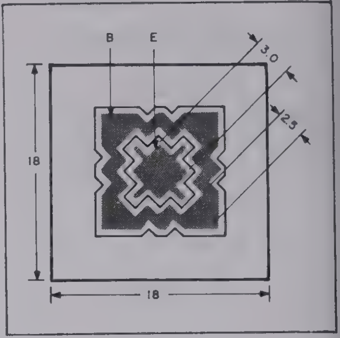
Silicon
Transistor Chips

NPN

2N3859 (Chip)

(M26P-X516)

This General Electric NPN silicon planar passivated transistor chip is designed primarily for AM radio, IF and converter applications.



General specifications:

- Gold collector contact backing, minimum thickness—3000Å
- Aluminum base and emitter contact metalization
- Maximum conditions for mounting chips—425°C for 5 minutes (Max.) in an inert atmosphere
- Shipping containers: Glass vials sealed with a nitrogen back-fill
  Maximum of 10k chips per vial
  Egg crate containers available at extra cost
- Chip drawing dimensions are in mils
- Chip thickness = 5.4 $^{+0.8}_{-0.9}$ mils

absolute maximum ratings: ($T_A = 25°C$)

	Symbol		
Voltages			
Collector to Base	V_{CBO}	40	V
Collector to Emitter	V_{CEO}	40	V
Emitter to Base	V_{EBO}	5	V
Current			
Collector	I_C	100	mA
Temperature			
Storage	T_{STG}	−65°C to +200°C	
Operating	T_J	−65°C to +200°C	

electrical characteristics: 100% Probe ($T_A = 25°C$)

Tested at outgoing acceptance to a 10% LTPD with a maximum accept number of 3.

	Symbol	Min.	Max.	
Collector Base Breakdown Voltage ($I_C = .05\ \mu A$)	BV_{CBO}	40	—	V
Collector Emitter Breakdown Voltage ($I_C = 10$ mA)	BV_{CEO}	40	—	V
Emitter Base Breakdown Voltage ($I_E = 0.1\ \mu A$)	BV_{EBO}	5	—	V
Forward Current Transfer Ratio ($I_C = 2$ mA, $V_{CE} = 4.5V$)	h_{FE}	100	200	

specifications: ($T_A = 25°C$)

Product yield is at least 93% to each of the following parameters:

	Symbol	Min.	Max.	
Collector Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)	$V_{CE(SAT)}$	—	0.125	V
Base Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)	$V_{BE(SAT)}$	—	0.78	V
Forward Current Transfer Ratio ($I_C = 2$ mA, $V_{CE} = 10V$, f = 10 MHz)	h_{fe}	18.5	28	
Gain Bandwidth Product ($I_C = 2$ mA, $V_{CE} = 10V$, f = 10 MHz)	f_t	90	250	MHz
Collector Base Capacitance ($V_{CB} = 10V$, f = 1 Mz)	C_{cb}	1.6	4.0	pF

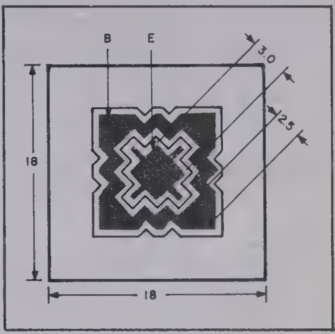
Silicon Transistor Chips

NPN

2N3860 (Chip)

(M26P-X560)

This General Electric NPN silicon planar passivated epitaxial transistor chip s designed primarily for AM radio, IF and converter applications.



General specifications:

- Gold collector contact backing, minimum thickness—3000Å
- Aluminum base and emitter contact metalization
- Maximum conditions for mounting chips—425°C for 5 minutes (Max.) in an inert atmosphere
- Shipping containers: Glass vials sealed with a nitrogen back-fill
  Maximum of 10k chips per vial
  Egg crate containers available at extra cost
- Chip drawing dimensions are in mils
- Chip thickness = $5.4^{+0.8}_{-0.9}$ mils

absolute maximum ratings: ($T_A = 25°C$)

	Symbol		
Voltages			
Collector to Base	V_{CBO}	40	V
Collector to Emitter	V_{CEO}	40	V
Emitter to Base	V_{EBO}	5	V
Current			
Collector	I_C	100	mA
Temperature			
Storage	T_{STG}	−65°C to +200°C	
Operating	T_J	−65°C to +200°C	

electrical characteristics: 100% Probe ($T_A = 25°C$)

Tested at outgoing acceptance to a 10% LTPD with a maximum accept number of 3.

	Symbol	Min.	Max.	
Collector Base Breakdown Voltage ($I_C = 0.05\ \mu A$)	BV_{CBO}	40	—	V
Collector Emitter Breakdown Voltage ($I_C = 1$ mA)	BV_{CEO}	40	—	V
Emitter Base Breakdown Voltage ($I_E = 0.1\ \mu A$)	BV_{EBO}	5	—	V
Forward Current Transfer Ratio ($I_C = 2$ mA, $V_{CE} = 4.5V$)	h_{FE}	150	300	

specifications: ($T_A = 25°C$)

Product yield is at least 93% to each of the following parameters:

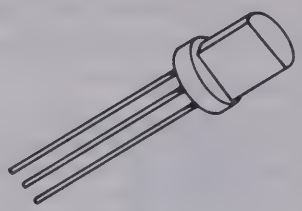
	Symbol	Min.	Max.	
Collector Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)	$V_{CE(SAT)}$	—	0.125	V
Base Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)	$V_{BE(SAT)}$	—	0.78	V
Forward Current Transfer Ratio ($I_C = 2$ mA, $V_{CE} = 5V$, f = 1 KHz)	h_{fe}	150	400	
Forward Current Transfer Ratio ($I_C = 2$ mA, $V_{CE} = 10V$, f = 10 MHz)	$\lvert h_{fe} \rvert$	18.5	28	dB
Gain Bandwidth Product ($I_C = 2$ mA, $V_{CE} = 10V$, f = 10 MHz)	f_t	90	250	MHz
Collector Base Capacitance ($V_{CB} = 10V$, f = 1 MHz)	C_{cb}	1.6	4.0	pF

Silicon
Transistors

NPN

2N3877,A

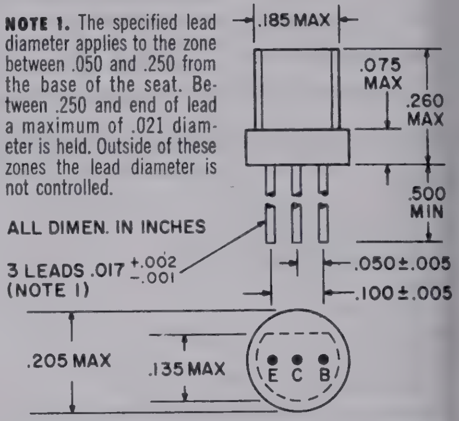
The General Electric 2N3877A and 2N3877 are NPN silicon planar passivated transistors designed for high voltage applications. The 2N3877A features a guaranteed minimum BVCEO of 85 volts. It is especially useful for driving high voltage indicating devices.



absolute maximum ratings: (25°C)

		2N3877A	2N3877	
Voltages				
Collector to Emitter (at 1 mA)	V_{CEO}	85	70	volts
Emitter to Base (at 1 mA)	V_{EBO}	4	4	volts
Collector to Base (at 1 mA)	V_{CBO}	85	70	volts
Current				
Collector* (Steady State)	I_C	50		mA
Dissipation				
Total Power (Free air @ 25°C)**	P_T	360	200	mW
Total Power (Free air @ 55°C)	P_T	250	100	mW
Temperature				
Storage	T_{STG}	−55°C to + 150		°C
Operating	T_J	−55°C to + 125		°C
Lead Soldering, 1/16" to 1/32" from case for 10 sec. max.	T_L	+ 260		°C

*Determined from power limitations due to saturation voltage at this current.
**Derate 2.67 mw/°C increase for temperature above 25°C.



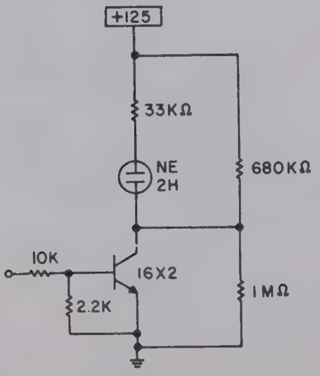
NOTE 1. The specified lead diameter applies to the zone between .050 and .250 from the base of the seat. Between .250 and end of lead a maximum of .021 diameter is held. Outside of these zones the lead diameter is not controlled.

.185 MAX
.075 MAX
.260 MAX
.500 MIN
ALL DIMEN. IN INCHES
3 LEADS .017 +.002 −.001 (NOTE 1)
.050±.005
.100±.005
.205 MAX
.135 MAX
E C B

electrical characteristics: (25°C) (unless otherwise specified)

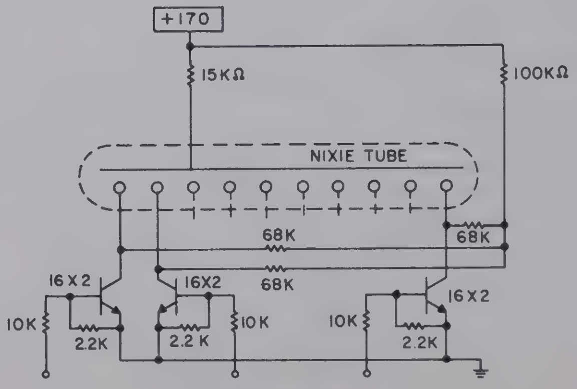
		Min.	Typ.	Max.
Collector Cutoff Current ($V_{CB} = 70V$)	I_{CBO}			0.1 μA
($V_{CB} = 70V$, $T_A = 100°C$)	I_{CBO}			10 μA
Forward Current Transfer Ratio ($V_{CB} = 4.5V$, $I_C = 2$ mA)	h_{FE}	20		
Collector Saturation ($I_B = 1$ mA, $I_C = 10$ mA)	$V_{CE(SAT)}$			1.0 volts
Base Saturation Voltage ($I_B = 1$ mA, $I_C = 10$ mA)	$V_{BE(SAT)}$			.9 volts
Gain Bandwidth Product ($I_C = 10$mA, $V_C = 10V$)	f_T		160	Mc/s

TYPICAL APPLICATIONS



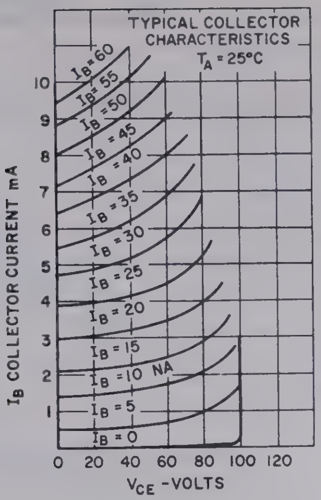
+125
33KΩ
NE 2H
680KΩ
10K
16X2
2.2K
1MΩ

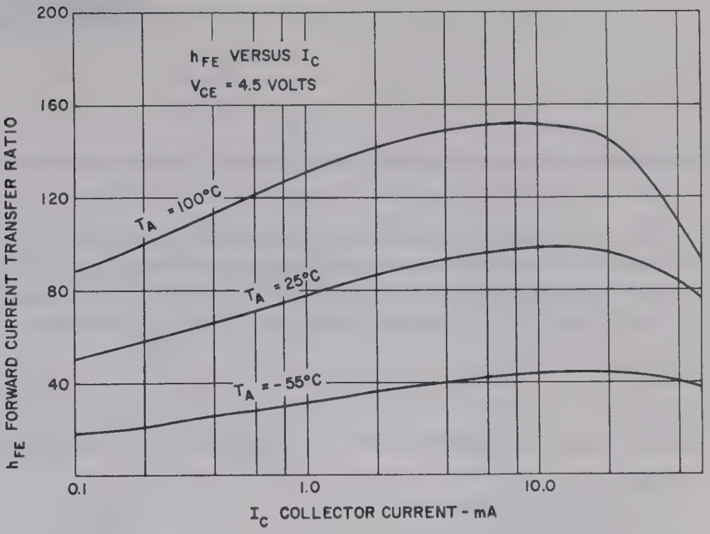
NEON DRIVER

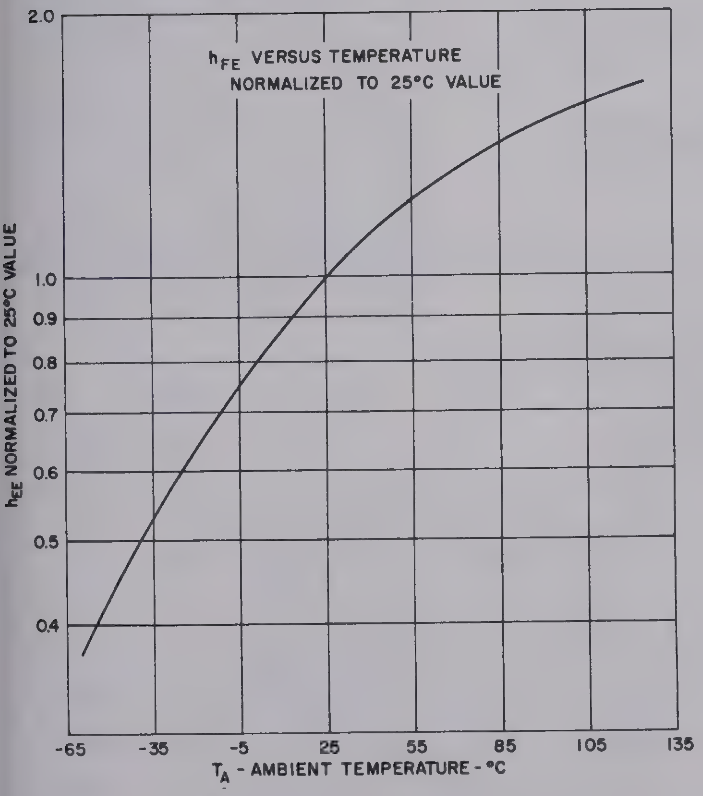


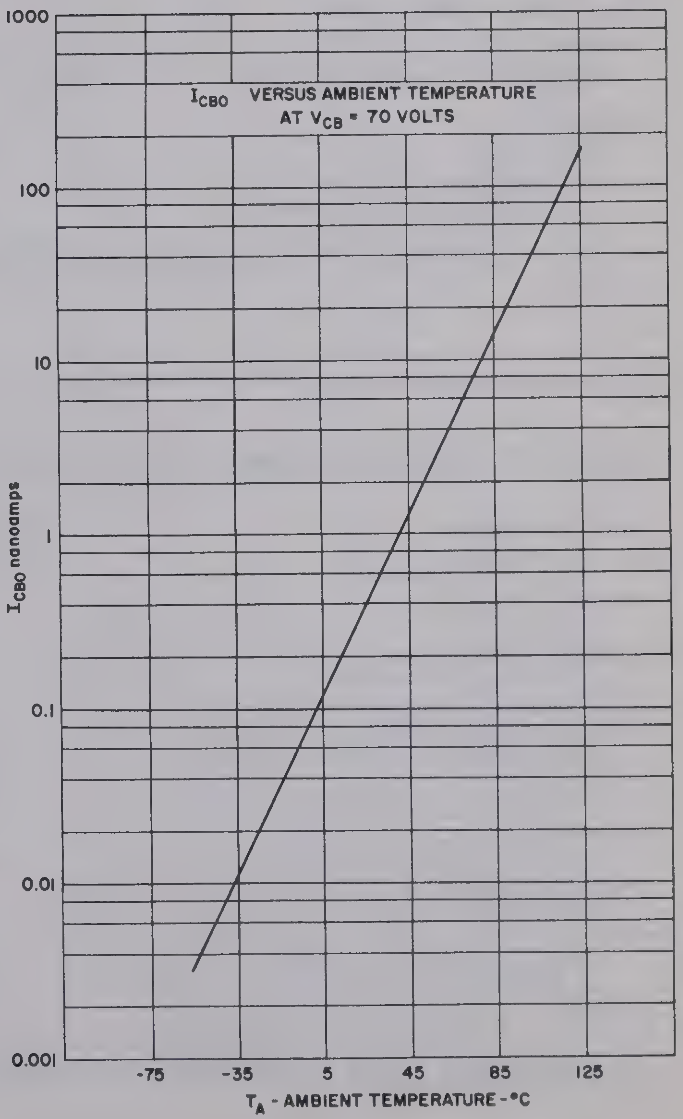
+170
15KΩ
100KΩ
NIXIE TUBE
68K
68K
68K
16 X 2
16X2
16X2
10K
10K
10K
2.2K
2.2 K
2.2K

NIXIE DRIVERS


TYPICAL COLLECTOR CHARACTERISTICS
$T_A = 25°C$
$I_B = 60$
$I_B = 55$
$I_B = 50$
$I_B = 45$
$I_B = 40$
$I_B = 35$
$I_B = 30$
$I_B = 25$
$I_B = 20$
$I_B = 15$
$I_B = 10$ NA
$I_B = 5$
$I_B = 0$
I_B COLLECTOR CURRENT mA
10
9
8
7
6
5
4
3
2
1
0
20
40
60
80
100
120
V_{CE} - VOLTS


h_{FE} VERSUS I_C
$V_{CE} = 4.5$ VOLTS
$T_A = 100°C$
$T_A = 25°C$
$T_A = -55°C$
h_{FE} FORWARD CURRENT TRANSFER RATIO
200
160
120
80
40
0.1
1.0
10.0
I_C COLLECTOR CURRENT - mA


h_{FE} VERSUS TEMPERATURE
NORMALIZED TO 25°C VALUE
h_{EE} NORMALIZED TO 25°C VALUE
2.0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
-65
-35
-5
25
55
85
105
135
T_A - AMBIENT TEMPERATURE - °C

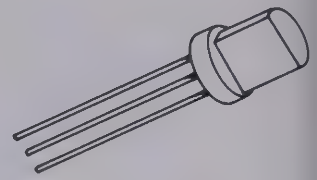

I_{CBO} VERSUS AMBIENT TEMPERATURE
AT $V_{CB} = 70$ VOLTS
I_{CBO} nanoamps
1000
100
10
1
0.1
0.01
0.001
-75
-35
5
45
85
125
T_A - AMBIENT TEMPERATURE - °C

Silicon
Transistors

NPN

2N3900,A

The General Electric 2N3900 and 2N3900A are NPN silicon planar passivated devices intended for low noise preamplifier applications. The planar passivated construction assures excellent device stability and life. These high performance, high value transistors are made possible by utilizing advanced manufacturing techniques.



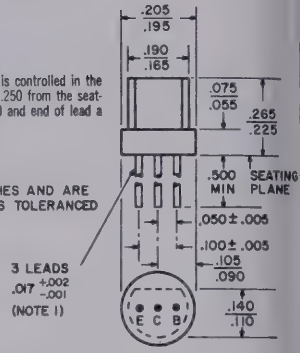
absolute maximum ratings (25°C) unless otherwise specified

Voltages			
Collector to Emitter	V_{CEO}	18	V
Emitter to Base	V_{EBO}	5	V
Collector to Base	V_{CBO}	18	V
Current			
Collector (Steady State) ⁽¹⁾	I_C	100	mA
Dissipation			
Total Power (Free Air @ 25°C) ⁽²⁾	P_T	360	mW
Total Power (Free Air @ 55°C) ⁽²⁾	P_T	260	mW
Temperature			
Storage	T_{stg}	−55 to +125	°C
Operating	T_J	+100	°C
Lead Soldering, 1/16″ ± 1/32″ from case for 10 seconds max.	T_L	+260	°C

⁽¹⁾ Determined from power limitations due to saturation voltage at this current.
⁽²⁾ Derate 3.6 mW °C increase in ambient temperature above 25°C.

NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

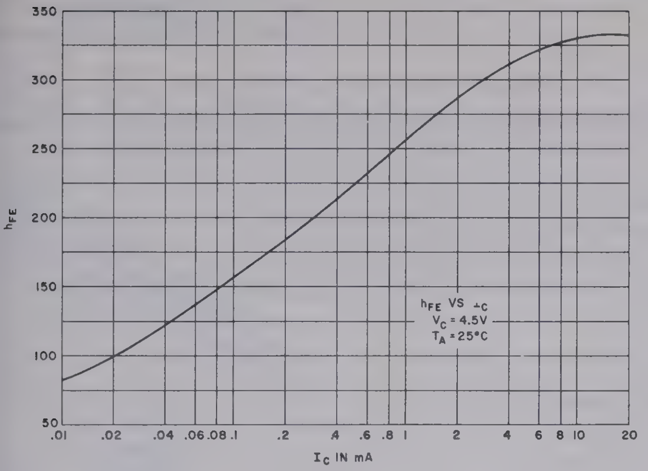


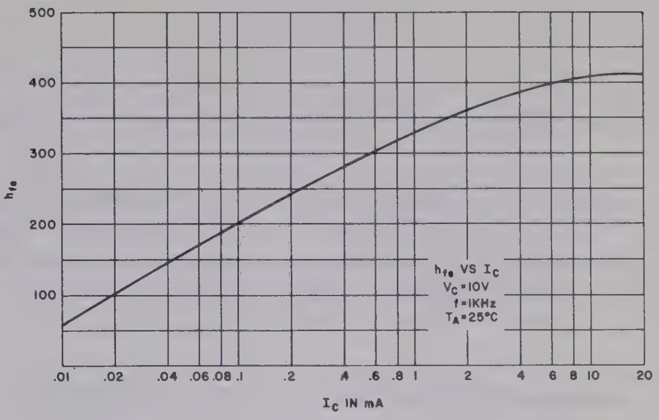
electrical characteristics (25°C) unless otherwise specified

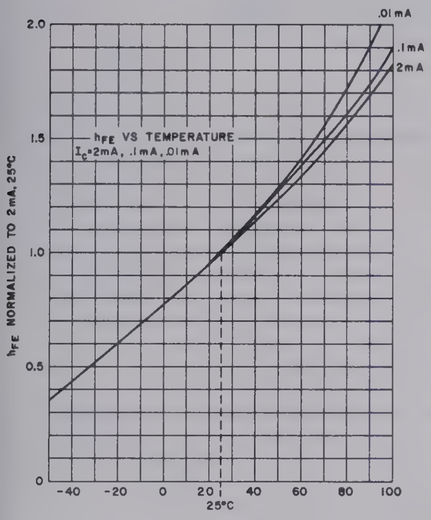
		Min.	Typ.	Max.	
Collector Cutoff Current					
($V_{CB} = 18V$)	I_{CBO}			.1	μA
($V_{CB} = 18V$, $T_A = 100°C$)	I_{CBO}			10	μA
Emitter Cutoff Current					
($V_{EB} = 5V$)	I_{EBO}			.1	μA
Forward Current Transfer Ratio					
($V_{CE} = 4.5V$, $I_C = 2$ mA)	h_{FE}	250		500	
SMALL SIGNAL CHARACTERISTICS					
Forward Current Transfer Ratio					
($V_{CE} = 10V$, $I_C = 100$ μA, f = 1 kHz)	h_{fe}	170⁽³⁾	200		
Input Impedance					
($V_{CE} = 10V$, $I_C = 2$ mA, f = 1 kHz)	h_{ib}		15		ohms
Output Capacitance					
($V_{CB} = 10V$, $I_E = 0$, f = 1 MHz)	C_{obo}	2.0	7	12	pF
Gain Bandwidth Product					
($I_C = 4$ mA, $V_{CB} = 5$ V)	f_t		160		MHz
NOISE					
(wide band—15 cps to 10 kHz, Equivalent Noise Bandwidth = 15.7 kHz)					
Noise Figure					
($I_C = 100$ μA, $V_{CE} = 4.5V$, $R_g = 5000$ ohms)	NF		1.9	5⁽⁴⁾	dB

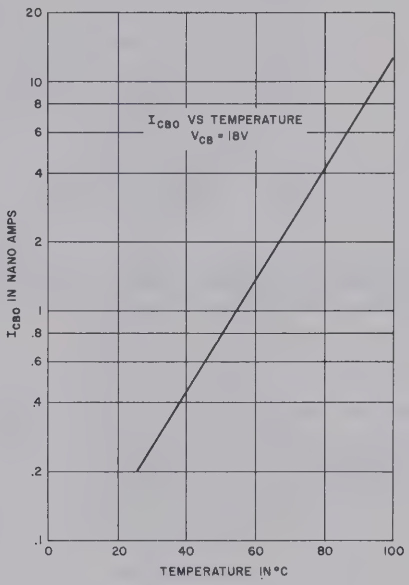
⁽³⁾ Typically a minimum of 95% of the distribution is above this value.
⁽⁴⁾ Type 2N3900A only.

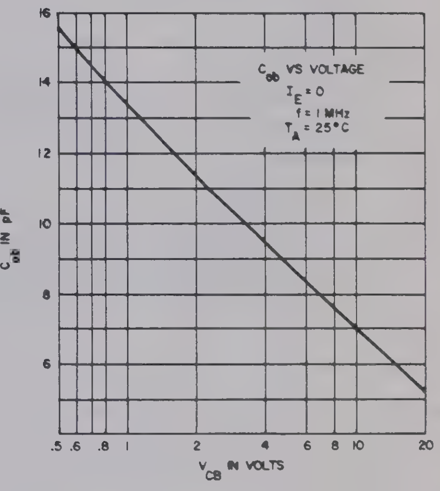
TYPICAL CURVES
2N3900 AND 2N3900A

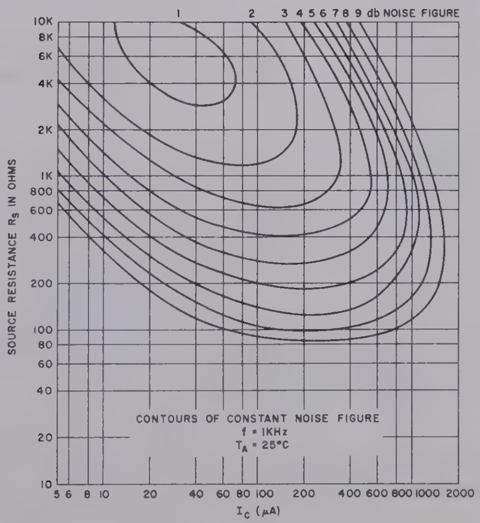


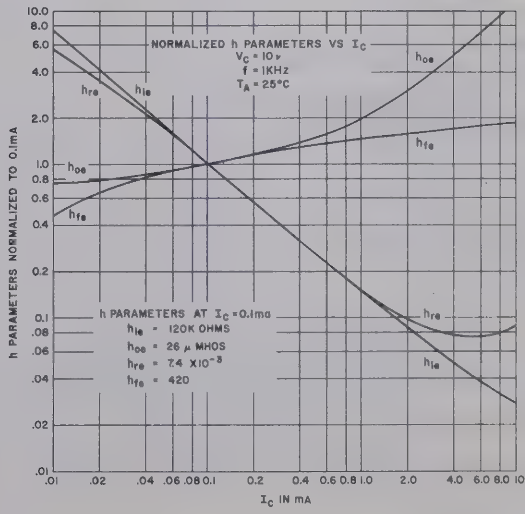










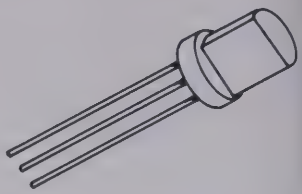


Silicon
Transistor

NPN

2N3901

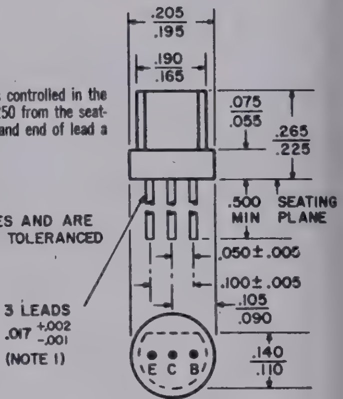
The General Electric 2N3901 is an NPN silicon planar transistor characterized for general industrial low signal level application. It features high current gain and ft, and low leakage current and collector capacitance. The planar construction assures excellent parameter stability with life.



absolute maximum ratings (25°C) unless otherwise specified

Voltages			
Collector to Emitter	V_{CEO}	18	V
Emitter to Base	V_{EBO}	5	V
Collector to Base	V_{CBO}	18	V
Current			
Collector (Steady State) (1)	I_C	100	mA
Dissipation			
Total Power (Free Air @ 25°C) (2)	P_T	360	mW
Total Power (Free Air @ 55°C) (2)	P_T	250	mW
Temperature			
Storage	T_{stg}	−55 to +125	°C
Operating	T_J	−55 to +125	°C
Lead Soldering, $\frac{1}{16}'' \pm \frac{1}{32}''$ from case for 10 seconds max.	T_L	+260	°C

(1) Determined from power limitations due to saturation voltage at this current.
(2) Derate 2.67 mw/°C increase in ambient temperature above 25°C.



NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

electrical characteristics (25°C) unless otherwise specified

		Min.	Typ.	Max.	
Collector Cutoff Current					
($V_{CB} = 15V$)	I_{CBO}		0.2	10	nA (3)
($V_{CB} = 15V, T_A = 100°C$)	I_{CBO}		.013	10	μA
Emitter Cutoff Current					
($V_{EB} = 5V$)	I_{EBO}			0.1	μA
Forward Current Transfer Ratio					
($V_{CE} = 4.5V, I_C = 2$ mA)	h_{FE}	350		700	
SMALL SIGNAL CHARACTERISTICS					
Forward Current Transfer Ratio					
($V_{CE} = 4.5V, I_C = 2$ mA, f = 1 kHz)	h_{fe}	350			
Output Capacitance					
($V_{CB} = 10V, I_E = 0$, f = 1 MHz)	C_{cb}	4.5	7	10	pF
Gain Bandwidth Product					
($I_C = 4$ mA, $V_{CE} = 5V$)	f_t		200		MHz

NOISE

$$NF \approx 10 \log_{10} \left(\frac{1 + e_n^2/Rg + i_n^2\, Rg}{4\ KTB} \right)$$

where: e_n, i_n are transistor noise voltage and noise current as obtained in Fig. 8
B is the bandwidth in cycles
$4\ KT = 1.66 \times 10^{-20}$

Optimum generator resistance for minimum noise, $R_{opt} = \frac{e_n}{i_n}$

(3) To 10% LTPD

2N3901

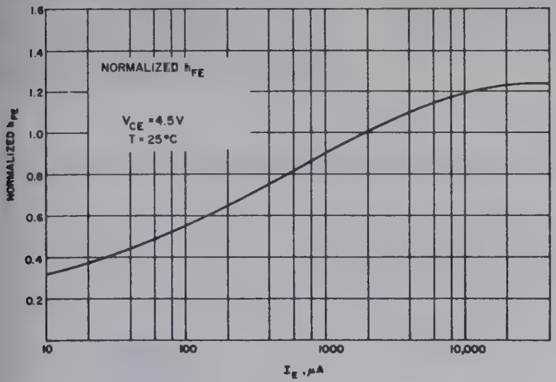


Fig. 1

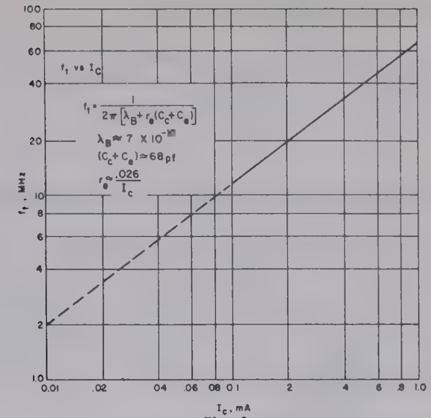


Fig. 2

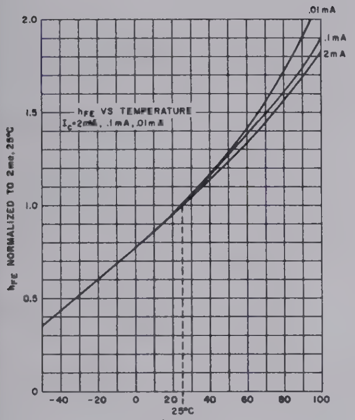


Fig. 3

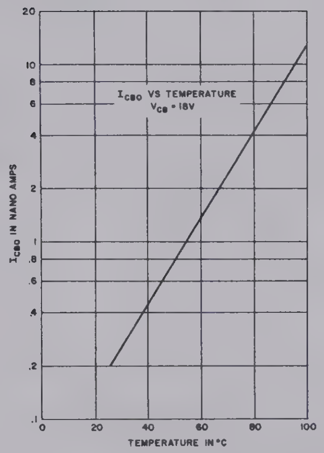


Fig. 4

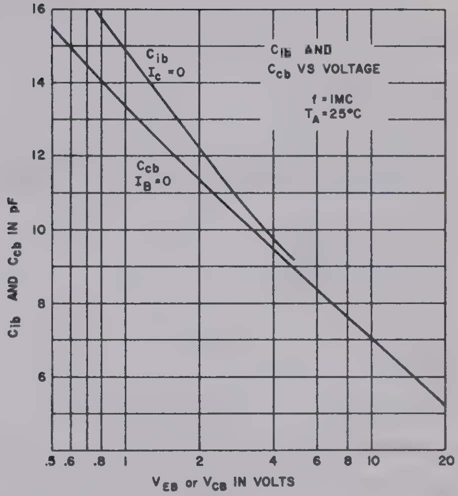


Fig. 5

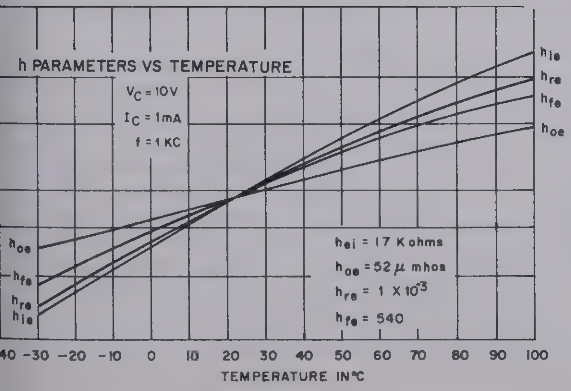


Fig. 6

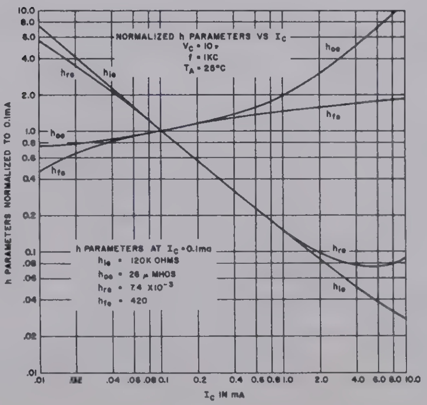


Fig. 7

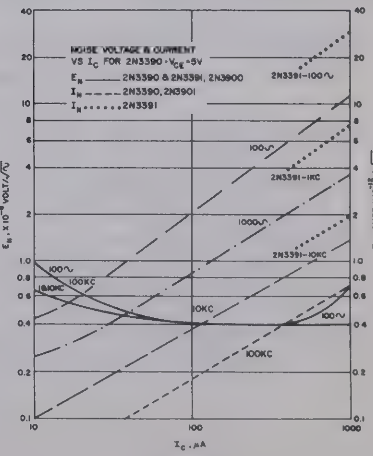


Fig. 8

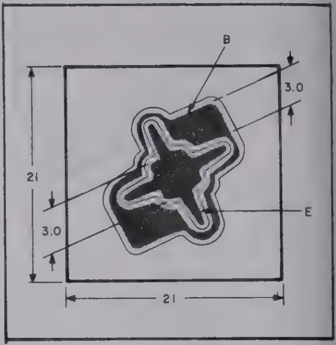
Silicon
Transistor Chips

NPN

2N3975 (Chip)

(M23P-X509)

This General Electric NPN silicon planar passivated transistor chip is designed primarily for medium-speed switching and large signal RF amplifiers. The chip features excellent h_{FE} holdup at collector currents between 0.1 mA and 500 mA, adequate switching times for 2 MHz saturated logic circuits, and typical gain bandwidth product of 350 MHz.



General specifications:

- Gold collector contact backing, minimum thickness—3000Å
- Aluminum base and emitter contact metalization
- Maximum conditions for mounting chips—425°C for 5 minutes (Max.) in an inert atmosphere
- Shipping containers: Glass vials sealed with a nitrogen back-fill
  Maximum of 10k chips per vial
  Egg crate containers available at extra cost
- Chip drawing dimensions are in mils
- Chip thickness = 6.8 $^{+0.7}_{-0.8}$ mils

absolute maximum ratings: ($T_A = 25°C$)

	Symbol		
Voltages			
Collector to Base	V_{CBO}	60	V
Collector to Emitter	V_{CEO}	30	V
Emitter to Base	V_{EBO}	5	V
Current			
Collector	I_C	400	mA
Temperature			
Storage	T_{STG}	−65°C to +200°C	
Operating	T_J	−65°C to +200°C	

electrical characteristics: 100% Probe ($T_A = 25°C$)

Tested at outgoing acceptance to a 10% LTPD with a maximum accept number of 3.

	Symbol	Min.	Max.	
Collector Base Breakdown Voltage ($I_C = 10\ \mu A$)	BV_{CBO}	60	—	V
Collector Emitter Breakdown Voltage ($I_C = 10$ mA)	BV_{CEO}	30	—	V
Emitter Base Breakdown Voltage ($I_E = 0.5\ \mu A$)	BV_{EBO}	5	—	V
Collector Cutoff Current ($V_{CB} = 40V$)	I_{CBO}	—	500	nA
Forward Current Transfer Ratio ($I_C = 10$ mA, $V_{CE} = 2V$)	h_{FE}	35	100	

specifications: ($T_A = 25°C$)

Product yield is at least 93% to each of the following parameters:

	Symbol	Min.	Max.	
Forward Current Transfer Ratio ($I_C = 150$ mA, $V_{CE} = 1V$)	h_{FE}	30	—	
Collector Saturation Voltage ($I_C = 150$ mA, $I_B = 15$ mA)	$V_{CE(SAT)}$	—	0.3	V
Base Saturation Voltage ($I_C = 150$ mA, $I_B = 15$ mA)	$V_{BE(SAT)}$	—	1.3	V
Collector Base Capacitance ($V_{CB} = 10V$, f = 1 MHz)	C_{cb}	—	7	pF
Gain Bandwidth Product ($V_{CE} = 5V$, $I_C = 20$ mA, f = 100 MHz)	f_t	200	—	MHz

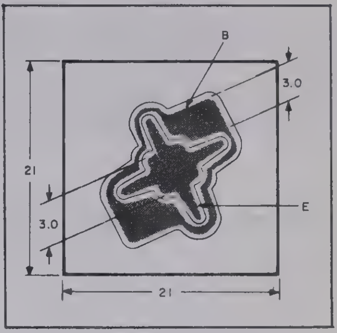
Silicon
Transistor Chips

NPN

2N3976 (Chip)

(M23P-X516)

The General Electric NPN silicon planar passivated transistor chip is designed primarily for medium-speed switching and large signal RF amplifiers. The chip features excellent h_{FE} holdup at collector currents between 1 mA and 500 mA, adequate switching times for 2 MHz saturated logic circuits, and typical gain bandwidth product of 350 MHz.



General specifications:

- Gold collector contact backing, minimum thickness—3000Å
- Aluminum base and emitter contact metalization
- Maximum conditions for mounting chips—425°C for 5 minutes (Max.) in an inert atmosphere
- Shipping containers: Glass vials sealed with a nitrogen back-fill
  Maximum of 10k chips per vial
  Egg crate containers available at extra cost
- Chip drawing dimensions are in mils
- Chip thickness = 6.8 $^{+0.7}_{-0.8}$ mils

absolute maximum ratings: ($T_A = 25°C$)

	Symbol		
Voltages			
Collector to Base	V_{CBO}	60	V
Collector to Emitter	V_{CEO}	30	V
Emitter to Base	V_{EBO}	5	V
Current			
Collector	I_C	400	mA
Temperature			
Storage	T_{STG}	−65°C to +200°C	
Operating	T_J	−65°C to +200°C	

electrical characteristics: 100% Probe ($T_A = 25°C$)

Tested at outgoing acceptance to a 10% LTPD with a maximum accept number of 3.

	Symbol	Min.	Max.	
Collector Base Breakdown Voltage ($I_C = 10\ \mu A$)	BV_{CBO}	60	—	V
Collector Emitter Breakdown Voltage ($I_C = 10$ mA)	BV_{CEO}	30	—	V
Emitter Base Breakdown Voltage ($I_E = 0.5\ \mu A$)	BV_{EBO}	5	—	V
Collector Cutoff Current ($V_{CB} = 40V$)	I_{CBO}	—	500	nA
Forward Current Transfer Ratio ($I_C = 10$ mA, $V_{CE} = 2V$)	h_{FE}	55	200	

specifications: ($T_A = 25°C$)

Product yield is at least 93% to each of the following parameters:

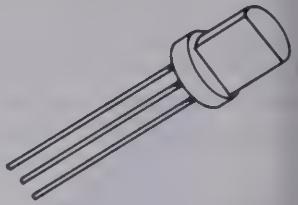
	Symbol	Min.	Max.	
Forward Current Transfer Ratio ($I_C = 150$ mA, $V_{CE} = 1V$)	h_{FE}	50	—	
Collector Saturation Voltage ($I_C = 150$ mA, $I_B = 15$ mA)	$V_{CE(SAT)}$	—	0.3	V
Base Saturation Voltage ($I_C = 150$ mA, $I_B = 15$ mA)	$V_{BE(SAT)}$	—	1.3	V
Collector Base Capacitance ($V_{CB} = 10V$, f = 1 MHz)	C_{cb}	—	7	pF
Gain Bandwidth Product ($V_{CE} = 5V$, $I_C = 20$ mA, f = 100 MHz)	f_t	200	—	MHz

Silicon Transistor

NPN

2N4256

The General Electric 2N4256 is a planar epitaxial, passivated NPN transistor characterized for low level medium speed switching applications in industrial circuits. This transistor features a high current transfer ratio over a wide range of collector current, a low collector saturation voltage, and a guaranteed stored base charge.



absolute maximum ratings: (25°C) (unless otherwise specified)

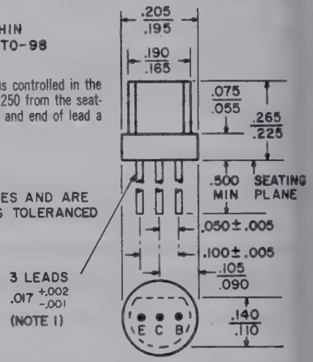
Voltages		
Collector to Emitter	V_{CES}	30 Volts
Emitter to Base	V_{EBO}	5 Volts
Collector to Base	V_{CBO}	30 Volts
Current		
Collector (Steady State)*	I_C	100 mA
Dissipation		
Total Power (Free air at 25°C)† P_T		360 mW
Total Power (Free air at 55°C)† P_T		250 mW
Temperature		
Storage	T_{STG}	−55 to 125°C
Operating	T_J	125°C
Lead Soldering, 1/16″ ± 1/32″ from case for 10 sec. max.	T_L	260°C

- Low Cost
- High Beta
- Low $V_{CE(SAT)}$
- Rugged Encapsulation

DIMENSIONS WITHIN
JEDEC OUTLINE TO-98

NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE
REFERENCE UNLESS TOLERANCED



*Determined from power limitations due to saturation voltage at this current.

†Derate 2.67 mW/°C increase in ambient temperature above 25°C.

electrical characteristics: (25°C) (unless otherwise specified)

STATIC CHARACTERISTICS

		Min.	Typ.	Max.
Collector to Base Breakdown Voltage ($I_C = 100\mu A$)	V_{CBO}	30		
Collector to Emitter Breakdown Voltage ($V_{EB} = 0, I_C = 1mA$)	V_{CES}	30		
Emitter to Base Breakdown Voltage ($I_E = 100\mu A$)	V_{EBO}	5		
Forward Current Transfer Ratio ($I_C = 2mA, V_{CE} = 4.5V$)	h_{FE}	100	220	500
Forward Current Transfer Ratio ($I_C = 10mA, V_{CE} = 0.2V$)	h_{FE}	60	120	
Forward Current Transfer Ratio ($I_C = 50mA, V_{CE} = 0.2V$)	h_{FE}	20		

2N4256

STATIC CHARACTERISTICS

		Min.	Typ.	Max.	Units
Collector-Emitter Saturation Voltage (I_C = 0.1 to 10mA, $I_B = I_C/50$)	$V_{CE(SAT}$		0.16	0.20	V
Collector-Emitter Saturation Voltage (I_C = 50mA, I_B = 2.5mA)	$V_{CE(SAT)}$		0.14	0.20	V
Base-Emitter Saturation Voltage (I_C = 50mA, I_B = 2.5mA)	$V_{BE(SAT)}$		0.82	0.92	V
Collector Cutoff Current (V_{CB} = 30V)	I_{CBO}		0.1	500	nA
Collector Cutoff Current (V_{CB} = 18V, T_A = 100°C)	I_{CBO}			15	μA
Collector Cutoff Current (V_{CE} = 30V, V_{EB} = 0)	I_{CES}		0.1	500	nA
Emitter Cutoff Current (V_{EB} = 5V)	I_{EBO}		0.1	500	nA

DYNAMIC CHARACTERISTICS

		Min.	Typ.	Max.	Units
Collector Capacitance (V_{CB} = 10V, I_E = 0, f = 1 MHz)	C_{ob}		2.7	4.0	pF
Transition Capacitance (V_{EB} = 0.5V, I_C = 0, f = 1 MHz)	C_{ib}		10		pF
Stored Base Charge (Circuit 1) (I_B = 0.32mA, I_C = 10mA)	Q_{SB}		250	600	pC
Gain Bandwidth product (V_{CE} = 1V, I_C = 10mA)	f_T		200		MHz
Turn-on Time (Figure 1) (I_C = 10mA)	t_{on}		4.0		nS
Turn-off Time (Figure 1) (I_C = 10mA)	t_{off}		40	100	nS
Turn-on Time (Figure 2) (I_C = 10mA, I_{B1} = 0.32mA, I_{B2} = 54μA)	t_{on}			180	nS
Turn-off Time (Figure 2) (I_C = 10mA, I_{BI} = 0.32mA, I_{B2} = 54μA)	t_{off}		2.5	3.5	μS

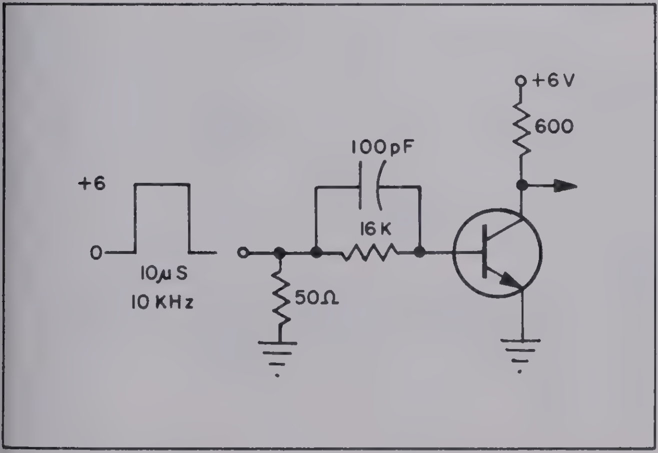


Figure 1

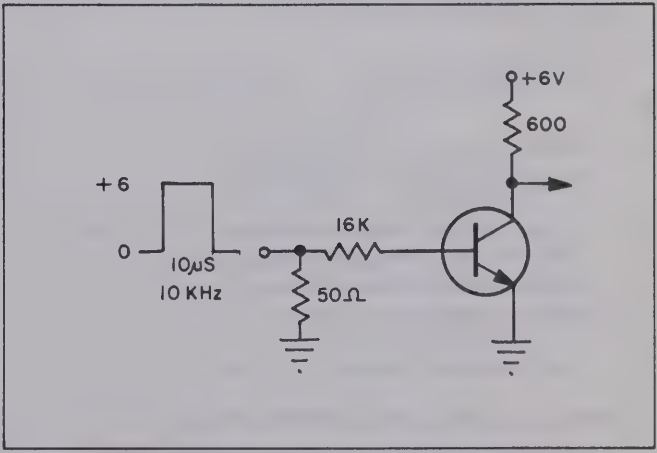


Figure 2

Q_{SB} measured in circuit of Figure 1, the capacitor is adjusted to give a turn off time of 100nS, and Q_{SB} is calculated from the equation $Q_{SB} = 6C$.

Silicon
Transistors

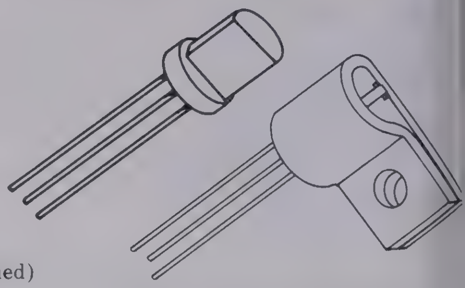
NPN

2N4424,5

The General Electric 2N4424 and 2N4425 types are NPN, silicon, planar, passivated, epitaxial transistors intended for general purpose industrial circuits. These transistors are especially suited for high level linear amplifiers or medium speed switching circuits in industrial control applications.

FEATURES:

- **Low Saturation Voltage**
- **High Beta**
- **900 mW @ 25°C Case 2N4424**
- **360 mW @ 25°C Free Air 2N4425**



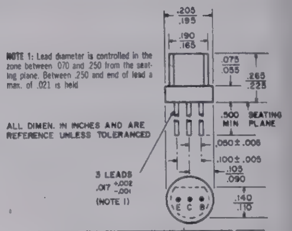
absolute maximum ratings: (25°C) (unless otherwise specified)

		2N4424	2N4425	
Voltages				
Collector to Emitter	V_{CEO}	40	40	V
Emitter to Base	V_{EBO}	5	5	V
Collector to Base	V_{CBO}	60	60	V
Current				
Collector (Steady State)*	I_C	500	500	mA
Dissipation				
Total Power (Free Air at 25°C)**	P_T	360	560	mW
Total Power (Free Air at 65°C)**	P_T	250	380	mW
Total Power (Heatsink at 25°C)***	P_T	—	900	mW
Temperature				
Storage	T_{stg}	−55 to +150		°C
Operating	T_J		+150	°C
Lead soldering, 1/16" ± 1/32" from case for 10 sec. max.	T_L		+260	°C

*Determined from power limitations due to saturation voltage at this current.

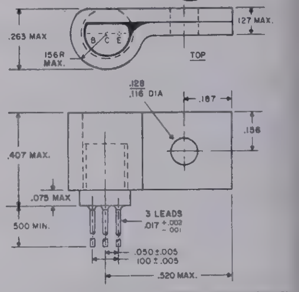
**Derate 2.88mW/°C increase in ambient temperature above 25°C.

***Derate 7.2 mW/°C for rise in heatsink temperature above 25°C.



NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED



ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

electrical characteristics: (25°C) (unless otherwise specified)

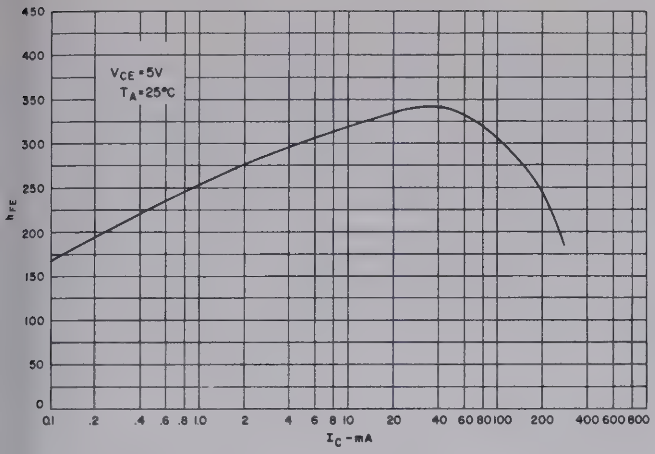
DC CHARACTERISTICS

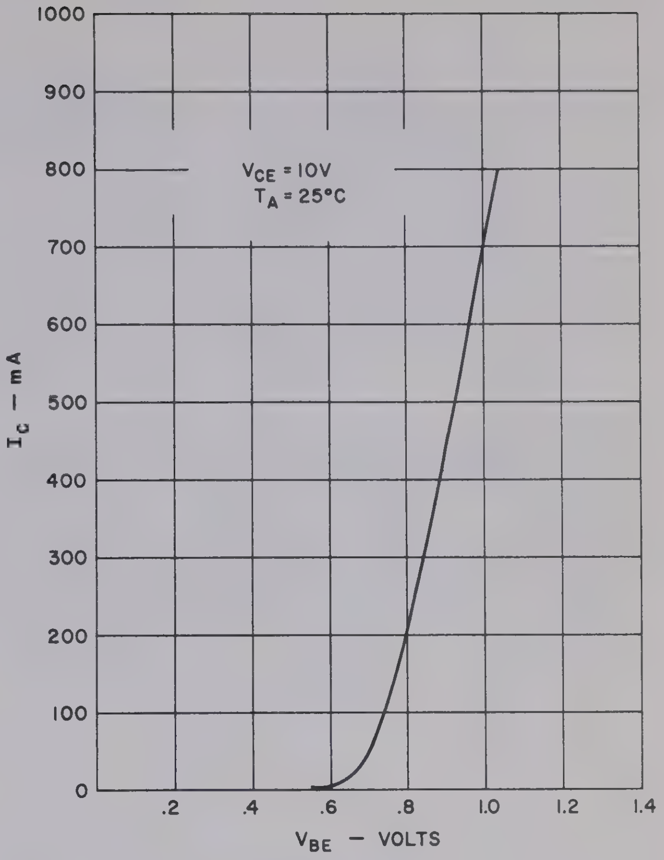
		Min.	Max.	
Collector Cutoff Current ($V_{CB} = 40V$)	I_{CBO}		30	nA
($V_{CB} = 40V$, $T_A = 100°C$)	I_{CBO}		10	μA
($V_{CB} = 40V$)	I_{CES}		30	nA
Emitter Cutoff Current ($V_{EB} = 5V$)	I_{EBO}		100	nA
Forward Current Transfer Ratio ($V_{CE} = 4.5V$, $I_C = 2$ mA)	h_{FE}	180	540	
Collector Emitter Breakdown Voltage ($I_C = 10$ mA)	$V_{(BR)CEO}$	40		V
Collector Base Breakdown Voltage ($I_C = 10$ μA)	$V_{(BR)CBO}$	60		V
Emitter Base Breakdown Voltage ($I_E = 0.1$ μA)	$V_{(BR)EBO}$	5		V
Collector Saturation Voltage ($I_B = 3$ mA, $I_C = 50$ mA)	$V_{CE(sat)}$		.30	V
Base Saturation Voltage ($I_B = 3$ mA, $I_C = 50$ mA)	$V_{BE(sat)}$		.85	V

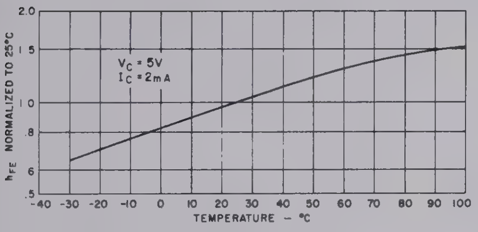
SMALL SIGNAL CHARACTERISTICS

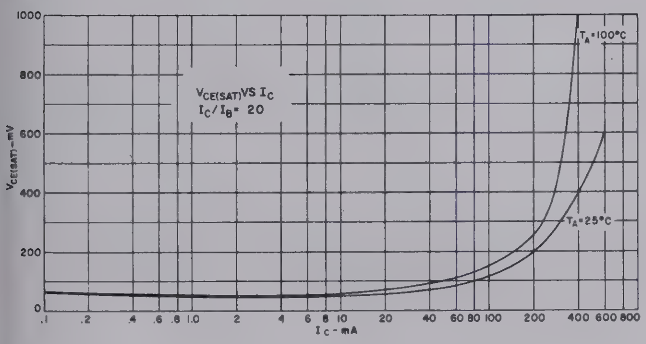
		Min.	
Forward Current Transfer Ratio Collector Voltage ($V_C = 4.5V$, $I_C = 2$ mA, f = 1 kHz)	h_{fe}	180	

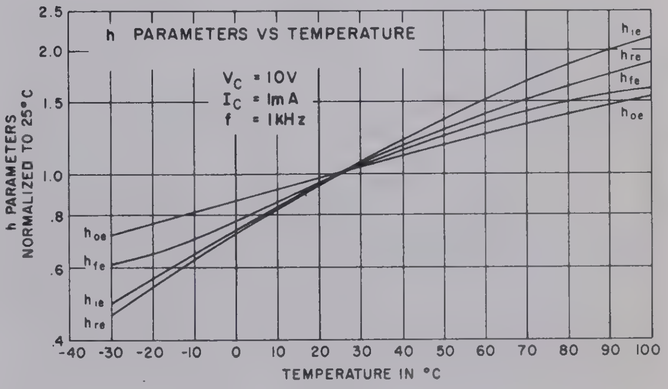
			Typical	
Forward Current Transfer Ratio	($V_{CE} = 10V$, $I_C = 1$ mA, f = 1 kHz, $T_A = 25°C$)	h_{fe}	180	
Input Impedance		h_{ie}	5100	ohms
Output Admittance		h_{oe}	14	μmhos
Voltage Feedback Ratio		h_{re}	.27	$\times 10^{-3}$

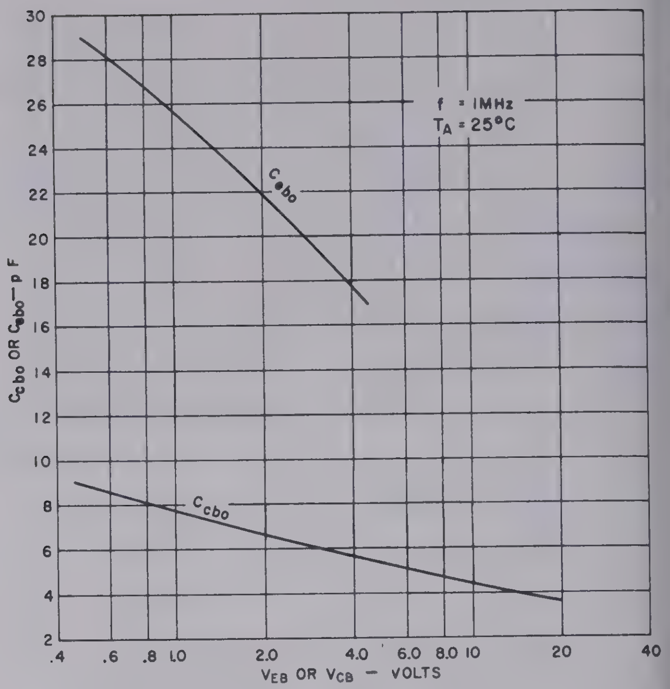

450
400
350
300
250
200
150
100
50
0
h_{FE}
V_{CE} = 5V
T_A = 25°C
0.1
.2
.4
.6
.8
1.0
2
4
6
8
10
20
40
60
80
100
200
400
600
800
I_C - mA

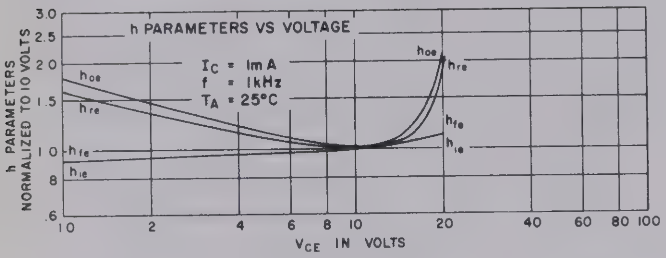

1000
900
800
700
600
500
400
300
200
100
0
I_C — mA
V_{CE} = 10V
T_A = 25°C
.2
.4
.6
.8
1.0
1.2
1.4
V_{BE} — VOLTS

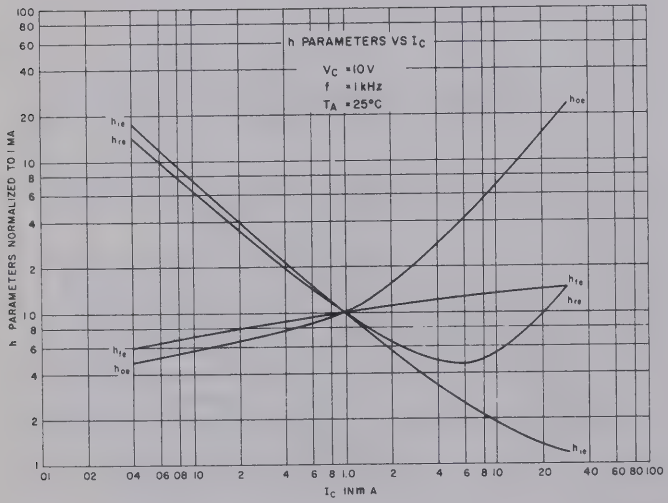

2.0
1.5
1.0
.8
.6
.5
h_{FE} NORMALIZED TO 25°C
V_C = 5V
I_C = 2mA
-40
-30
-20
-10
0
10
20
30
40
50
60
70
80
90
100
TEMPERATURE — °C

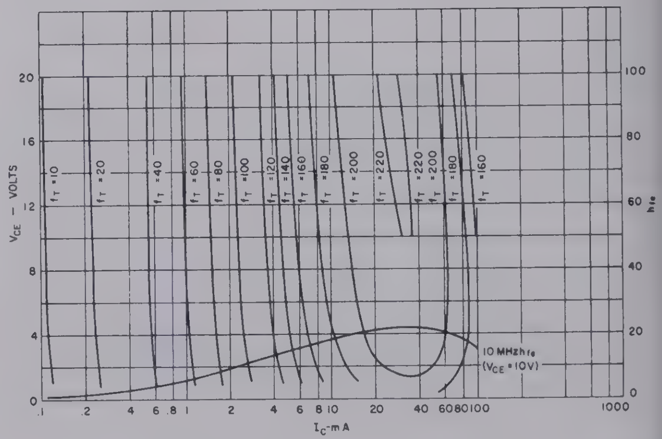

1000
800
600
400
200
0
$V_{CE(SAT)}$ – mV
$V_{CE(SAT)}$ VS I_C
I_C/I_B = 20
T_A = 100°C
T_A = 25°C
.1
.2
.4
.6
.8
1.0
2
4
6
8
10
20
40
60
80
100
200
400
600
800
I_C - mA

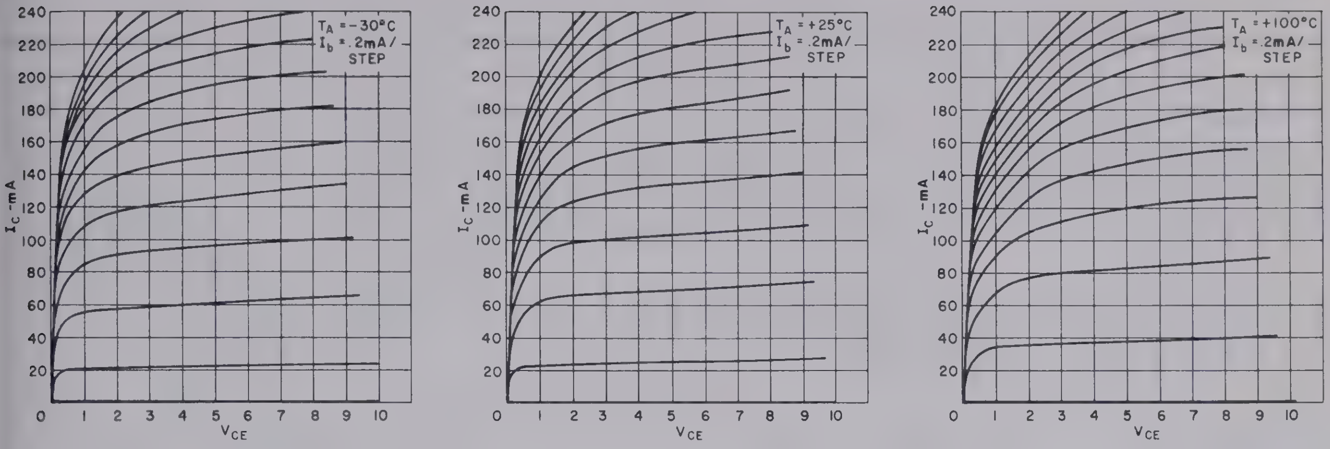

h PARAMETERS VS TEMPERATURE
V_C = 10V
I_C = 1mA
f = 1KHz
2.5
2.0
1.5
1.0
.8
.6
.4
h PARAMETERS NORMALIZED TO 25°C
h_{ie}
h_{re}
h_{fe}
h_{oe}
h_{oe}
h_{fe}
h_{ie}
h_{re}
-40
-30
-20
-10
0
10
20
30
40
50
60
70
80
90
100
TEMPERATURE IN °C


f = 1MHz
T_A = 25°C
C_{ebo}
C_{cbo}
C_{cbo} OR C_{ebo} — pF
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
.4
.6
.8
1.0
2.0
4.0
6.0
8.0
10
20
40
V_{EB} OR V_{CB} — VOLTS

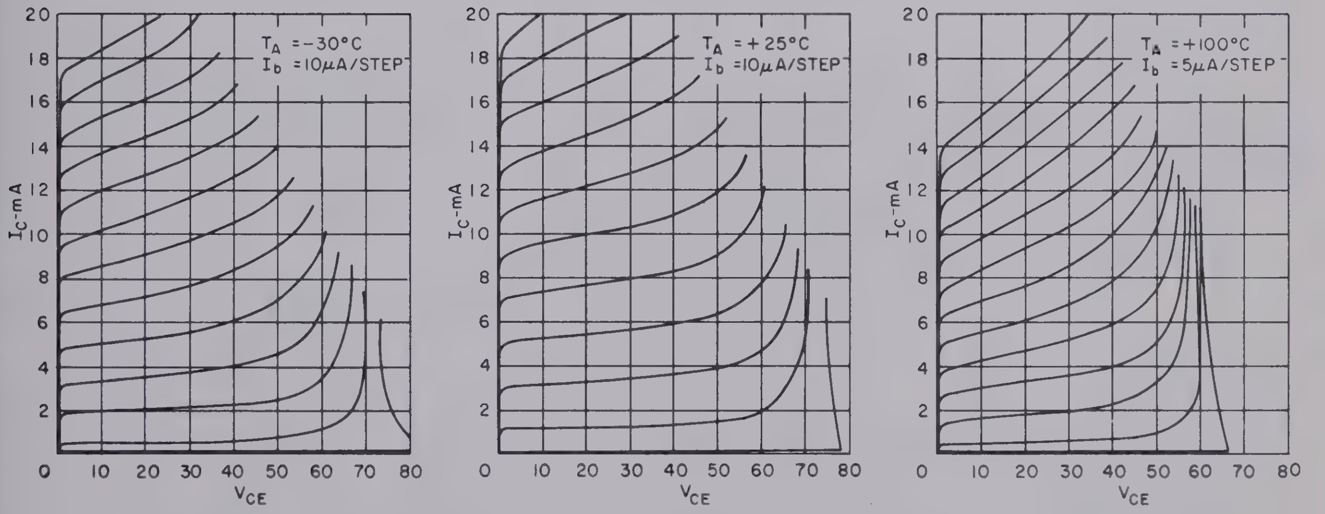

h PARAMETERS VS VOLTAGE
I_C = 1mA
f = 1kHz
T_A = 25°C
h_{oe}
h_{re}
h_{fe}
h_{ie}
h PARAMETERS NORMALIZED TO 10 VOLTS
3.0
2.5
2.0
1.5
1.0
.8
.6
1.0
2
4
6
8
10
20
40
60
80
100
V_{CE} IN VOLTS


h PARAMETERS VS I_C
V_C = 10V
f = 1kHz
T_A = 25°C
h_{ie}
h_{re}
h_{oe}
h_{fe}
h PARAMETERS NORMALIZED TO 1 MA
100
80
60
40
20
10
8
6
4
2
1.0
.8
.6
.4
.2
.1
.01
.02
.04
.06
.08
.10
.2
.4
.6
.8
1.0
2
4
6
8
10
20
40
60
80
100
I_C IN mA


f_T = 10
f_T = 20
f_T = 40
f_T = 60
f_T = 80
f_T = 100
f_T = 120
f_T = 140
f_T = 160
f_T = 180
f_T = 200
f_T = 220
f_T = 220
f_T = 200
f_T = 180
f_T = 160
10 MHz h_{fe}
(V_{CE} = 10V)
V_{CE} — VOLTS
20
16
12
8
4
0
h_{fe}
100
80
60
40
20
0
.1
.2
.4
.6
.8
1
2
4
6
8
10
20
40
60
80
100
1000
I_C-mA



Typical Common Emitter Current Characteristic Curves

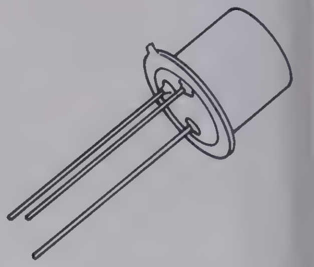


Typical Common Emitter Characteristic Curves

SUS

2N4983,6

The General Electric SUS is a silicon planar, monolithic integrated circuit having thyristor electrical characteristics closely approximating those of an "ideal" four layer diode. The device is designed to switch at 8 volts with a 0.02%/°C temperature coefficient. A gate lead is provided to eliminate rate effect, obtain triggering at lower voltages and to obtain transient free wave forms.



Silicon Unilateral Switches are specifically designed and characterized for use in monostable and bistable applications where low cost is of prime importance. These devices are in the TO-18 hermetic package.

Applications Include:

- SCR Triggers
- Frequency Dividers
- Ring Counters
- Cross Point Switching
- Over-Voltage Sensors

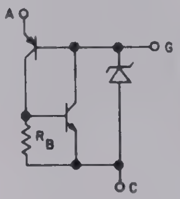
absolute maximum ratings: (25°C free air) (unless otherwise specified)

Storage Temperature Range	−65 to +150	°C
Junction Temperature Range	−55 to +125	°C
Power Dissipation*	300	mW
Peak Reverse Voltage	−30	Volts
DC Forward Anode Current*	175	mA
DC Gate Current*†	5	mA
Peak Recurrent Forward Current (1% duty cycle, 10 μsec pulse width, $T_A = 100°C$)	1.0	Amp
Peak Non-Recurrent Forward Current (10 μsec pulse width, $T_A = 25°C$)	5.0	Amps

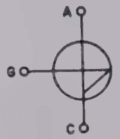
***Derate linearly to zero at 125°C.**

†This rating applicable only in OFF state.
Maximum gate current in conducting state limited by maximum power rating.

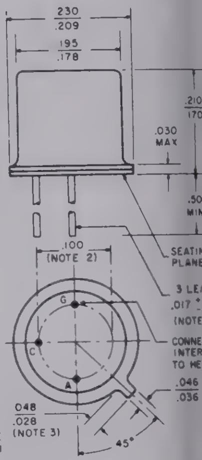
EQUIVALENT CIRCUIT



CIRCUIT SYMBOL



DIMENSIONS WITHIN
JEDEC OUTLINE TO-18



NOTE 1: Lead diameter is controlled in the zone between .050 and .250 from the seating plane. Between .250 and end of lead a max of .021 is held.

NOTE 2: Leads having maximum diameter (.019) measured in gaging plane .054 + .001 − .000 below the seating plane of the device shall be within .007 of true position relative to a maximum width tab.

NOTE 3: Measured from max. diameter of the actual device

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

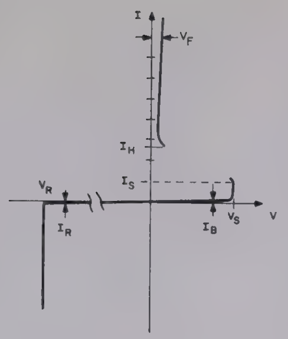
electrical characteristics: (25°C) (unless otherwise specified)

		2N4983			2N4986			
STATIC		**Min.**	**Typ.**	**Max.**	**Min.**	**Typ.**	**Max.**	
Forward Switching Voltage	V_S	6.0		10.0	7.0		9.0	Volts
Forward Switching Current	I_S			500			200	μA
Holding Current	I_H			1.5			.75	mA
Reverse Current ($V_R = -30V, T_A = 25°C$)	I_R			0.1			0.1	μA
($V_R = -30V, T_A = 100°C$)	I_R			10.0			10.0	μA
Forward Current (off state) ($V_F = 5V, T_A = 25°C$)	I_B			1.0			0.1	μA
($V_F = 5V, T_A = 100°C$)	I_B			10.0			10.0	μA
Forward Voltage Drop (on state) ($I_F = 175$ mA)	V_F			1.5			1.5	Volts
Temperature Coefficient of Switching Voltage ($T_A = -55°C$ to $+100°C$)	T_C		±.02			±.02		%/°C
DYNAMIC								
Turn-on Time (See Circuit 1)	t_{on}			1.0			1.0	μsec
Turn-off Time (See Circuit 2)	t_{off}			25.0			25.0	μsec
Peak Pulse Voltage (See Circuit 3)	V_O	3.5			3.5			Volts
Capacitance (0V., f = 1 MHz)	C		2.5			2.5		pF

2N4983,6

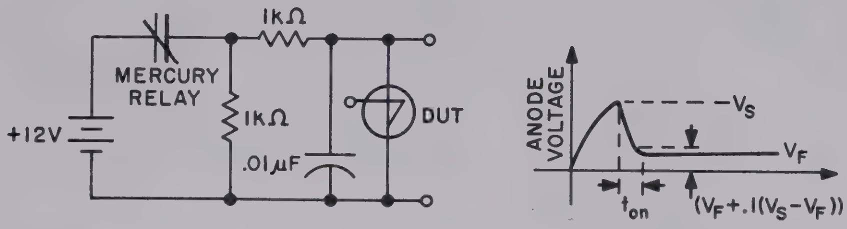
PARAMETER DEFINITIONS

Static Characteristics



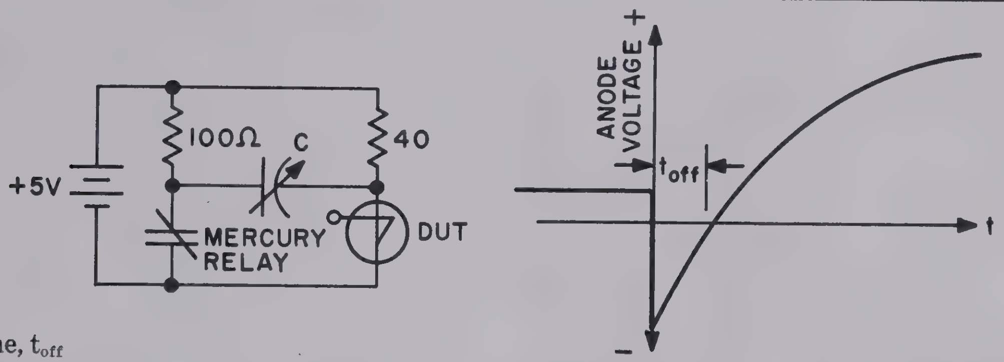
TEST CIRCUITS

Circuit 1
Turn-on Time, t_{on}


1kΩ
MERCURY RELAY
1kΩ
+12V
.01µF
DUT
ANODE VOLTAGE
V_S
V_F
t_on
(V_F+.1(V_S-V_F))

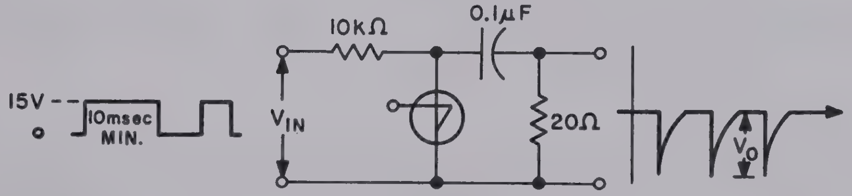
Turn-on time is measured from the time the anode voltage first reaches V_S to the time where the anode voltage has fallen 90% of the difference between V_S and V_F.

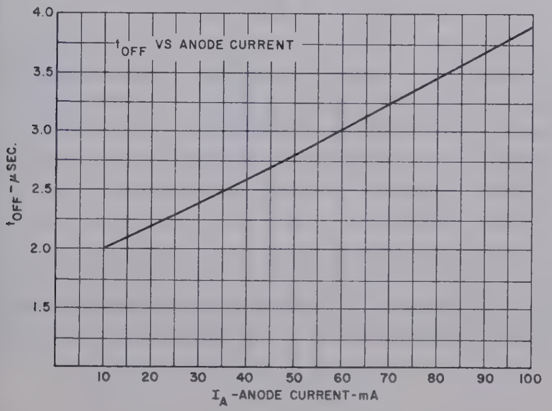
Circuit 2
Turn-off Time, t_{off}

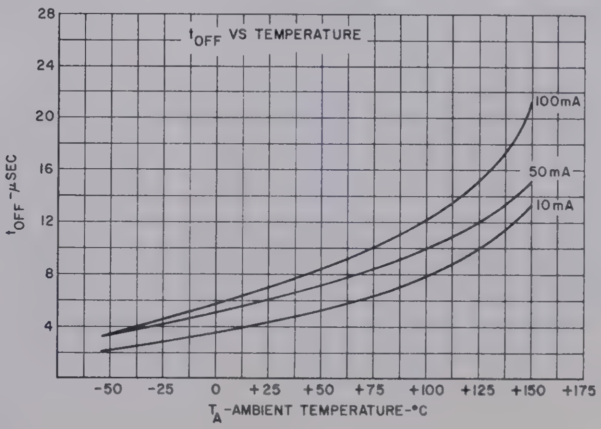

100Ω
C
40
+5V
MERCURY RELAY
DUT
+
ANODE VOLTAGE
t_off
t
-

The turn-off test is begun with the SUS in conduction and the relay contacts open. At t = 0 the contacts close and the anode is driven negative. C is adjusted downward, so that when the anode voltage becomes positive, the SUS just remains off. The turn-off time, t_{off}, is the time between initial contact closure and the point where the anode voltage passes up through zero volts. The capacitor is allowed to fully charge to 5 volts, at which time the contacts are reopened and the SUS triggers on.

Circuit 3
V_o

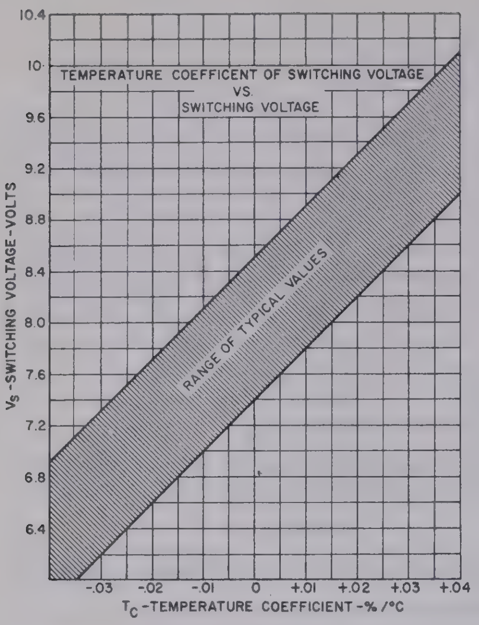

15V
10msec MIN.
V_IN
10kΩ
0.1µF
20Ω
V_O

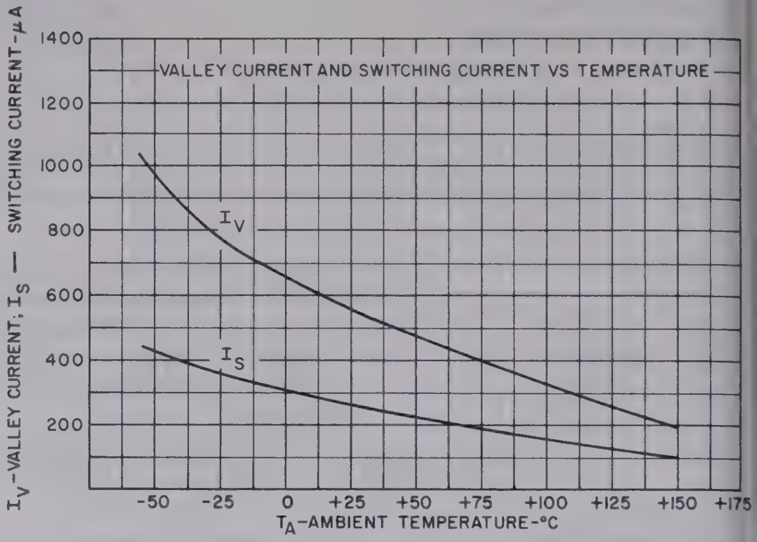


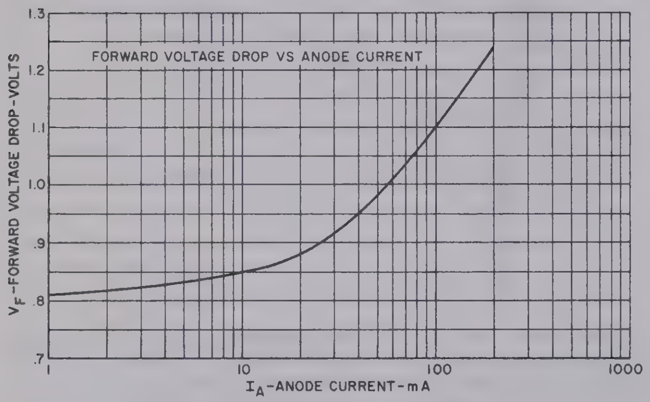


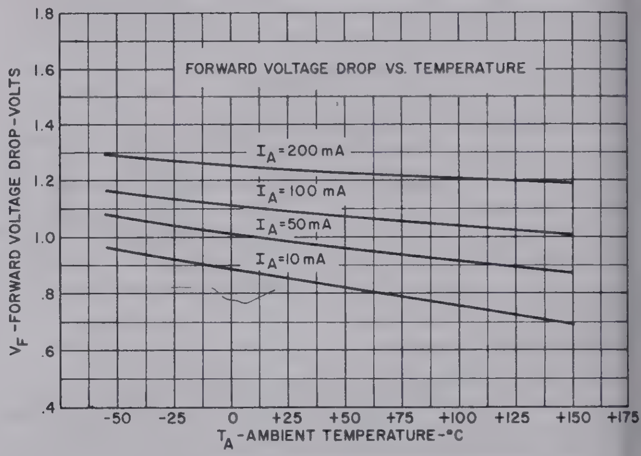
2N4983,6

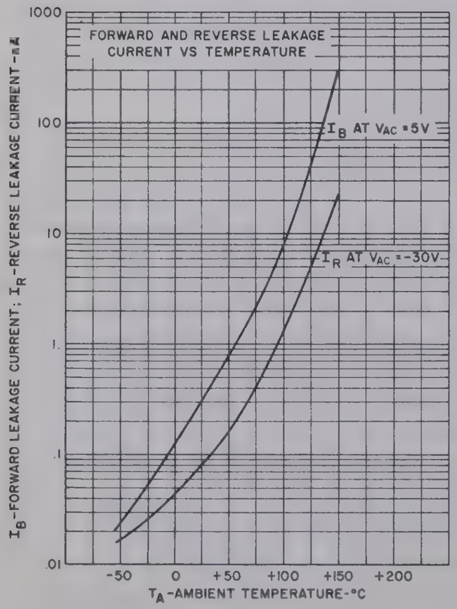
TYPICAL CHARACTERISTICS

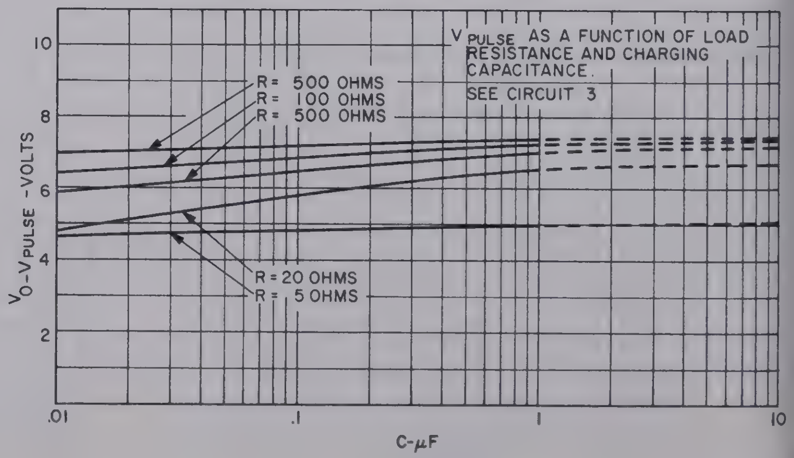










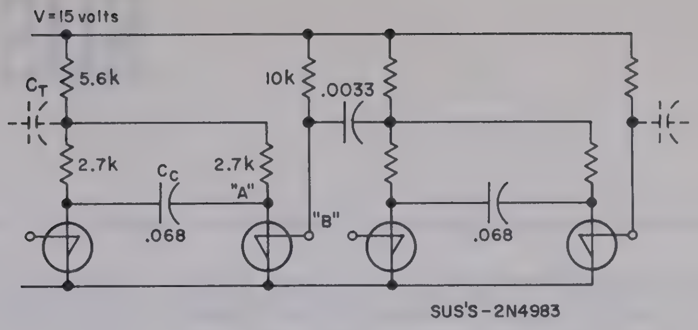


2N4983,6

APPLICATIONS

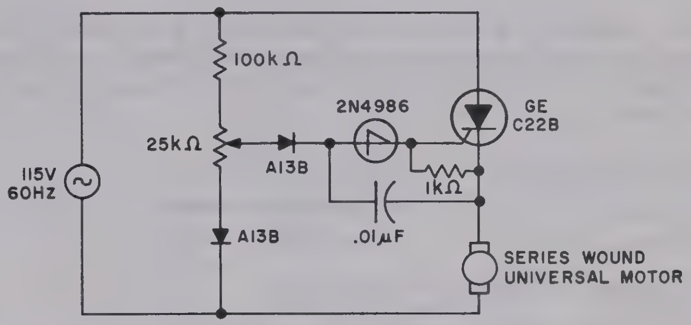
BINARY DIVIDER CHAIN

Uses fewer components than transistor flip flops. Output at "B" gives transient free waveform.


V = 15 volts
C_T
5.6k
10k
.0033
2.7k
C_C
2.7k
"A"
"B"
.068
.068
SUS'S-2N4983

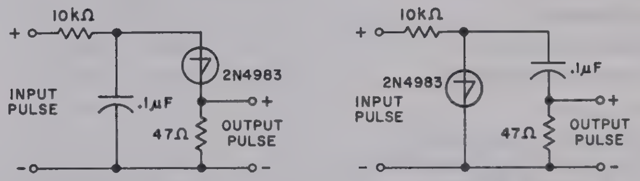
MOTOR SPEED CONTROL

Switching action of the 2N4986 allows smaller capacitors to be used while achieving reliable thyristor triggering.

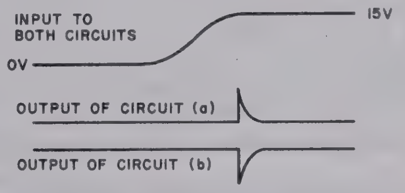

100kΩ
2N4986
GE
C22B
25kΩ
A13B
1kΩ
115V
60HZ
.01μF
A13B
SERIES WOUND
UNIVERSAL MOTOR

PULSE SHARPENERS

SUS is used to generate a rapid rise or fall time by using energy stored in a capacitor.

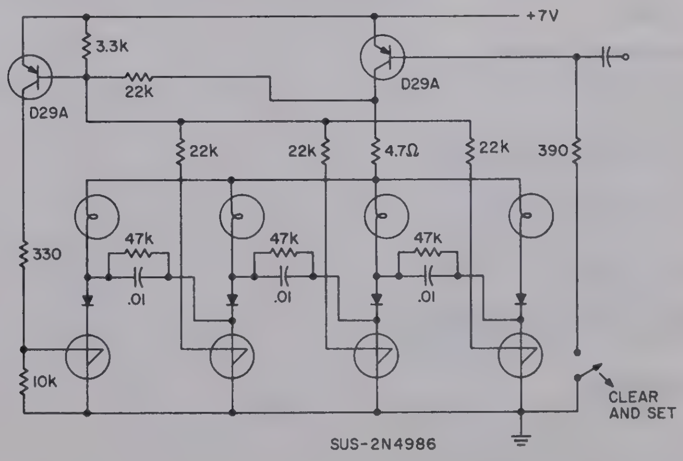

10kΩ
+
INPUT
PULSE
.1μF
2N4983
+
47Ω
OUTPUT
PULSE
−
−
10kΩ
+
2N4983
INPUT
PULSE
.1μF
+
47Ω
OUTPUT
PULSE
−
−

(a) POSITIVE OUTPUT (b) NEGATIVE OUTPUT



(c) TYPICAL WAVEFORMS

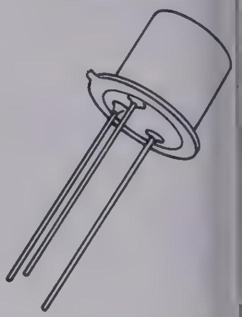
RING COUNTER FOR INCANDESCENT LAMPS


+7V
3.3k
22k
D29A
D29A
22k
22k
4.7Ω
22k
390
47k
47k
47k
330
.01
.01
.01
10k
CLEAR
AND SET
SUS-2N4986

SUS

2N4984,5

The General Electric SUS is a silicon planar, monolithic integrated circuit having thyristor electrical characteristics closely approximating those of an "ideal" four layer diode. The device is designed to switch at 8 volts with a 0.02%/°C temperature coefficient. A gate lead is provided to eliminate rate effect, obtain triggering at lower voltages and to obtain transient free wave forms.



Silicon Unilateral Switches are specifically designed and characterized for use in monostable and bistable applications where stability of the switching voltage is required over wide temperature variations. These devices are in the TO-18 hermetic package.

Applications Include:

- SCR Triggers
- Frequency Dividers
- Ring Counters
- Cross Point Switching
- Over-Voltage Sensors

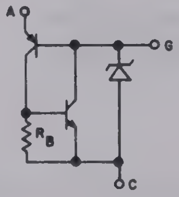
absolute maximum ratings (25°C free air) (unless otherwise specified)

Storage Temperature Range	−65 to +200	°C
Junction Temperature Range	−55 to +150	°C
Power Dissipation*	350	mW
Peak Reverse Voltage	−30	Volts
DC Forward Anode Current*	200	mA
DC Gate Current*†	5	mA
Peak Recurrent Forward Current (1% duty cycle, 10 μsec pulse width, $T_A = 100°C$)	1.0	Amp
Peak Non-Recurrent Forward Current (10 μsec pulse width, $T_A = 25°C$)	5.0	Amps

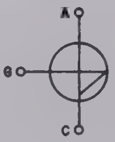
***Derate linearly to zero at 150°C.**

†This rating applicable only in OFF state.
Maximum gate current in conducting state limited by maximum power rating.

EQUIVALENT CIRCUIT



CIRCUIT SYMBOL

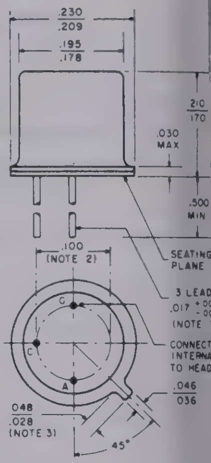


DIMENSIONS WITHIN JEDEC OUTLINE TO-18

NOTE 1: Lead diameter is controlled in the zone between .050 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

NOTE 2: Leads having maximum diameter (.019) measured in gaging plane .054 + .001 — .000 below the seating plane of the device shall be within .007 of true position relative to a maximum width tab.

NOTE 3: Measured from max. diameter of the actual device.



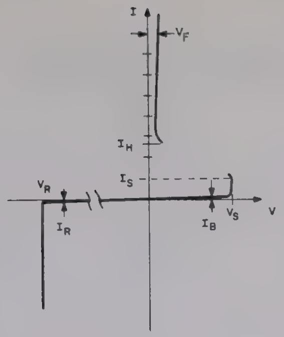
ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

electrical characteristics: (25°C) (unless otherwise specified)

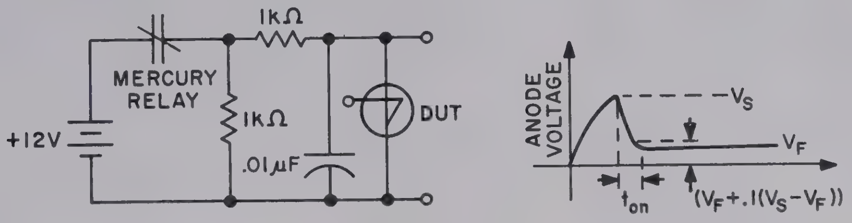
		2N4984			2N4985			UNITS
STATIC		Min.	Typ.	Max.	Min.	Typ.	Max.	
Forward Switching Voltage	V_S	7.5		9.0	7.5		8.2	Volts
Forward Switching Current	I_S			150			300	μA
Holding Current	I_H	.05		.5	.05		1.0	mA
Reverse Current								
($V_R = -30V$, $T_A = 25°C$)	I_R			.1			.1	μA
($V_R = -30V$, $T_A = 150°C$)	I_R			10.0			10.0	μA
Forward Current (off state)								
($V_F = 5V$, $T_A = 25°C$)	I_B			.1			.010	μA
($V_F = 5V$, $T_A = 150°C$)	I_B			10.0			1.0	μA
Forward Voltage Drop (on state) ($I_F = 200$ mA)	V_F			1.5			1.5	Volts
Temperature Coefficient of Switching Voltage ($T_A = -55°C$ to $+150°C$)	T_C			±.05			±.02	%/°C
DYNAMIC								
Turn-on Time (See Circuit 1)	t_{on}			1.0			1.0	μsec
Turn-off Time (See Circuit 2)	t_{off}			25.0			25.0	μsec
Peak Pulse Voltage (See Circuit 3)	V_O	3.5			3.5			Volts
Capacitance (0V., f = 1 MHz)	C		2.5			2.5		pF

PARAMETER DEFINITIONS

Static Characteristics

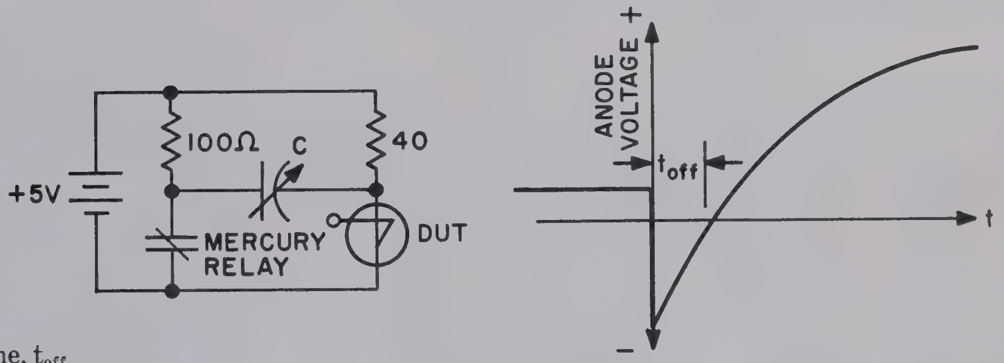


TEST CIRCUITS


1KΩ
MERCURY RELAY
1KΩ
+12V
.01µF
DUT
ANODE VOLTAGE
V_S
V_F
t_on
(V_F+.1(V_S−V_F))

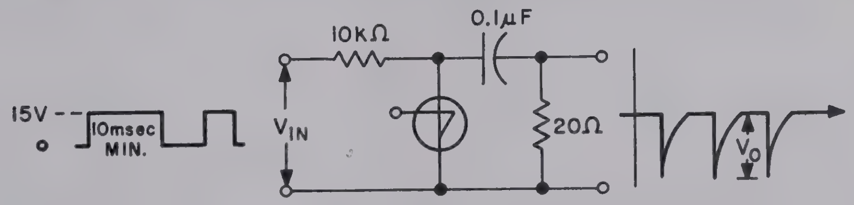
Circuit 1
Turn-on Time, t_{on}

Turn-on time is measured from the time the anode voltage first reaches V_S to the time where the anode voltage has fallen 90% of the difference between V_S and V_F.

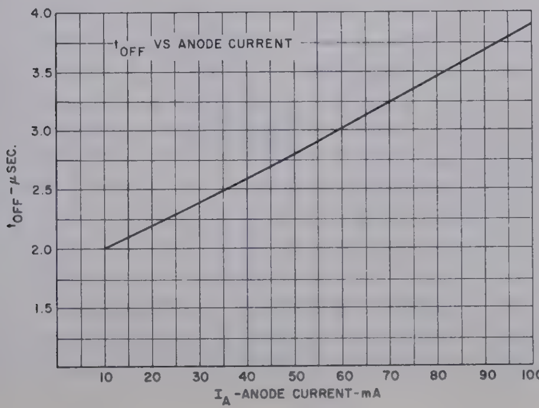

100Ω
C
40
+5V
MERCURY RELAY
DUT
+
ANODE VOLTAGE
t_off
t
−

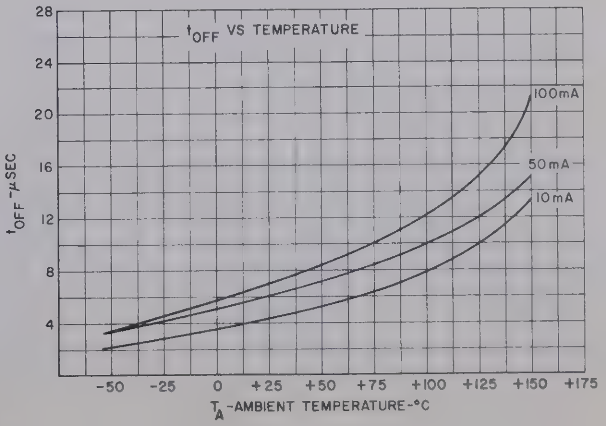
Circuit 2
Turn-off Time, t_{off}

The turn-off test is begun with the SUS in conduction and the relay contacts open. At t = 0 the contacts close and the anode is driven negative. C is adjusted downward, so that when the anode voltage becomes positive, the SUS just remains off. The turn-off time, t_{off}, is the time between initial contact closure and the point where the anode voltage passes up through zero volts. The capacitor is allowed to fully charge to 5 volts, at which time the contacts are reopened and the SUS triggers on.

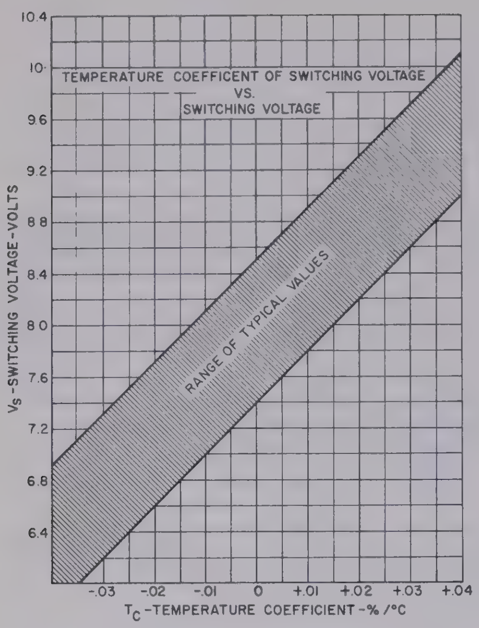

15V
0
10msec MIN.
10KΩ
0.1µF
V_IN
20Ω
V_O

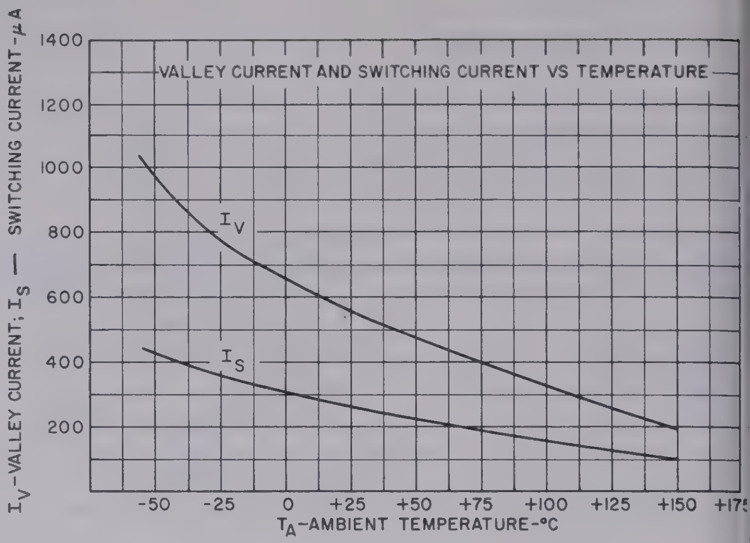
Circuit 3
V_o

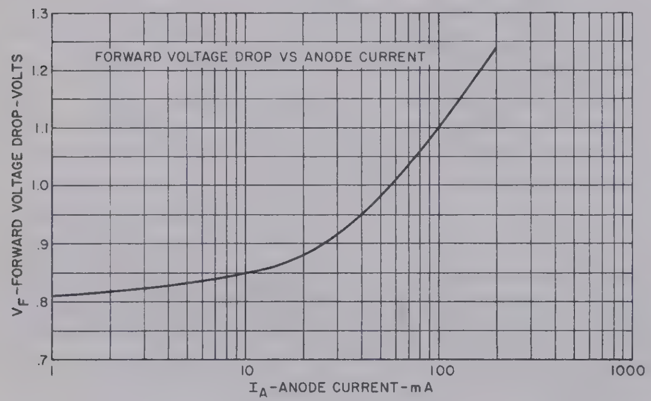


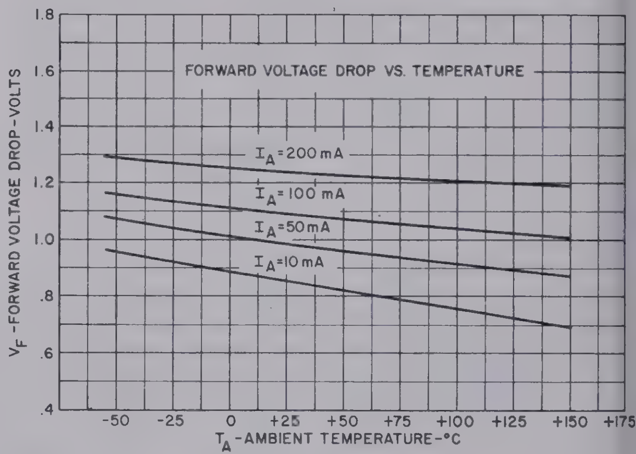


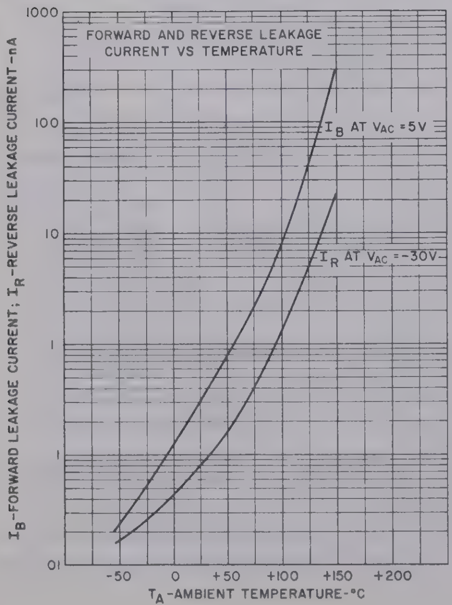
TYPICAL CHARACTERISTICS

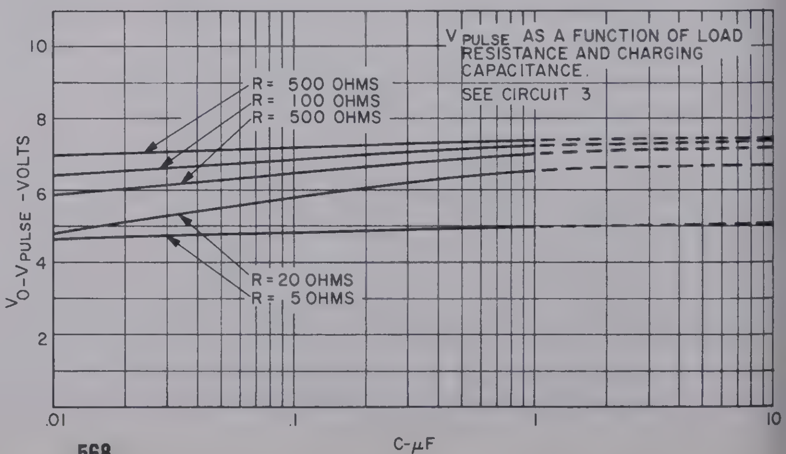








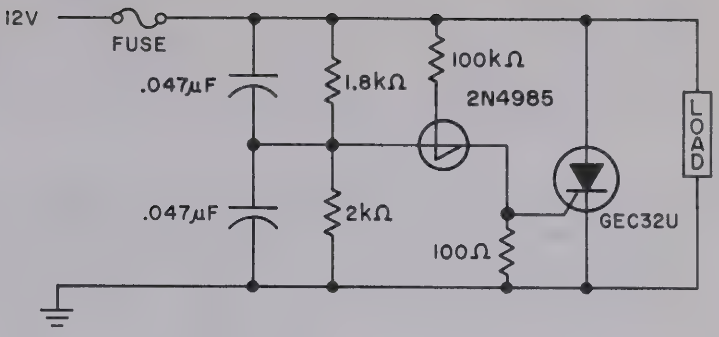




APPLICATIONS

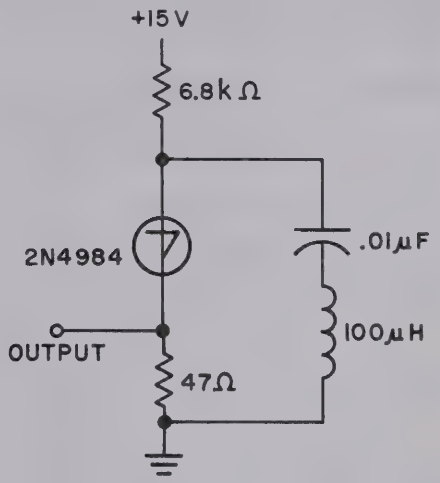
OVERVOLTAGE PROTECTION CIRCUIT

For overvoltages, SCR turns on and blows fuse. For rapidly rising voltages, circuit triggers between 13.2 & 14 volts. For slowly increasing voltages, circuit triggers between 14 & 17 volts.


12V
FUSE
.047µF
1.8kΩ
100kΩ
2N4985
LOAD
.047µF
2kΩ
GEC32U
100Ω

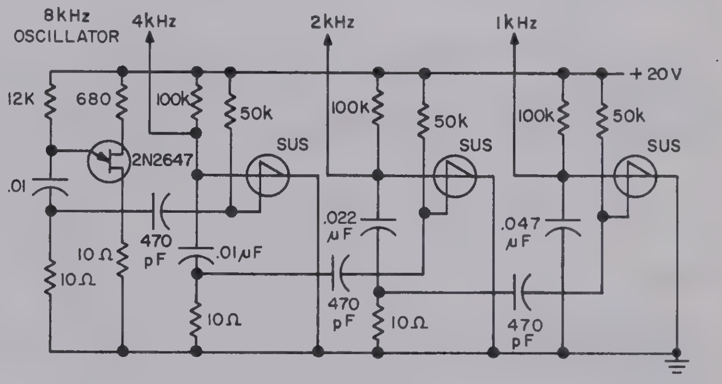
10kHz OSCILLATOR

Capacitor charges until switching voltage is reached. When SUS switches on, inductor causes current to ring. When current thru SUS drops below holding current, device turns off and cycle repeats.


+15 V
6.8k Ω
2N4984
.01µF
OUTPUT
100µH
47Ω

FREQUENCY DIVIDER WITH TRANSIENT FREE OUTPUT

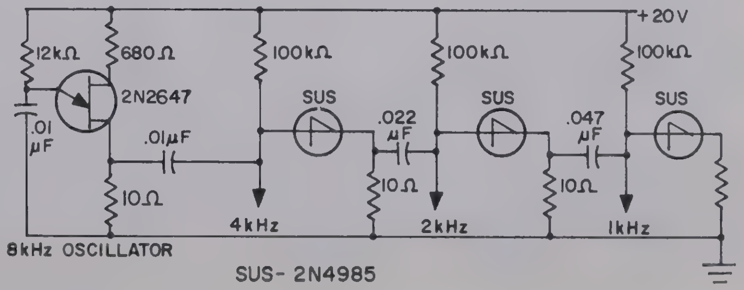
Spikes in center of sawtooth are eliminated in this circuit by triggering at gate.


8kHz OSCILLATOR
4kHz
2kHz
1kHz
+ 20V
12K
680
100k
50k
2N2647
SUS
100K
50k
SUS
100k
50k
SUS
.01
.022 µF
.047 µF
10Ω
10Ω
470 pF
.01µF
10Ω
470 pF
10Ω
470 pF

SUS - 2N4985

FREQUENCY DIVIDER CHAIN

Sawtooth Output from each stage is one half frequency of preceding stage.

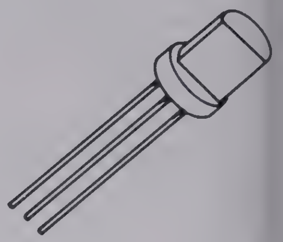

+20V
12kΩ
680Ω
100kΩ
100kΩ
100kΩ
2N2647
SUS
SUS
SUS
.01 µF
.01µF
.022 µF
.047 µF
10Ω
10Ω
10Ω
4kHz
2kHz
1kHz
8kHz OSCILLATOR
SUS- 2N4985

SUS

2N4987,90

The General Electric SUS is a silicon planar, monolithic integrated circuit having thyristor electrical characteristics closely approximating those of an "ideal" four layer diode. The device is designed to switch at 8 volts with a 0.02%/°C temperature coefficient. A gate lead is provided to eliminate rate effect, obtain triggering at lower voltages and to obtain transient free wave forms.

Silicon Unilateral Switches are specifically designed and characterized for use in monostable and bistable applications where low cost is of prime importance. These devices are in the low cost, TO-98 plastic package.



Applications Include:

- SCR Triggers
- Frequency Dividers
- Ring Counters
- Cross Point Switching
- Over-Voltage Sensors

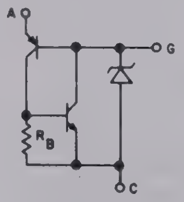
absolute maximum ratings: (25°C free air) (unless otherwise specified)

Storage Temperature Range	−65 to +150	°C
Junction Temperature Range	−55 to +125	°C
Power Dissipation*	300	mW
Peak Reverse Voltage	−30	Volts
DC Forward Anode Current*	175	mA
DC Gate Current*†	5	mA
Peak Recurrent Forward Current (1% duty cycle, 10 μsec pulse width, $T_A = 100°C$)	1.0	Amp
Peak Non-Recurrent Forward Current (10 μsec pulse width, $T_A = 25°C$)	5.0	Amps

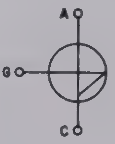
***Derate linearly to zero at 125°C.**

†This rating applicable only in OFF state.
Maximum gate current in conducting state limited by maximum power rating.

EQUIVALENT CIRCUIT



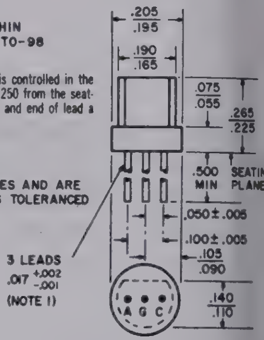
CIRCUIT SYMBOL



DIMENSIONS WITHIN
JEDEC OUTLINE TO-98

NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE
REFERENCE UNLESS TOLERANCED



electrical characteristics: (25°C) (unless otherwise specified)

STATIC

		2N4987			2N4990			
		Min.	Typ.	Max.	Min.	Typ.	Max.	
Forward Switching Voltage	V_S	6.0		10.0	7.0		9.0	Volts
Forward Switching Current	I_S			500			200	μA
Holding Current	I_H			1.5			.75	mA
Reverse Current								
($V_R = -30V$, $T_A = 25°C$)	I_R			0.1			0.1	μA
($V_R = -30V$, $T_A = 85°C$)	I_R			10.0			10.0	μA
Forward Current (off state)								
($V_F = 5V$, $T_A = 25°C$)	I_B			1.0			0.1	μA
($V_F = 5V$, $T_A = 85°C$)	I_B			10.0			10.0	μA
Forward Voltage Drop (on state) ($I_F = 175$ mA)	V_F			1.5			1.5	Volts
Temperature Coefficient of Switching Voltage ($T_A = -55°C$ to $+85°C$)	T_C		±.02			±.02		%/°C

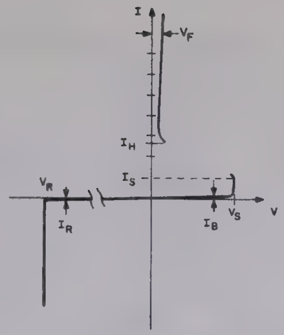
DYNAMIC

		Min.	Typ.	Max.	Min.	Typ.	Max.	
Turn-on Time (See Circuit 1)	t_{on}			1.0			1.0	μsec
Turn-off Time (See Circuit 2)	t_{off}			25.0			25.0	μsec
Peak Pulse Voltage (See Circuit 3)	V_O	3.5			3.5			Volts
Capacitance (0V., f = 1 MHz)	C		2.5			2.5		pF

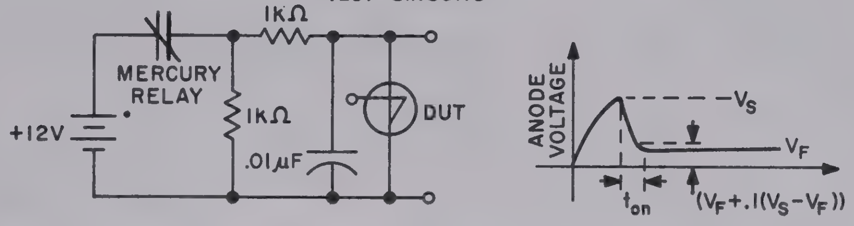
2N4987,90

PARAMETER DEFINITIONS

Static Characteristics

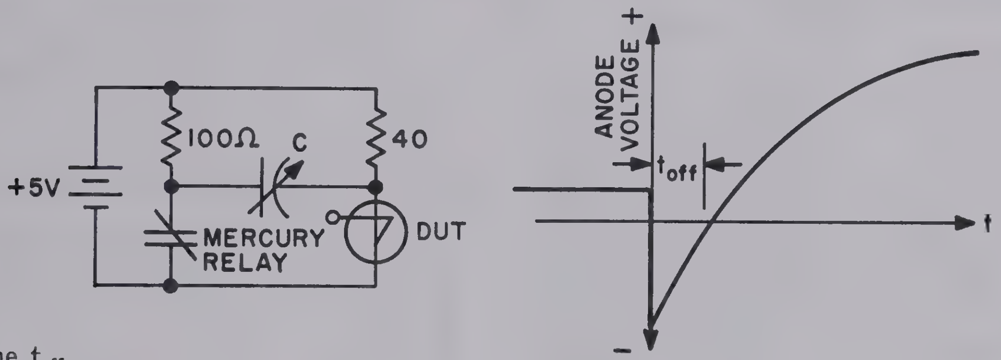


TEST CIRCUITS


1KΩ
MERCURY RELAY
+12V
1KΩ
.01μF
DUT
ANODE VOLTAGE
V_S
V_F
t_{on}
$(V_F+.1(V_S-V_F))$

Circuit 1
Turn-on Time, t_{on}

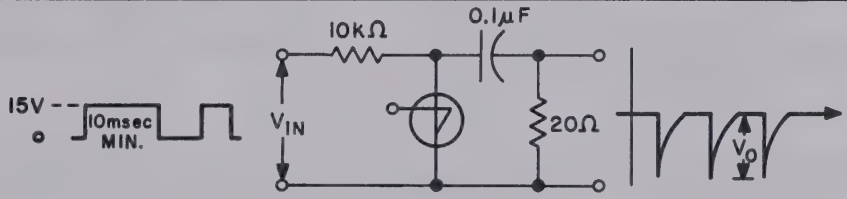
Turn-on time is measured from the time the anode voltage first reaches V_S to the time where the anode voltage has fallen 90% of the difference between V_S and V_F.

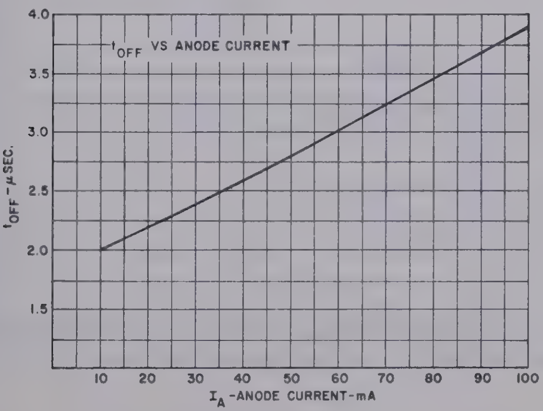

+5V
100Ω
C
40
MERCURY RELAY
DUT
ANODE VOLTAGE
+
t_{off}
t
–

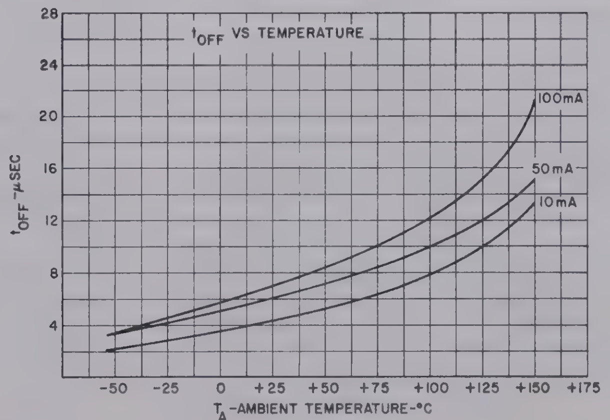
Circuit 2
Turn-off Time, t_{off}

The turn-off test is begun with the SUS in conduction and the relay contacts open. At t = 0 the contacts close and the anode is driven negative. C is adjusted downward, so that when the anode voltage becomes positive, the SUS just remains off. The turn-off time, t_{off}, is the time between initial contact closure and the point where the anode voltage passes up through zero volts. The capacitor is allowed to fully charge to 5 volts, at which time the contacts are reopened and the SUS triggers on.

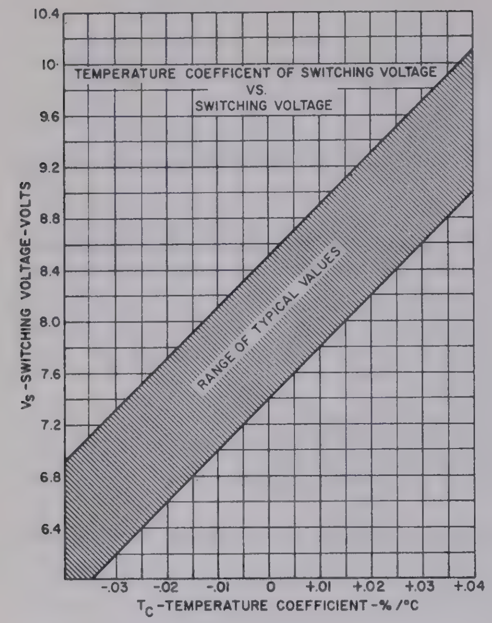
Circuit 3
V_o

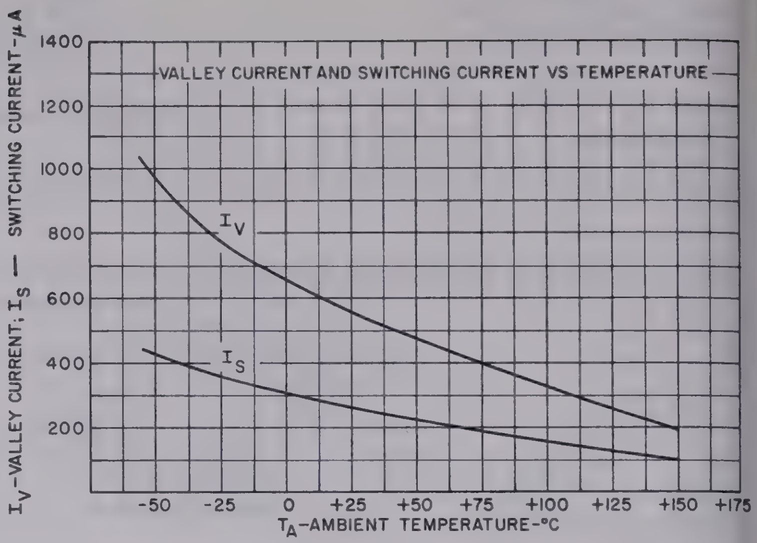

15V
10msec MIN.
V_{IN}
10kΩ
0.1μF
20Ω
V_O

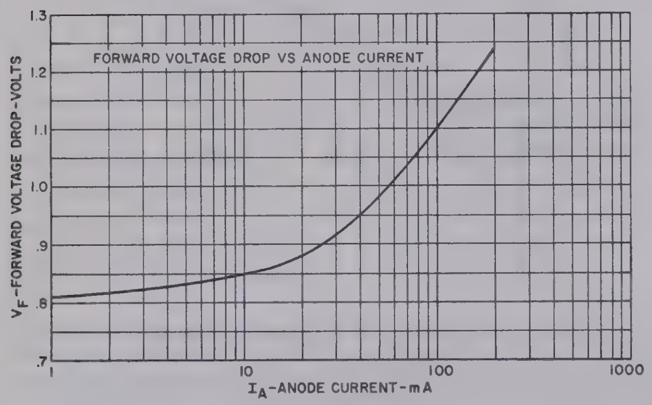


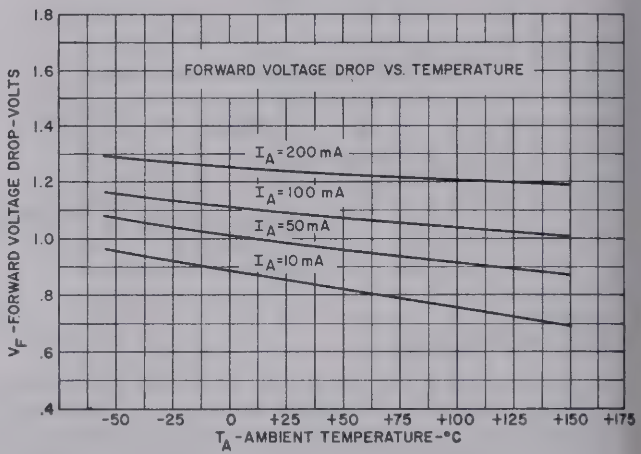


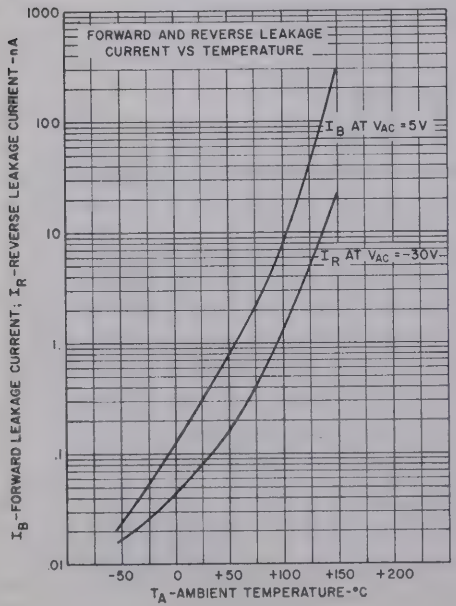
TYPICAL CHARACTERISTICS

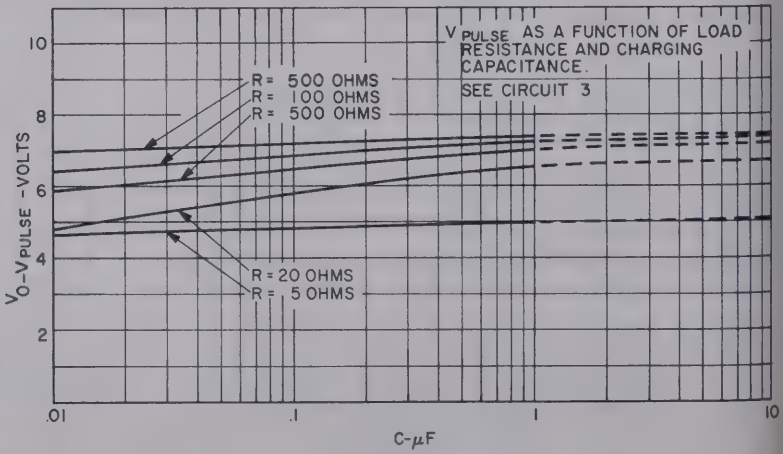








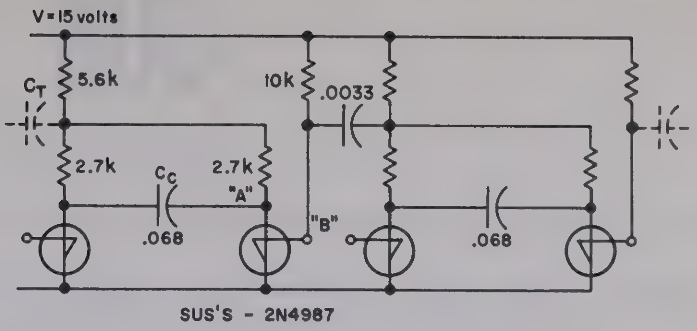




APPLICATIONS

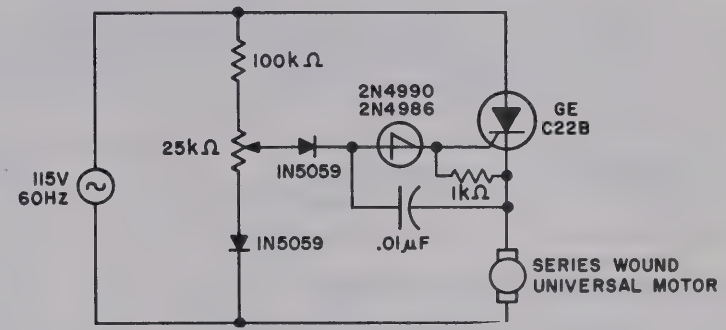
BINARY DIVIDER CHAIN

Uses fewer components than transistor flip flops. Output at "B" gives transient free waveform.


V = 15 volts
C_T
5.6k
10k
.0033
2.7k
C_C
2.7k
"A"
"B"
.068
.068
SUS'S - 2N4987

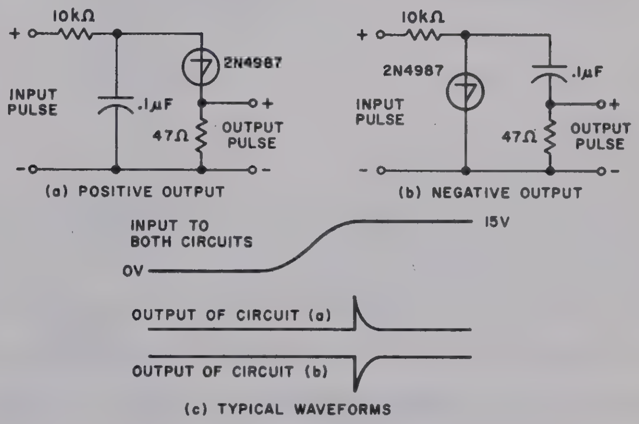
MOTOR SPEED CONTROL

Switching action of the 2N4990 allows smaller capacitors to be used while achieving reliable thyristor triggering.


100kΩ
2N4990
2N4986
GE
C22B
25kΩ
IN5059
1kΩ
115V
60HZ
IN5059
.01μF
SERIES WOUND
UNIVERSAL MOTOR

PULSE SHARPENERS

SUS is used to generate a rapid rise or fall time by using energy stored in a capacitor.

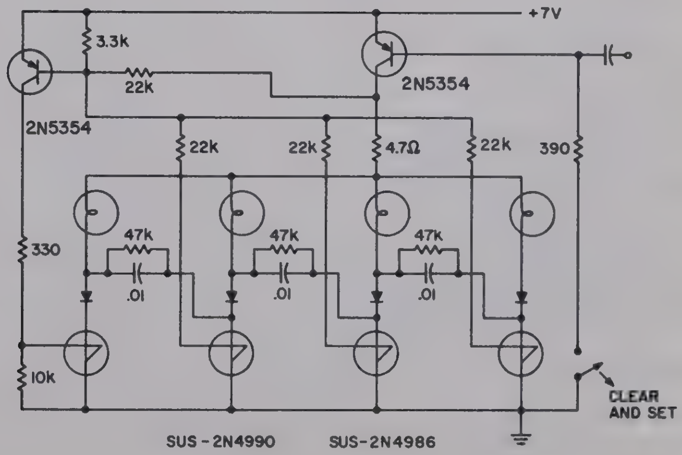

10kΩ
+
2N4987
INPUT
PULSE
.1μF
+
47Ω
OUTPUT
PULSE
-
-
10kΩ
+
2N4987
.1μF
INPUT
PULSE
+
47Ω
OUTPUT
PULSE
-
-
INPUT TO
BOTH CIRCUITS
15V
0V
OUTPUT OF CIRCUIT (a)
OUTPUT OF CIRCUIT (b)

(a) POSITIVE OUTPUT

(b) NEGATIVE OUTPUT

(c) TYPICAL WAVEFORMS

Ring Counter for Incandescent Lamps.

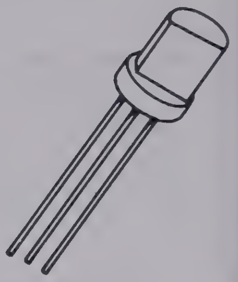

+7V
3.3k
22k
2N5354
2N5354
22k
22k
4.7Ω
22k
390
330
47k
.01
47k
.01
47k
.01
10k
CLEAR
AND SET
SUS - 2N4990
SUS-2N4986

SUS

2N4988,9

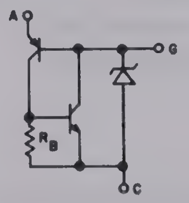
The General Electric SUS is a silicon planar, monolithic integrated circuit having thyristor electrical characteristics closely approximating those of an "ideal" four layer diode. The device is designed to switch at 8 volts with a 0.02%/°C temperature coefficient. A gate lead is provided to eliminate rate effect, obtain triggering at lower voltages and to obtain transient free wave forms.

Silicon Unilateral Switches are specifically designed and characterized for use in monostable and bistable applications where stability of the switching voltage is required over wide temperature variations. These devices are in the low cost, TO-98 plastic package.

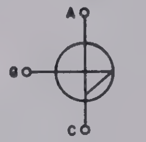


Applications Include:
- SCR Triggers
- Frequency Dividers
- Ring Counters
- Cross Point Switching
- Over-Voltage Sensors

EQUIVALENT CIRCUIT



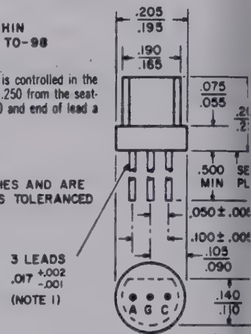
CIRCUIT SYMBOL



DIMENSIONS WITHIN
JEDEC OUTLINE TO-98

NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE
REFERENCE UNLESS TOLERANCED



absolute maximum ratings (25°C free air) (unless otherwise specified)

Storage Temperature Range	−65 to +200	°C
Junction Temperature Range	−55 to +150	°C
Power Dissipation*	350	mW
Peak Reverse Voltage	−30	Volts
DC Forward Anode Current*	200	mA
DC Gate Current*†	5	mA
Peak Recurrent Forward Current (1% duty cycle, 10 μsec pulse width, $T_A = 100°C$)	1.0	Amp
Peak Non-Recurrent Forward Current (10 μsec pulse width, $T_A = 25°C$)	5.0	Amps

***Derate linearly to zero at 150°C.**

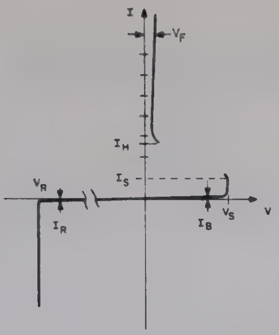
†This rating applicable only in OFF state.
Maximum gate current in conducting state limited by maximum power rating.

electrical characteristics: (25°C) (unless otherwise specified)

		2N4988			2N4989			UNITS
STATIC		Min.	Typ.	Max.	Min.	Typ.	Max.	
Forward Switching Voltage	V_S	7.5		9.0	7.5		8.2	Volts
Forward Switching Current	I_S			150			300	μA
Holding Current	I_H	.05		.5	.05		1.0	mA
Reverse Current								
($V_R = -30V$, $T_A = 25°C$)	I_R			.1			.1	μA
($V_R = -30V$, $T_A = 100°C$)	I_R			10.0			10.0	μA
Forward Current (off state)								
($V_F = 5V$, $T_A = 25°C$)	I_B			.1			.010	μA
($V_F = 5V$, $T_A = 100°C$)	I_B			10.0			1.0	μA
Forward Voltage Drop (on state) ($I_F = 200$ mA)	V_F			1.5			1.5	Volts
Temperature Coefficient of Switching Voltage ($T_A = -55°C$ to $+100°C$)	T_C			±.05			±.02	%/°C
DYNAMIC								
Turn-on Time (See Circuit 1)	t_{on}			1.0			1.0	μsec
Turn-off Time (See Circuit 2)	t_{off}			25.0			25.0	μsec
Peak Pulse Voltage (See Circuit 3)	V_O	3.5			3.5			Volts
Capacitance (0V., f = 1 MHz)	C		2.5			2.5		pF

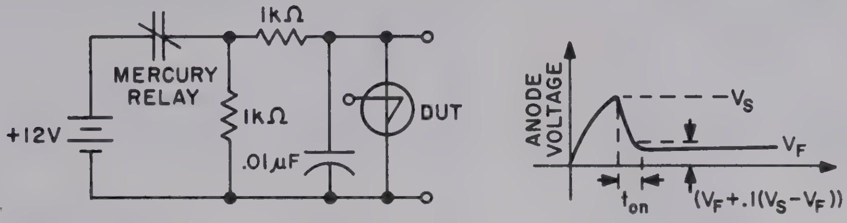
PARAMETER DEFINITIONS

Static Characteristics



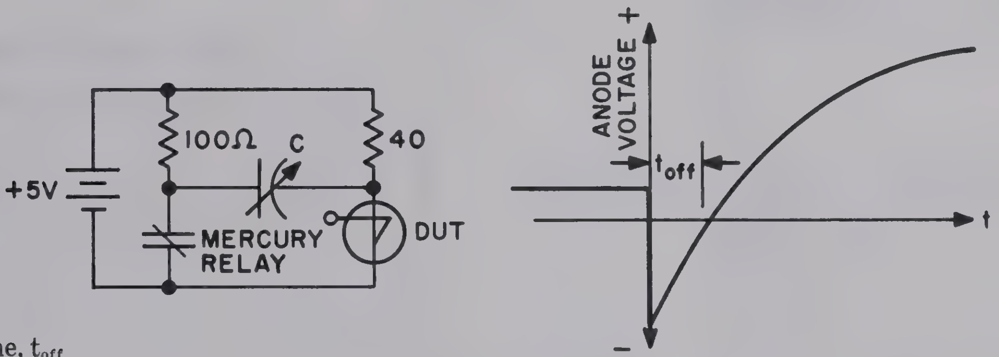
TEST CIRCUITS

Circuit 1
Turn-on Time, t_{on}


1kΩ
MERCURY RELAY
1kΩ
+12V
.01μF
DUT
ANODE VOLTAGE
V_S
V_F
t_on
(V_F+.1(V_S−V_F))

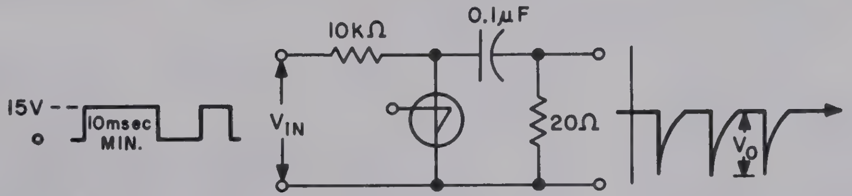
Turn-on time is measured from the time the anode voltage first reaches V_S to the time where the anode voltage has fallen 90% of the difference between V_S and V_F.

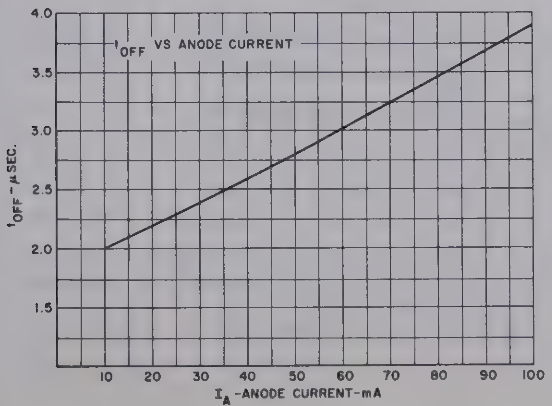
Circuit 2
Turn-off Time, t_{off}

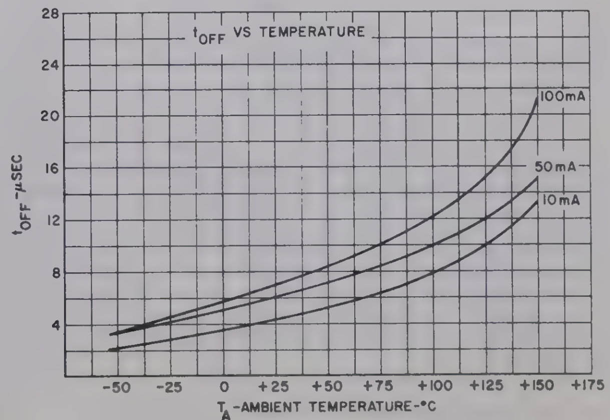

100Ω
C
40
+5V
MERCURY RELAY
DUT
ANODE VOLTAGE
+
−
t_off
t

The turn-off test is begun with the SUS in conduction and the relay contacts open. At $t = 0$ the contacts close and the anode is driven negative. C is adjusted downward, so that when the anode voltage becomes positive, the SUS just remains off. The turn-off time, t_{off}, is the time between initial contact closure and the point where the anode voltage passes up through zero volts. The capacitor is allowed to fully charge to 5 volts, at which time the contacts are reopened and the SUS triggers on.

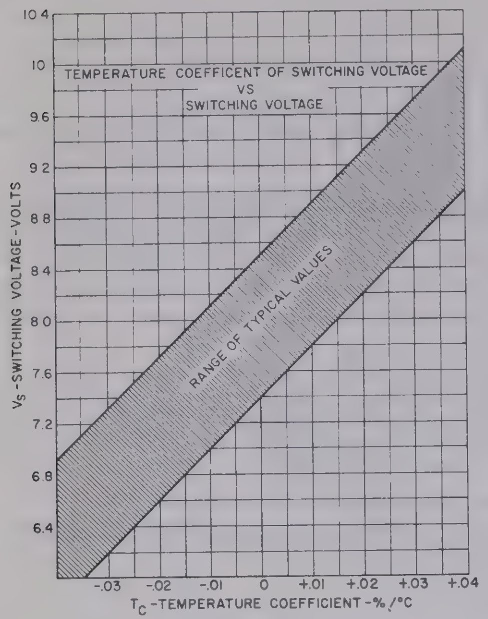
Circuit 3
V_o

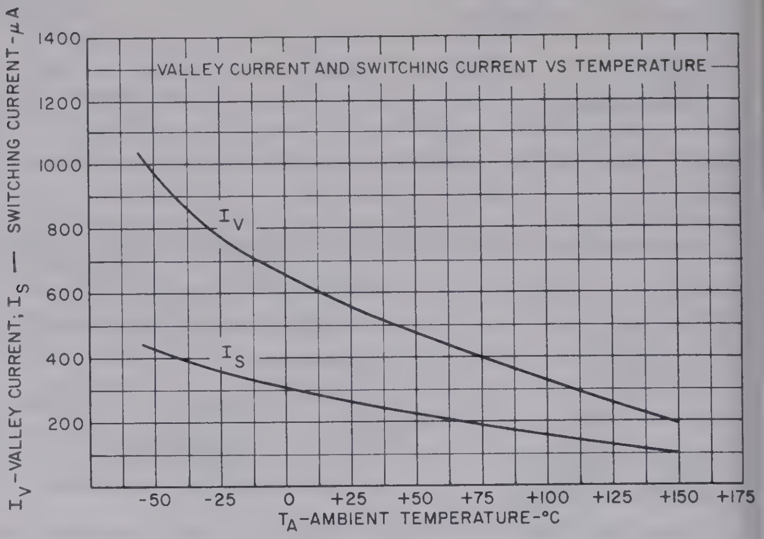

15V
0
10msec MIN.
10kΩ
0.1μF
V_IN
20Ω
V_O

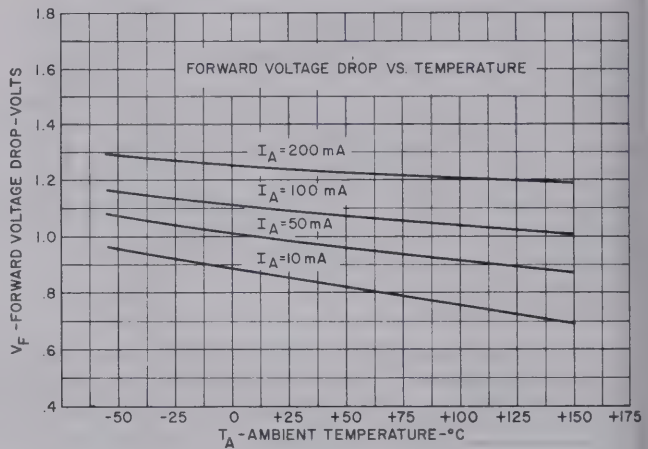


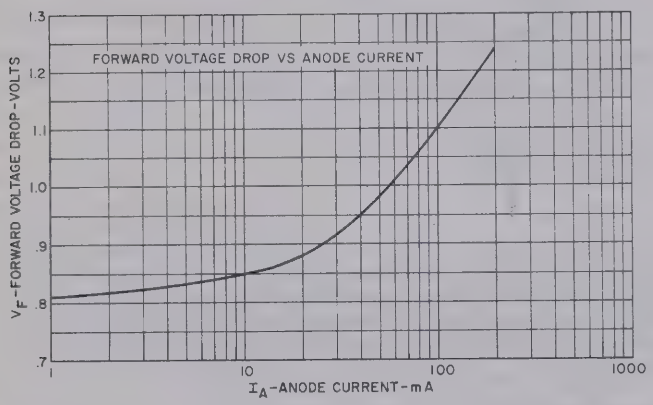


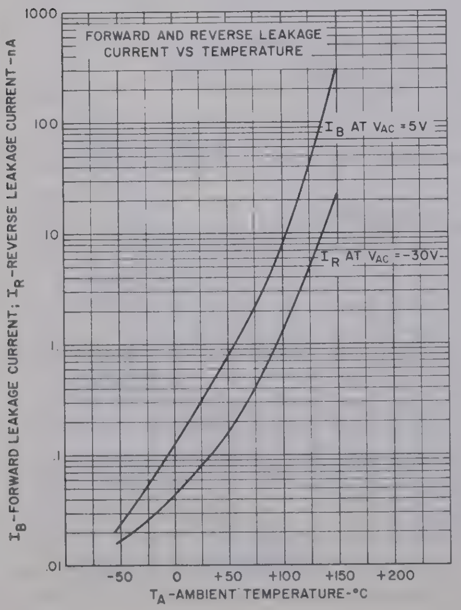
TYPICAL CHARACTERISTICS

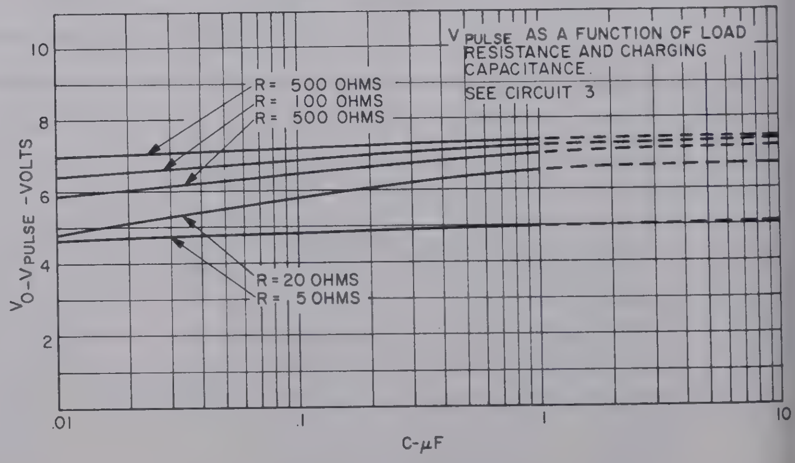








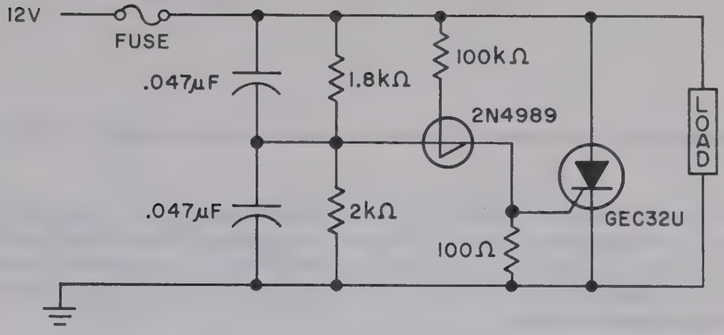




APPLICATIONS

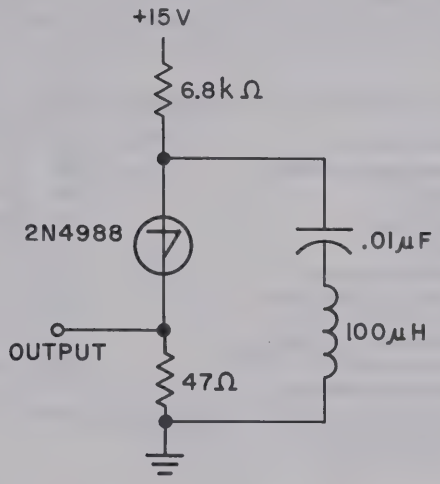
OVERVOLTAGE PROTECTION CIRCUIT

For overvoltages, SCR turns on and blows fuse. For rapidly rising voltages, circuit triggers between 13.2 & 14 volts. For slowly increasing voltages, circuit triggers between 14 & 17 volts.


12V
FUSE
.047µF
1.8kΩ
100kΩ
2N4989
LOAD
.047µF
2kΩ
GEC32U
100Ω

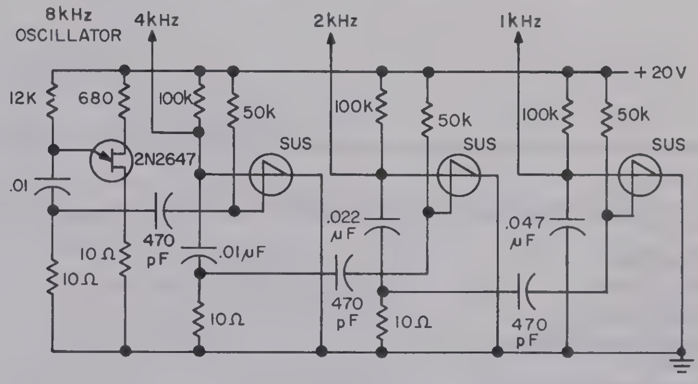
10kHz OSCILLATOR

Capacitor charges until switching voltage is reached. When SUS switches on, inductor causes current to ring. When current thru SUS drops below holding current, device turns off and cycle repeats.


+15V
6.8kΩ
2N4988
.01µF
OUTPUT
100µH
47Ω

FREQUENCY DIVIDER WITH TRANSIENT FREE OUTPUT

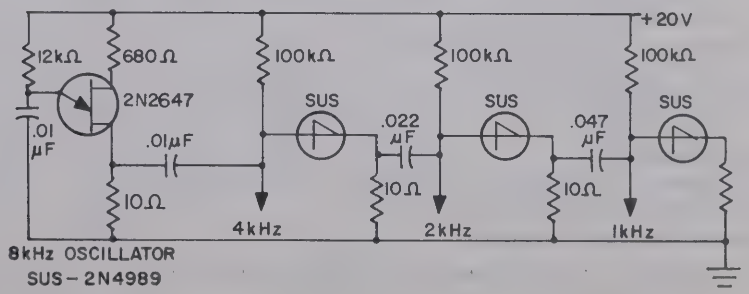
Spikes in center of sawtooth are eliminated in this circuit by triggering at gate.


8kHz OSCILLATOR
4kHz
2kHz
1kHz
+20V
12K
680
100k
50k
100k
50k
100k
50k
SUS
SUS
SUS
2N2647
.01
.022 µF
.047 µF
470 pF
.01µF
470 pF
470 pF
10Ω
10Ω
10Ω
10Ω

SUS-2N4989

FREQUENCY DIVIDER CHAIN

Sawtooth Output from each stage is one half frequency of preceding stage.

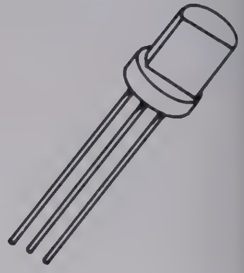

+20V
12kΩ
680Ω
100kΩ
100kΩ
100kΩ
2N2647
SUS
SUS
SUS
.01 µF
.01µF
.022 µF
.047 µF
10Ω
10Ω
10Ω
4kHz
2kHz
1kHz
8kHz OSCILLATOR
SUS-2N4989

SBS

2N4991

The General Electric SBS is a silicon planar, monolithic integrated circuit having the electrical characteristics of a bilateral thyristor. The device is designed to switch at 8 volts with a 0.02%/°C temperature coefficient and excellently matched characteristics in both directions. A gate lead is provided to eliminate rate effect and to obtain triggering at lower voltages.

The Silicon Bilateral Switches are specifically designed and characterized for applications where stability of switching voltage over a wide temperature range and well matched bilateral characteristics are an asset. They are ideally suited for half wave and full wave triggering in low voltage SCR and Triac phase control circuits. The 2N4991 is in the low cost, TO-98 plastic package.

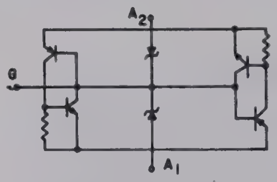


absolute maximum ratings: (25°C free air) (unless otherwise specified)

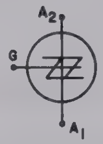
Storage Temperature Range	−65 to +150	°C
Operating Junction Temperature Range	−55 to +125	°C
Power Dissipation*	300	mW
DC Forward Anode Current*	175	mA
DC Gate Current *†	5	mA
Peak Recurrent Forward Current (1% duty cycle, 10 μsec pulse width, $T_A = 100°C$)	1.0	Amp
Peak Non-Recurrent Forward Current (10 μsec pulse width, $T_A = 25°C$)	5.0	Amps

*Derate linearly to zero at 125°C.

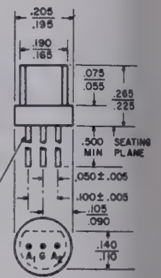
†This rating applicable only on OFF state. Maximum gate current in conducting state limited by maximum power rating.



EQUIVALENT CIRCUIT



CIRCUIT SYMBOL



NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

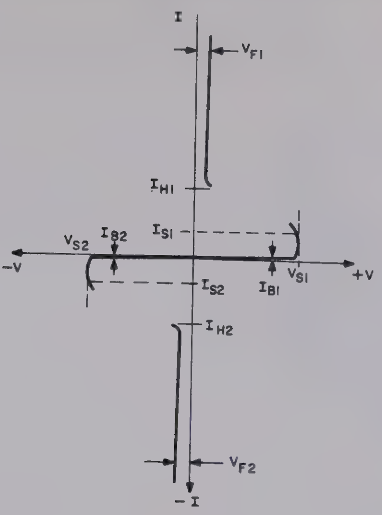
ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED
TO-98

electrical characteristics:** (25°C) (unless otherwise specified)

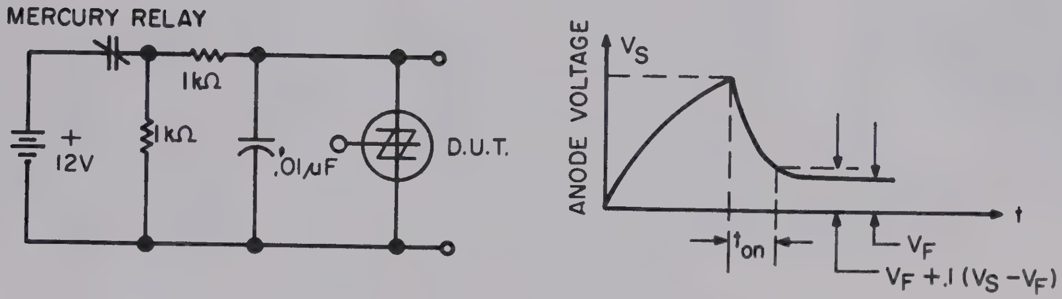
		Min.	Typ.	Max.	
STATIC					
Switching Voltage	V_S	6		10	V
Switching Current	I_S			500	μA
Absolute Switching Voltage Difference	$\lvert V_{S2} - V_{S1} \rvert$			.5	V
Absolute Switching Current Difference	$\lvert I_{S2} - I_{S1} \rvert$			100	μA
Holding Current	I_H			1.5	mA
Current (Off State)					
($V_F = 5V$, $T_A = 25°C$)	I_B			1.0	μA
($V_F = 5V$, $T_A = 85°C$)	I_B			10.0	μA
Temperature Coefficient of Switching Voltage ($T_A = -55°C$ to $+85°C$)	T_C		±.02		%/°C
Forward Voltage Drop (On State) ($I_F = 175$ mA)	V_F			1.70	V
DYNAMIC					
Turn-on Time (See Circuit 1)	t_{on}			1.0	μsec
Peak Pulse Amplitude (See Circuit 3)	V_o	3.5			V
Turn-off Time (See Circuit 2)	t_{off}			30.0	μsec

**This device is a symmetrical negative resistance diode. All electrical limits shown apply in either direction of current flow.

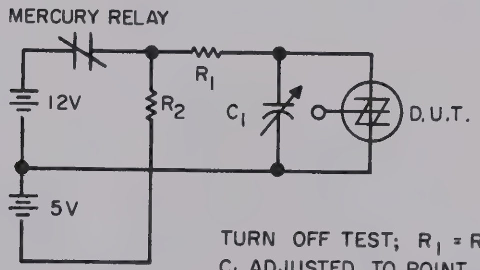
STATIC CHARACTERISTICS



TEST CIRCUITS

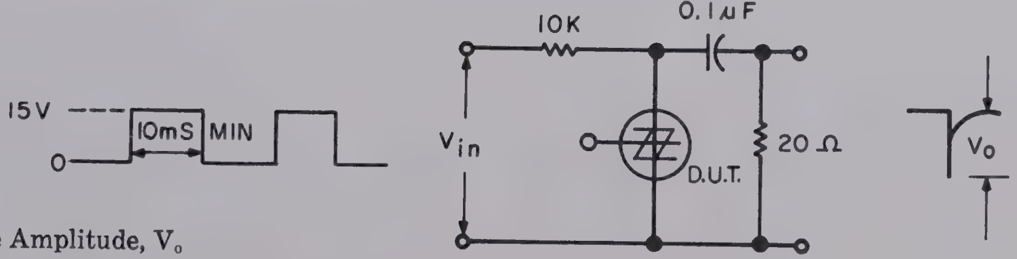

MERCURY RELAY
1kΩ
1kΩ
+
12V
.01μF
D.U.T.
ANODE VOLTAGE
V_S
t
t_{on}
V_F
$V_F + .1 (V_S - V_F)$

Circuit 1
Turn-on Time, t_{on}


MERCURY RELAY
12V
R_2
R_1
C_1
D.U.T.
5V

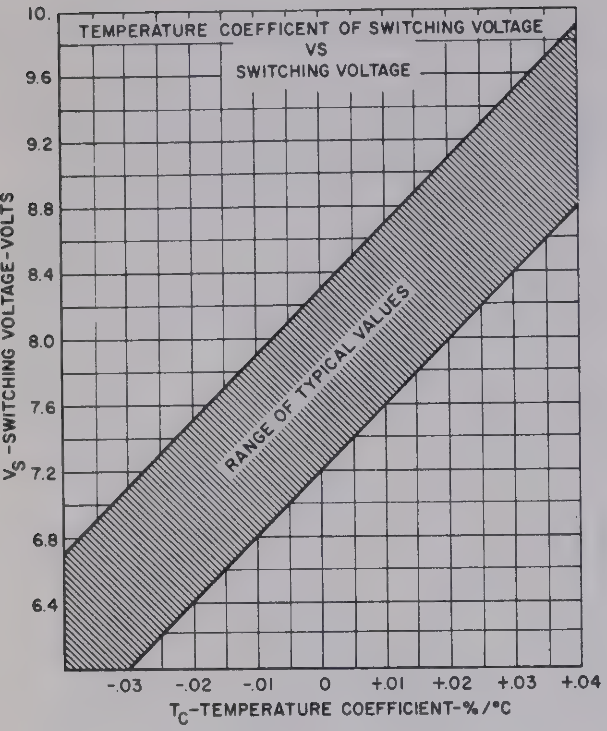
TURN OFF TEST; $R_1 = R_2 = 500\ \Omega$
C_1 ADJUSTED TO POINT WHERE
TURN – OFF JUST OCCURS
$t_{off} \triangleq (R_1 + R_2) C1$

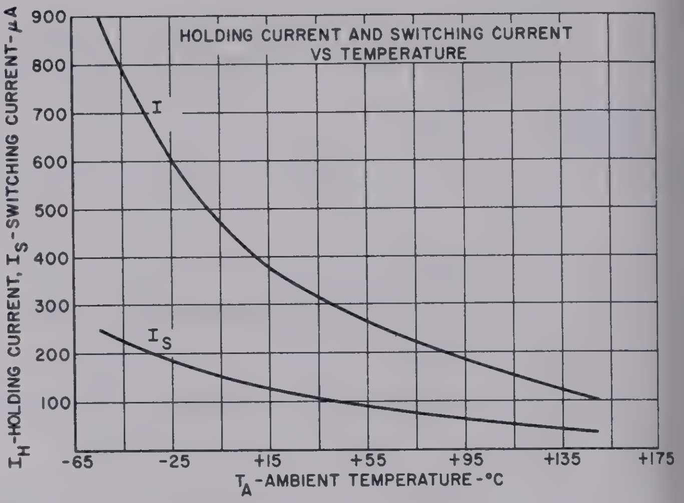
Circuit 2
Turn-off Time, t_{off}

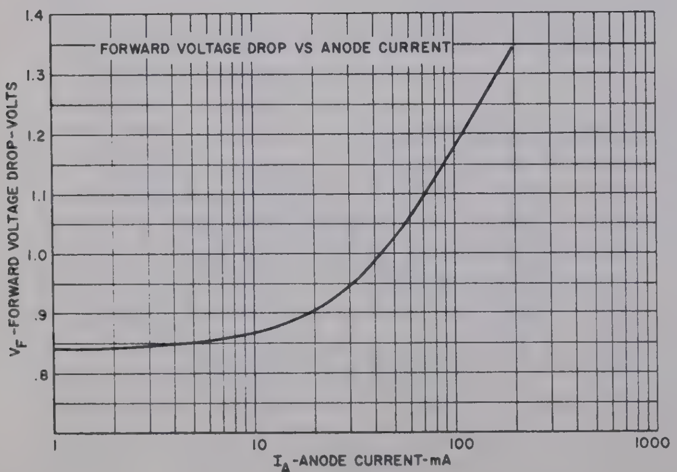

15V
10mS MIN
0
10K
0.1μF
V_{in}
D.U.T.
20 Ω
V_o

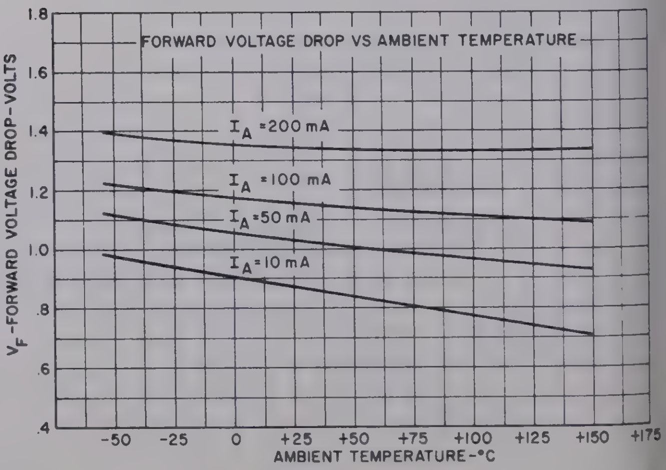
Circuit 3
Peak Pulse Amplitude, V_o

TYPICAL CHARACTERISTICS

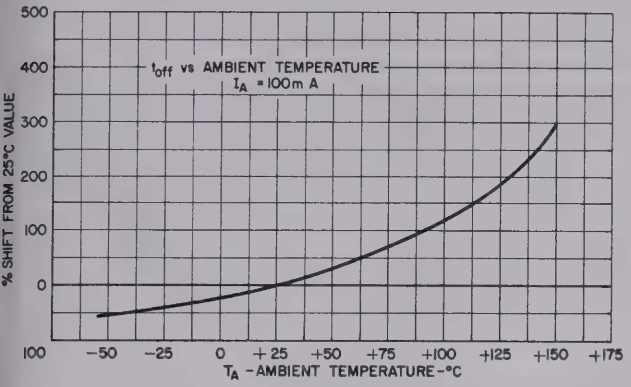


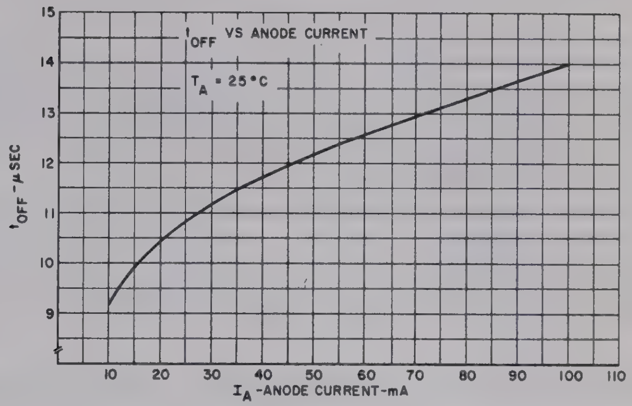


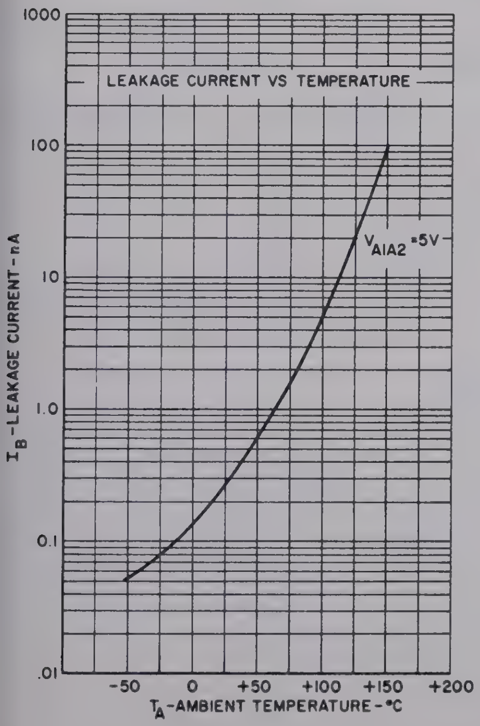


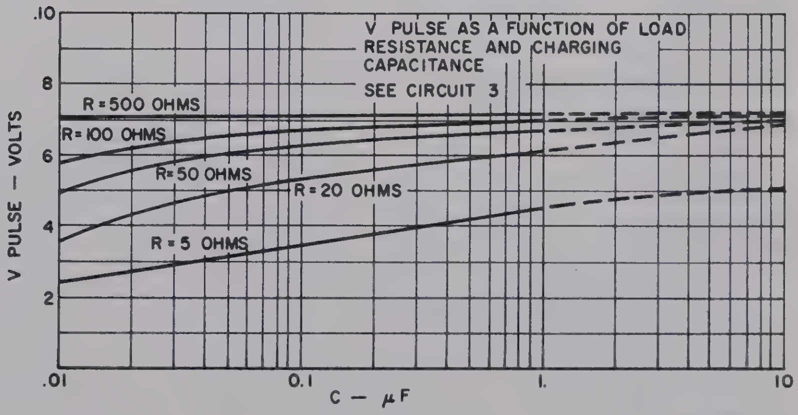


TYPICAL CHARACTERISTICS







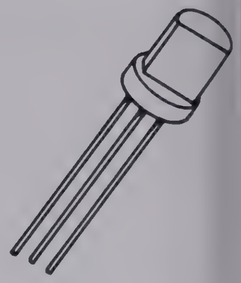


SBS

2N4992

The General Electric SBS is a silicon planar, monolithic integrated circuit having the electrical characteristics of a bilateral thyristor. The device is designed to switch at 8 volts with a 0.02%/°C temperature coefficient and excellently matched characteristics in both directions. A gate lead is provided to eliminate rate effect and to obtain triggering at lower voltages.

The Silicon Bilateral Switches are specifically designed and characterized for applications where stability of switching voltage over a wide temperature range and well matched bilateral characteristics are an asset. They are ideally suited for half wave and full wave triggering in low voltage SCR and Triac phase control circuits. The 2N4992 is in the low cost, TO-98 plastic package.

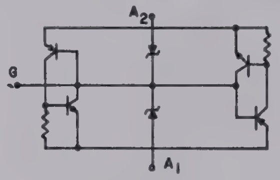


absolute maximum ratings: (25°C free air) (unless otherwise specified)

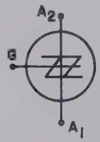
Storage Temperature Range	−65 to +150	°C
Operating Junction Temperature Range	−55 to +150	°C
Power Dissipation*	350	mW
DC Forward Anode Current*	200	mA
DC Gate Current*†	5	mA
Peak Recurrent Forward Current (1% duty cycle, 10 μsec pulse width, $T_A = 100°C$)	1.0	Amp
Peak Non-Recurrent Forward Current (10 μsec pulse width, $T_A = 25°C$)	5.0	Amps

*Derate linearly to zero at 150°C.

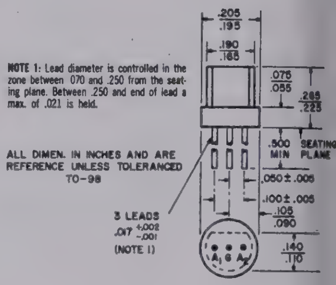
†This rating applicable only on OFF state. Maximum gate current in conducting state limited by maximum power ratings.



EQUIVALENT CIRCUIT



CIRCUIT SYMBOL

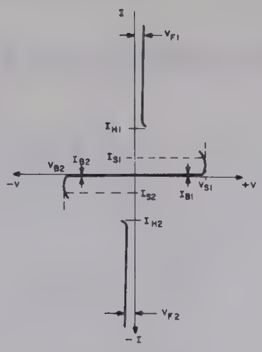

.205
.195
.190
.165
NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.
.075
.055
.265
.225
.500 MIN
SEATING PLANE
ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED
TO-98
.050±.005
.100±.005
.105
.090
3 LEADS
.017 +.002 −.001
(NOTE 1)
A1 G A2
.140
.110

electrical characteristics:** (25°C) (unless otherwise specified)

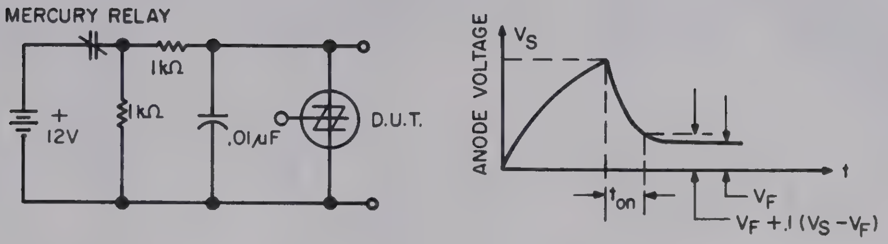
STATIC		Min.	Max.	
Switching Voltage	V_S	7.5	9.0	V
Switching Current	I_S		120	μA
Forward Gate Current to Trigger ($V_F = 5V$, $R_L = 1k\ \Omega$)	I_{GF}		100	μA
Absolute Switching Voltage Difference	$\lvert V_{S2} - V_{S1} \rvert$		.2	V
Absolute Switching Current Difference	$\lvert I_{S2} - I_{S1} \rvert$		10.0	μA
Holding Current	I_H		.5	mA
Current (Off State)				
($V_F = 5V$, $T_A = 25°C$)	I_B		0.1	μA
($V_F = 5V$, $T_A = 100°C$)	I_B		10.0	μA
Temperature Coefficient of Switching Voltage ($T = -55°C$ to $+100°C$)	T_C		±.05	%/°C
Forward Voltage Drop (On State) ($I_F = 200$ mA)	V_F		1.70	V
DYNAMIC				
Turn-on Time (See Circuit 1)	t_{on}		1.0	μsec
Turn-off Time (See Circuit 2)	t_{off}		30	μsec
Peak Pulse Amplitude (See Circuit 3)	V_o	3.5		V

**This device is a symmetrical negative resistance diode. All electrical limits shown apply in either direction of current flow.

STATIC CHARACTERISTICS

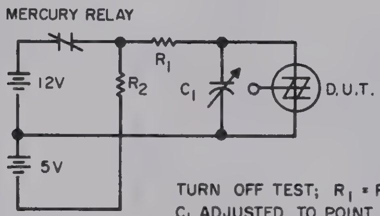


TEST CIRCUITS


MERCURY RELAY
1kΩ
1kΩ
+
12V
.01μF
D.U.T.
ANODE VOLTAGE
V_S
t
t_{on}
V_F
$V_F + .1 (V_S - V_F)$

Circuit 1

Turn-on Time, t_{on}

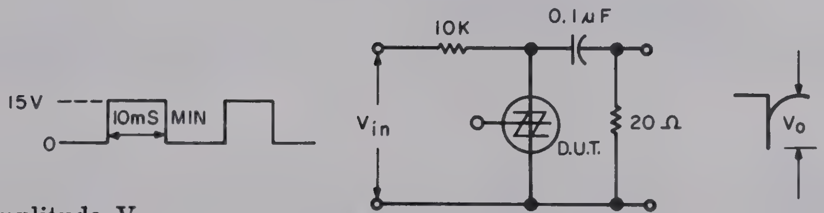

MERCURY RELAY
12V
R_2
R_1
C_1
D.U.T.
5V

TURN OFF TEST; $R_1 = R_2 = 500\ \Omega$
C_1 ADJUSTED TO POINT WHERE
TURN-OFF JUST OCCURS

$t_{off} \triangleq (R_1 + R_2) C1$

Circuit 2

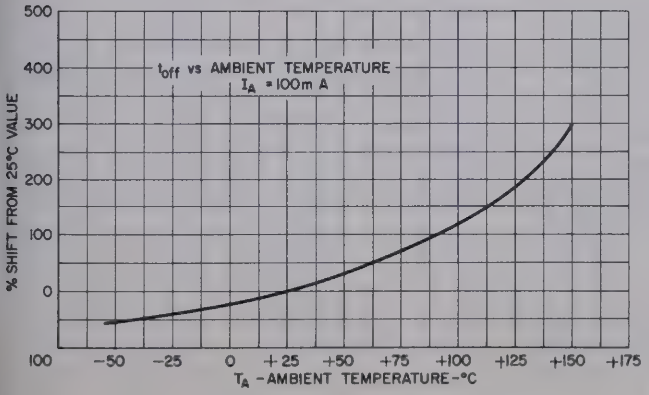
Turn-off Time, t_{off}

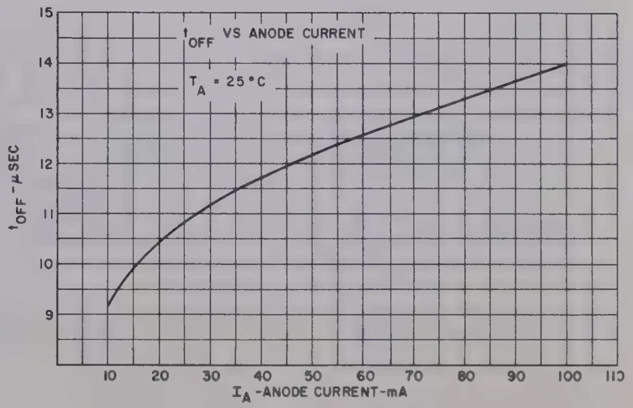

15V
0
10mS MIN
10K
0.1μF
V_{in}
D.U.T.
20 Ω
V_o

Circuit 3

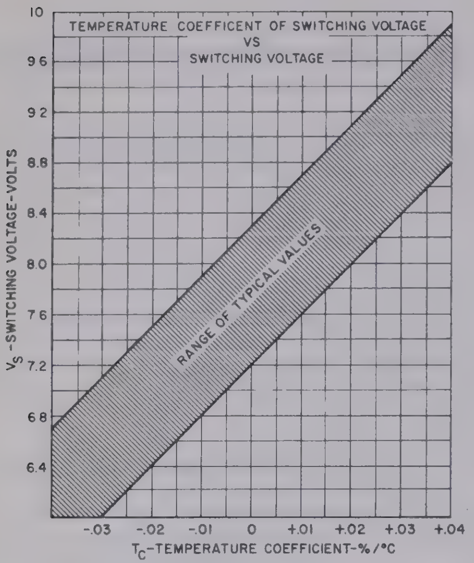
Peak Pulse Amplitude, V_o

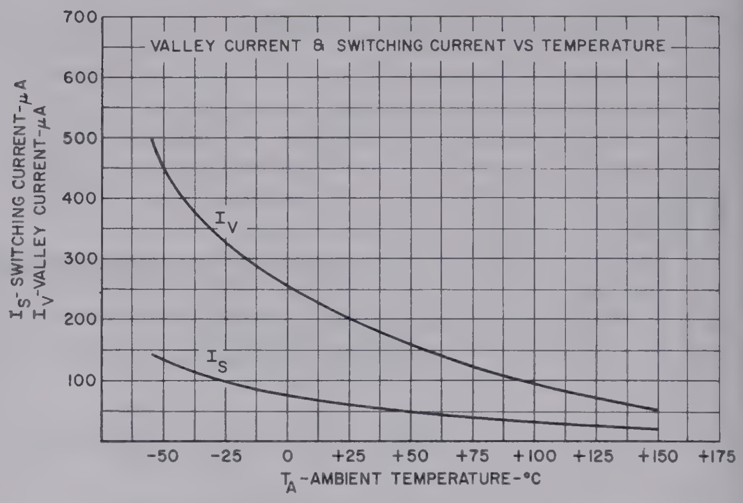
TYPICAL CHARACTERISTIC CURVES

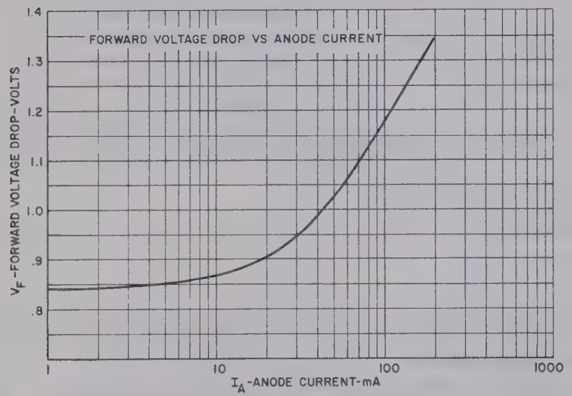


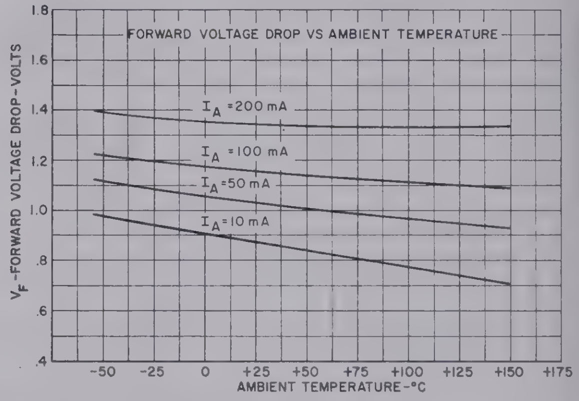


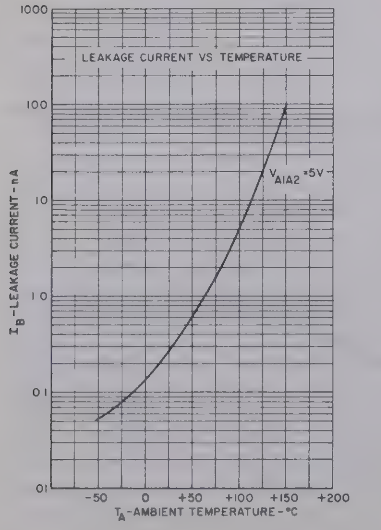
TYPICAL CHARACTERISTICS

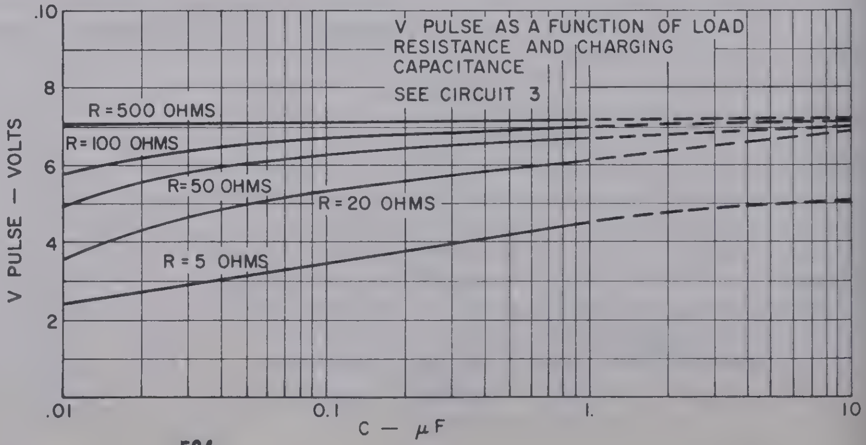










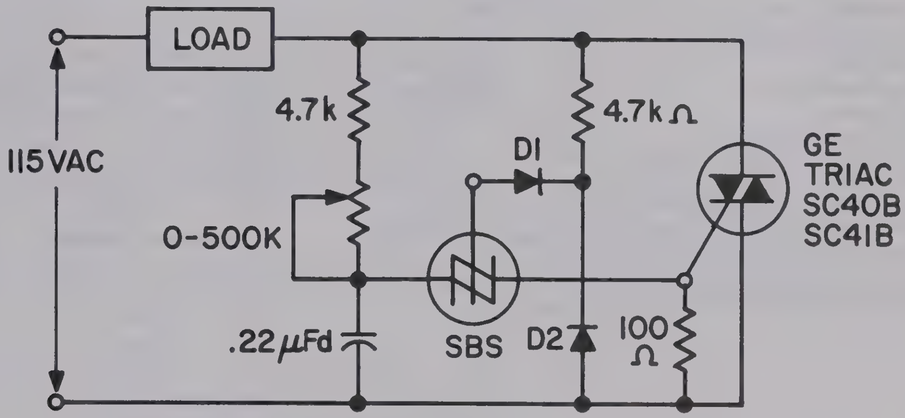


APPLICATION IN HYSTERESIS-FREE PHASE CONTROL CIRCUIT

The circuit in Figure 1 is a simple hysteresis-free phase control circuit intended for lamp dimming and similar applications. The circuit requires only one RC phase lag network. To avoid the hysteresis (or "snap-on") effect, the capacitor, C, is reset to approximately 0 volts at the end of every positive half cycle (for pot values such that no power is applied to the load). This is accomplished using the gate lead. At the end of the positive half, as the line voltage drops below the capacitor voltage, gate current flows from C out through the gate, D1 and 47k Ω resistor. The SBS fires and discharges C to 0 volts. In the negative half cycle diodes D2 and D1 clamp the gate voltage to ground and block the flow of gate current respectively. Electrical requirements of D1 and D2 are easily met. Any diode with $V_R > 10$ volts works fine. Forward conductance must be fairly good since the voltage across D2 at 3mA must be smaller than the drop across the Triac gate, the SBS gate, and D1 at the trigger current of the SBS. The General Electric 6RS5GC1UAJ1 (common cathode) dual diode makes an excellent choice. These are available from General Electric Semiconductor Products Department, Lynchburg, Virginia.

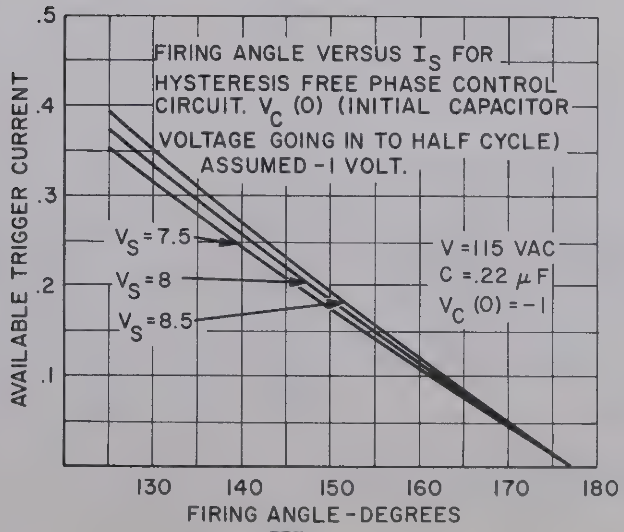
Figure 2 shows the excellent degree of phase control available in the circuit. For the worst case unit, $\phi\text{max} = 155°$ ($V_S = 7.5$ volts, $I_S = 120\mu A$).

FIGURE 1



SBS 2N4992
D1, D2-GE 6RS5GC1LAJ1
-COMMON CATHODE

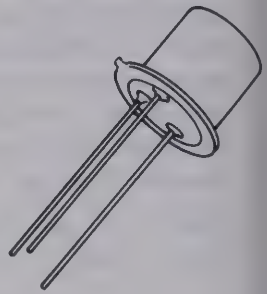
FIGURE 2



SBS

2N4993

The General Electric SBS is a silicon planar, monolithic integrated circuit having the electrical characteristics of a bilateral thyristor. The device is designed to switch at 8 volts with a 0.02%/°C temperature coefficient and excellently matched characteristics in both directions. A gate lead is provided to eliminate rate effect and to obtain triggering at lower voltages.



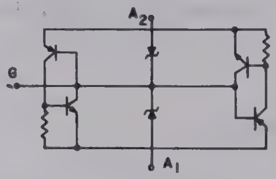
The Silicon Bilateral Switches are specifically designed and characterized for applications where stability of switching voltage over a wide temperature range and well matched bilateral characteristics are an asset. They are ideally suited for half wave and full wave triggering in low voltage SCR and Triac phase control circuits. The 2N4993 is in the TO-18 hermetic package.

absolute maximum ratings: (25°C free air) (unless otherwise specified)

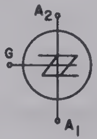
Storage Temperature Range	−65 to +200	°C
Operating Junction Temperature Range	−55 to +150	°C
Power Dissipation*	350	mW
DC Forward Anode Current*	200	mA
DC Gate Current *†	5	mA
Peak Recurrent Forward Current (1% duty cycle, 10 μsec pulse width, $T_A = 100°C$)	1.0	Amp
Peak Non-Recurrent Forward Current (10 μsec pulse width, $T_A = 25°C$)	5.0	Amps

*Derate linearly to zero at 150°C.

†This rating applicable only on OFF state. Maximum gate current in conducting state limited by maximum power rating.

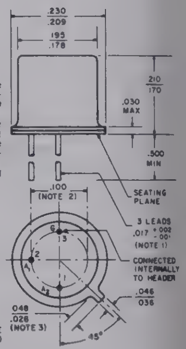


EQUIVALENT CIRCUIT



CIRCUIT SYMBOL

DIMENSIONS WITHIN JEDEC OUTLINE TO-18



NOTE 1: Lead diameter is controlled in the zone between .050 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

NOTE 2: Leads having maximum diameter (.019) measured in gaging plane .054 + .001 − .000 below the seating plane of the device shall be within .007 of true position relative to a maximum width tab.

NOTE 3: Measured from max. diameter of the actual device.

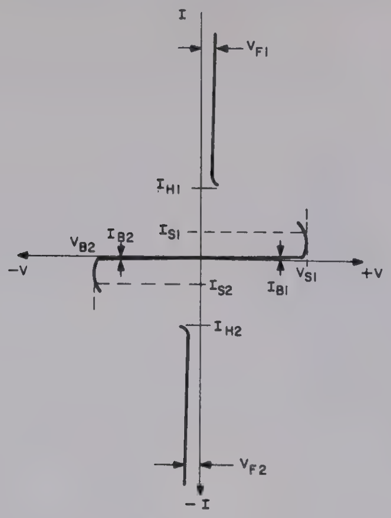
ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

electrical characteristics:** (25°C) (unless otherwise specified)

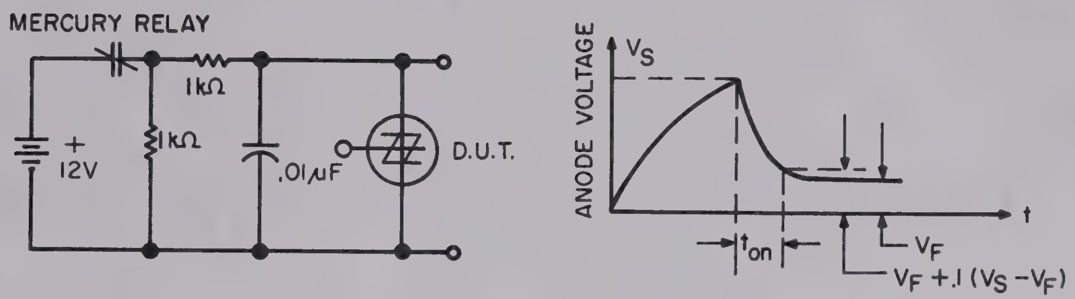
		Min.	Typ.	Max.	
STATIC					
Switching Voltage	V_S	6		10	V
Switching Current	I_S			500	μA
Absolute Switching Voltage Difference	$\lvert V_{S2} - V_{S1} \rvert$			.5	V
Absolute Switching Current Difference	$\lvert I_{S2} - I_{S1} \rvert$			100	μA
Holding Current	I_H			1.5	mA
Current (Off State)					
($V_F = 5V$, $T_A = 25°C$)	I_B			1.0	μA
($V_F = 5V$, $T_A = 100°C$)	I_B			10.0	μA
Temperature Coefficient of Switching Voltage ($T = -55°C$ to $+100°C$)	T_C		+.02		%/°C
Forward Voltage Drop (On State) ($I_F = 200$ mA)	V_F			1.70	V
DYNAMIC					
Turn-on Time (See Circuit 1)	t_{on}			1.0	μsec
Peak Pulse Amplitude (See Circuit 2)	V_o	3.5			V
Turn-off Time (See Circuit 3)	t_{off}			30.0	μsec

**This device is a symmetrical negative resistance diode. All electrical limits shown apply in either direction of current flow.

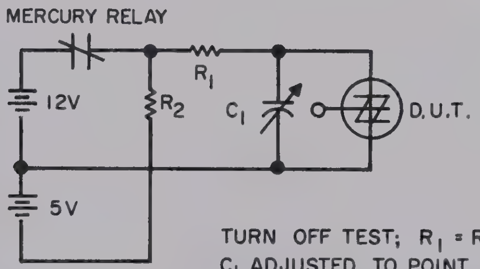
STATIC CHARACTERISTICS



TEST CIRCUITS


MERCURY RELAY
1kΩ
1kΩ
+
12V
.01µF
D.U.T.
ANODE VOLTAGE
V_S
t
t_{on}
V_F
$V_F + .1 (V_S - V_F)$

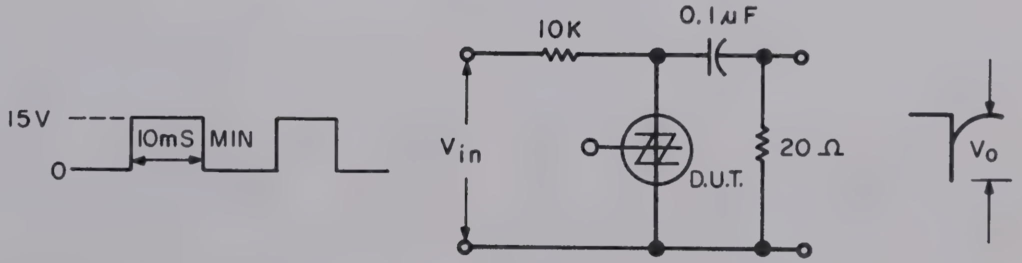
Circuit 1
Turn-on Time, t_{on}


MERCURY RELAY
12V
R_1
R_2
C_1
D.U.T.
5V

TURN OFF TEST; $R_1 = R_2 = 500\ \Omega$
C_1 ADJUSTED TO POINT WHERE
TURN – OFF JUST OCCURS

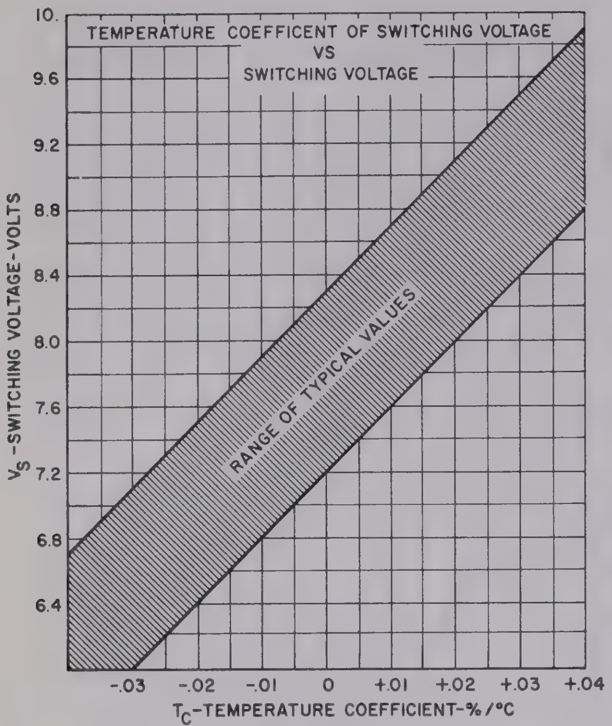
$$t_{off} \triangleq (R_1 + R_2) C1$$

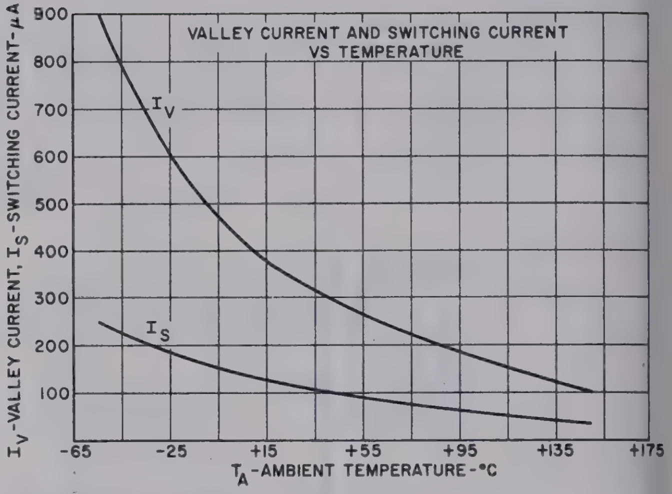
Circuit 2
Turn-off Time, t_{off}

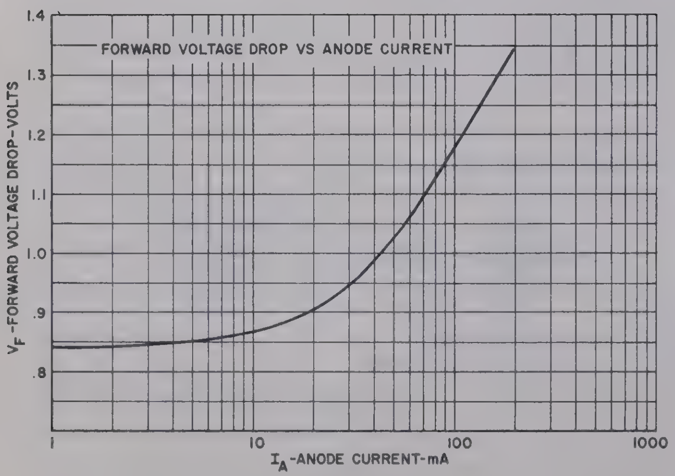

15V
0
10mS
MIN
10K
0.1µF
V_{in}
D.U.T.
20 Ω
V_o

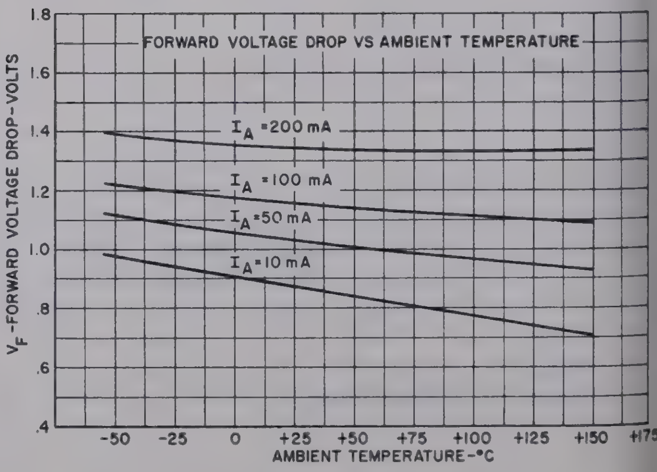
Circuit 3
Peak Pulse Amplitude, V_o

TYPICAL CHARACTERISTICS

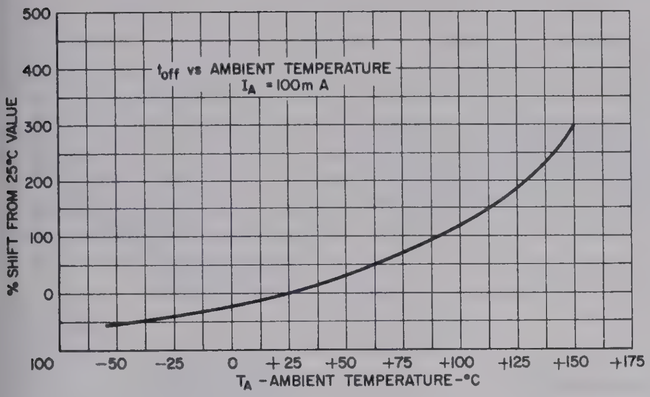


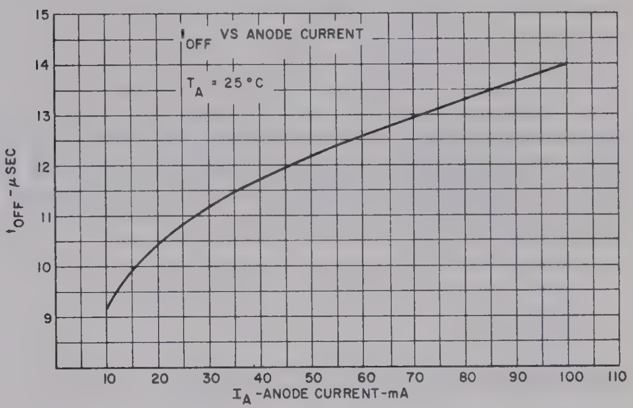


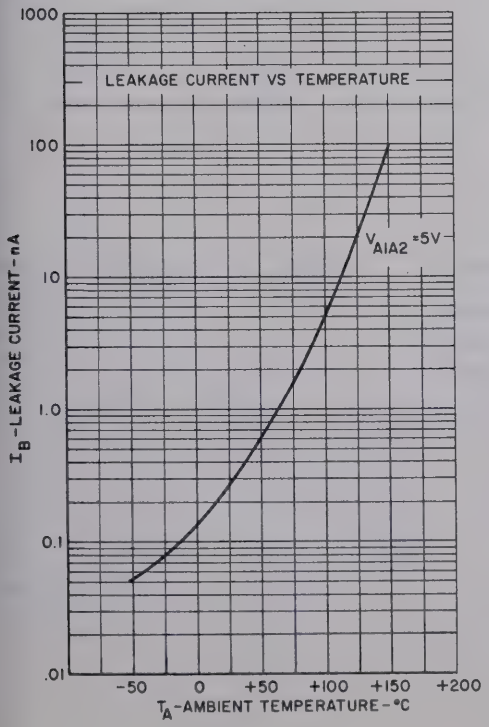


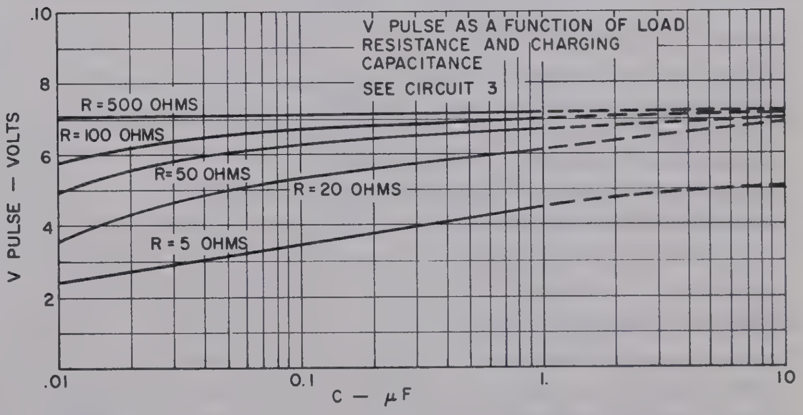


TYPICAL CHARACTERISTICS









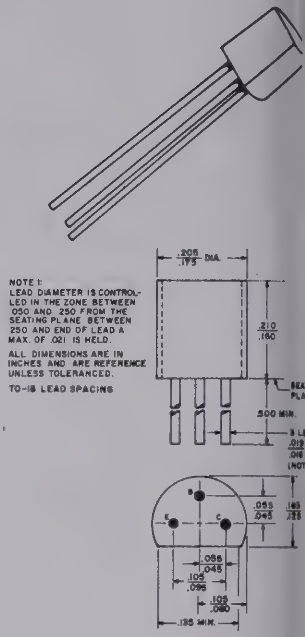
Silicon Transistors

NPN

2N4994

2N4995

The General Electric 2N4994 and 2N4995 are NPN planar epitaxial passivated silicon transistors. They are primarily intended for radio receiver applications including small signal audio IF and RF functions. For full characterization, see publ. no. 40.84.


NOTE 1:
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND .250 FROM THE SEATING PLANE BETWEEN .250 AND END OF LEAD A MAX. OF .021 IS HELD.
ALL DIMENSIONS ARE IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.
TO-18 LEAD SPACING
.205/.175 DIA.
.210/.160
.500 MIN.
.019/.016
.055/.045
.165/.125
B
E
C
.055/.045
.105/.095
.105/.080
.135 MIN.

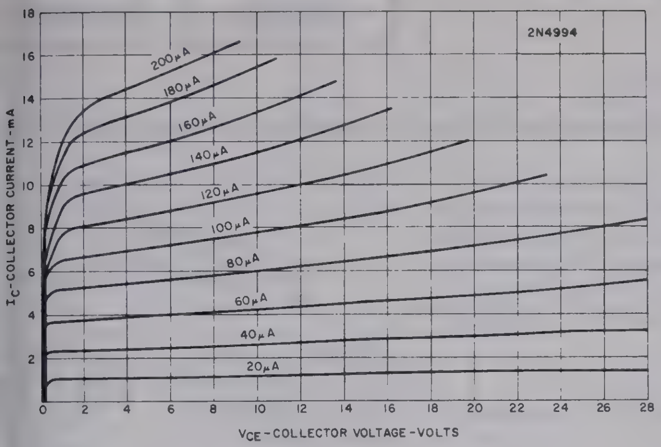
absolute maximum ratings: (T_A = 25°C unless otherwise specified)

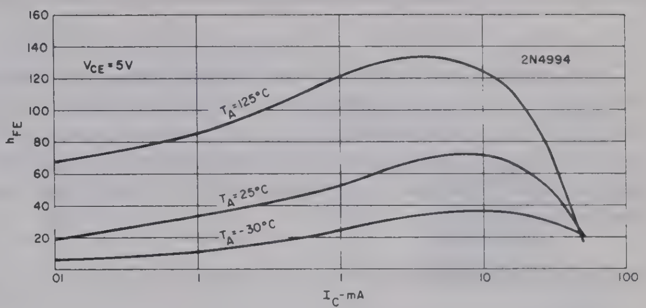
Voltages			
Collector to Emitter	V_{CEO}	45	Volts
Collector to Base	V_{CBO}	60	Volts
Emitter to Base	V_{EBO}	4	Volts
Current			
Collector	I_c	30	mA
Dissipation			
Total Power T_A = 25°C	P_T	.360	Watts
Derate Factor T_A = 25°C		2.88	mW/°C
Temperature			
Storage	T_{stg}	−65 to +150	°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	+260	°C

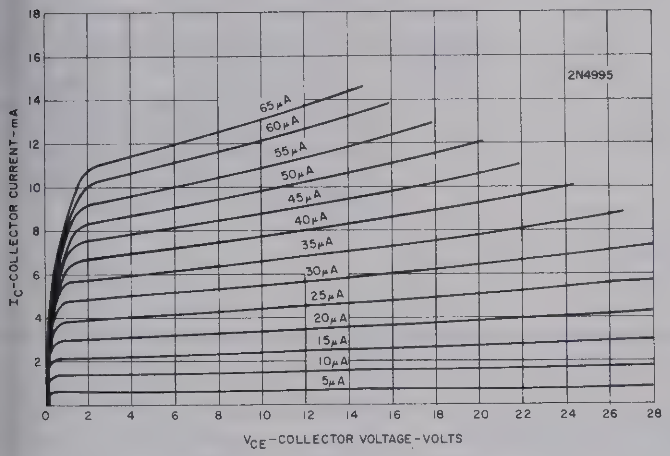
electrical characteristics: (T_A = 25°C unless otherwise specified)

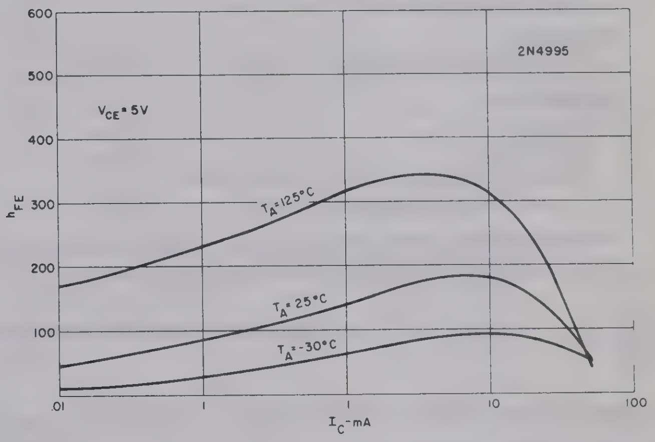
STATIC CHARACTERISTICS		SYMBOL	MIN.	MAX.	UNITS
Collector-emitter breakdown voltage (I_C = 10 mA, I_B = 0)		$V_{(BR)CEO}$	45	–	Volts
Collector-base breakdown voltage (I_C = 100 μA, I_E = 0)		$V_{(BR)CBO}$	60	–	Volts
Emitter-base breakdown voltage (I_E = 100 μA, I_c = 0)		$V_{(BR)EBO}$	4	–	Volts
Collector cutoff current (V_{CB} = 30 V, I_E = 0)		I_{CBO}		100	nA
Collector cutoff current (V_{CB} = 30 V, I_E = 0, T_A = 85°C)		I_{CBO}		5	μA
Forward current transfer ratio					
(V_{CE} = 10 V, I_C = 10 mA)	2N4994	h_{FE}	40	160	
(V_{CE} = 10 V, I_C = 10 mA)	2N4995	h_{FE}	100	400	

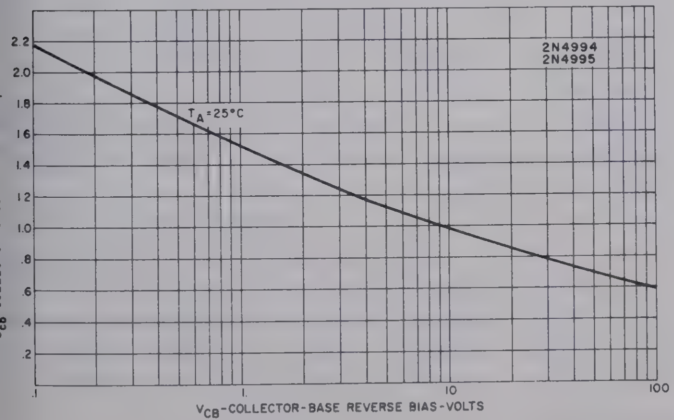
DYNAMIC CHARACTERISTICS		MIN.	TYP.	MAX.	
Collector-base capacitance (V_{CB} = 10 V, I_E = 0, f = 1 MHz)	C_{cb}		1.0	3.5	pF
Forward current transfer ratio (V_{CE} = 10 V, I_C = 10 mA, f = 455 kHz)	h_{fe}		43		dB
Forward current transfer ratio (V_{CE} = 10 V, I_C = 10 mA, f = 100 MHz)	$\|h_{fe}\|$	2	3	8	
Collector base time constant (V_{CB} = 10 V, I_E = −10 mA, f = 79.8 MHz)			45	100	ps

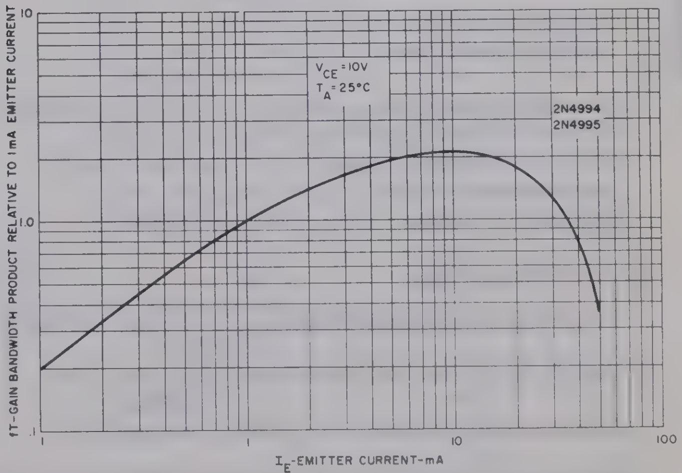

2N4994
200μA
180μA
160μA
140μA
120μA
100μA
80μA
60μA
40μA
20μA
I_C-COLLECTOR CURRENT-mA
V_{CE}-COLLECTOR VOLTAGE-VOLTS
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28


V_{CE}=5V
2N4994
T_A=125°C
T_A=25°C
T_A=-30°C
h_{FE}
160
140
120
100
80
60
40
20
.01
.1
1
10
100
I_C-mA


2N4995
65μA
60μA
55μA
50μA
45μA
40μA
35μA
30μA
25μA
20μA
15μA
10μA
5μA
I_C-COLLECTOR CURRENT-mA
V_{CE}-COLLECTOR VOLTAGE-VOLTS
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28


2N4995
V_{CE}=5V
T_A=125°C
T_A=25°C
T_A=-30°C
h_{FE}
600
500
400
300
200
100
.01
.1
1
10
100
I_C-mA

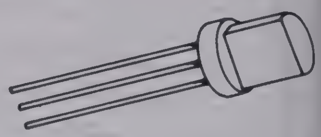

2N4994
2N4995
T_A=25°C
2.2
2.0
1.8
1.6
1.4
1.2
1.0
.8
.6
.4
.2
.1
1
10
100
V_{CB}-COLLECTOR-BASE REVERSE BIAS-VOLTS

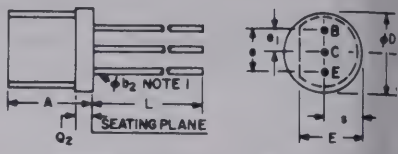

V_{CE}=10V
T_A=25°C
2N4994
2N4995
fT-GAIN BANDWIDTH PRODUCT RELATIVE TO 1mA EMITTER CURRENT
10
1.0
.1
.1
1
10
100
I_E-EMITTER CURRENT-mA

Silicon
Transistors

NPN	PNP
2N5172	**2N6076**

The General Electric 2N5172 and 2N6076 transistors are designed for general purpose applications. The planar, passivated construction assures excellent device stability and life. This high performance and high value is made possible by advanced manufacturing techniques, epoxy encapsulation and utilization of full line beta distribution. Significant savings may be realized by designing equipment utilizing these "full line distribution" type transistors.





SYMBOL	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	.170	.265	4.32	6.73
ϕb_2	.016	.019	.406	.483
ϕD	.165	.205	4.19	5.21
E	.110	.155	2.79	3.94
e	.095	.105	2.41	2.67
e_1	.045	.055	1.14	1.40
L	.500		12.70	
Q_2		.075		1.90
s	.080	.115	2.03	2.92

NOTE I: LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .070 AND .250 FROM THE SEATIN PLANE. BETWEEN .250 AND END OF LEAD A MAX OF .021 IS HELD.

absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to emitter*	V_{CEO}	25	Volts
Emitter to base*	V_{EBO}	5	Volts
Collector to base*	V_{CBO}	25	Volts
Current			
Collector (steady state)†*	I_C	100	mA
Dissipation			
Total Power (free air at 25° C)††*	P_T	360	mW
Temperature			
Storage*	T_{stg}	–55 to +150	°C
Operating	T_j	+125	°C
Lead Temperature, 1/16" ± 1/32" from case for 10 seconds maximum	T_L	+260	°C

†Determined from power limitations due to saturation voltage at this current.
††Derate 3.6 mW/°C increase in ambient temperature above 25° C.

electrical characteristics: (25°C) (unless otherwise specified)

Static Characteristics		Min.	Typ.	Max.	
Collector Cutoff Current (V_{CB} = 25V),*	I_{CBO}			100	nA
(V_{CB} = 25V; T_A = 100°C)	I_{CBO}			10	μA
Collector Cutoff Current (V_{CB} = 25V)	I_{CES}			100	nA
Emitter Cutoff Current (V_{EB} = 5V)* 2N5172	I_{EBO}			100	nA
(V_{EB} = 3V)* 2N6076	I_{EBO}			100	nA
Forward Current Transfer Ratio (V_{CE} = 10V, I_C= 10 mA)*	h_{FE} ‡	100		500	
Collector-Emitter Breakdown Voltage (I_C= 10 mA)*	$V_{(BR)CEO}$	25			Volts
Collector Saturation Voltage (I_C= 10 mA, I_B= 1 mA)*	$V_{CE(sat)}$			.25	Volts
Base Saturation Voltage (I_C=10 mA, I_B= 1 mA)	$V_{BE(sat)}$			.80	Volts
Base Emitter Voltage (V_{CE} = 10V, I_C= 10 mA)*	V_{BE}	0.5		1.2	Volts
Dynamic Characteristics					
Forward Current Transfer Ratio (V_{CE} = 10V, I_C = 10 mA, f = 1 kHz)*	h_{fe}	100		750	
Output Capacitance, Common Base (V_{CB} = 10V, I_E = 0, f = 1 MHz)	C_{cb}	1.0		13	pF
Gain Bandwidth Product (V_{CB} = 5V, I_C = 2 mA)*	f_T		200		MHz

‡Typically a minimum of 50% of the distribution will have h_{FE} > 150 at stated conditions.
Note: Polarities are absolute.
*Registered Values

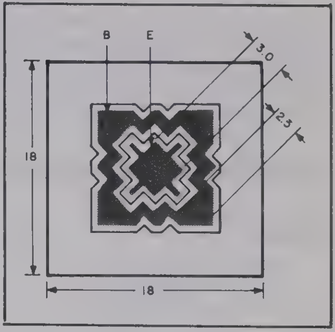
Silicon
Transistor Chips

NPN

2N5172 (Chip)

(M26P-X558)

This General Electric NPN silicon planar passivated transistor chip is designed for general purpose applications.



General specifications:

- Gold collector contact backing, minimum thickness—3000Å
- Aluminum base and emitter contact metalization
- Maximum conditions for mounting chips—425°C for 5 minutes (Max.) in an inert atmosphere
- Shipping containers: Glass vials sealed with a nitrogen back-fill
  Maximum of 10k chips per vial
  Egg crate containers available at extra cost
- Chip drawing dimensions are in mils
- Chip thickness = $5.4\ {}^{+0.8}_{-0.9}$ mils

absolute maximum ratings: ($T_A = 25°C$)

	Symbol		
Voltages			
Collector to Base	V_{CBO}	25	V
Collector to Emitter	V_{CEO}	25	V
Emitter to Base	V_{EBO}	5	V
Current			
Collector	I_C	100	mA
Temperature			
Storage	T_{STG}	−65°C to +200°C	
Operating	T_J	−65°C to +200°C	

electrical characteristics: 100% Probe ($T_A = 25°C$)

Tested at outgoing acceptance to a 10% LTPD with a maximum accept number of 3.

	Symbol	Min.	Max.	
Collector Base Breakdown Voltage ($I_C = 0.1\ \mu A$)	BV_{CBO}	35	—	V
Collector Emitter Breakdown Voltage ($I_C = 10$ mA)	BV_{CEO}	25	—	V
Emitter Base Breakdown Voltage ($I_E = 0.1\ \mu A$)	BV_{EBO}	5	—	V
Forward Current Transfer Ratio ($I_C = 10$ mA, $V_{CE} = 10V$)	h_{FE}	100	500	

specifications: ($T_A = 25°C$)

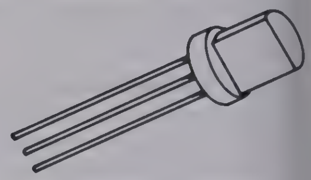
Product yield is at least 93% to each of the following parameters:

	Symbol	Min.	Max.	
Collector Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)	$V_{CE(SAT)}$	—	0.25	V
Base Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)	$V_{BE(SAT)}$	—	0.8	V
Forward Current Transfer Ratio ($I_C = 10$ mA, $V_{CE} = 10V$, f = 1 KHz)	h_{fe}	100	750	
Collector Base Capacitance ($V_{CB} = 10$ V, f = 1 MHz)	C_{cb}	1.6	10	pF

Silicon
Transistors

NPN
2N5174,5,6

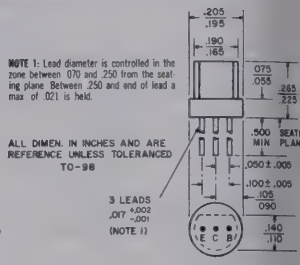
The General Electric 2N5174-2N5176 are NPN silicon planar passivated transistors designed for high voltage applications. They are especially suited for driving high voltage indicating devices. The planar, passivated construction assures excellent device stability and life. These high performance, high value transistors are made possible by advanced manufacturing techniques and epoxy encapsulation.



absolute maximum ratings: (25°C) (unless otherwise specified)

		2N5174	2N5175, 6	
Voltages				
Collector to Emitter	V_{CEO}	75	100	Volts
Emitter to Base	V_{EBO}	5	5	Volts
Collector to Base	V_{CBO}	90	130	Volts
Current				
Collector (Steady State)*	I_C	25	25	mA
Dissipation				
Total Power (free air @ 25°C)†	P_T	360	200	mW
Total Power (free air @ 55°C)†	P_T	260	120	mW
Temperature				
Storage	T_{stg}	−55 to +150°C		
Operating	T_J	−55 to +125°C		
Lead soldering, 1/16" to 1/32" from case for 10 seconds max.	T_L	+260°C		

*Determined from power limitations due to saturation voltage at this current.
†Derate 2.67 mW/°C increase for temperature above 25°C.


.205
.195
.190
.165
NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max of .021 is held.
.075
.055
.265
.225
.500
MIN
SEAT
PLAN
ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED
TO-98
.050 ± .005
.100 ± .005
.105
.090
3 LEADS
.017 +.002 −.001
(NOTE 1)
E C B
.140
.110

---

electrical characteristics: (25°C) (unless otherwise specified)

Static Characteristics

			Min.	Max.	
Collector Cutoff Current ($V_{CB} = 60V$)		I_{CBO}		.5	μA
Emitter Cutoff Current ($V_{EB} = 5V$)		I_{EBO}		100	μA
Collector Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)‡		$V_{CE(sat)}$		.95	Volts
Base Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)‡		$V_{BE(sat)}$	.60	.80	Volts
Base Emitter Voltage ($I_C = 10$ mA, $V_{CE} = 5V$)‡		V_{BE}	.20	.80	Volts
Collector to Emitter Breakdown Voltage ($I_C = 10$ mA)‡		$V_{(BR)CEO}$			
	2N5174		75		Volts
	2N5175		100		Volts
	2N5176		100		Volts
Forward Current Transfer Ratio ($V_{CE} = 5V$, $I_C = .1$ mA)		h_{FE}			
	2N5174		30		
	2N5175		40		
	2N5176		100		
($V_{CE} = 5V$, $I_C = 10$ mA)‡		h_{FE}			
	2N5174		40	600	
	2N5175		55	160	
	2N5176		140	300	

‡Pulse test, 300 μsec, 2% duty cycle.

Dynamic Characteristics

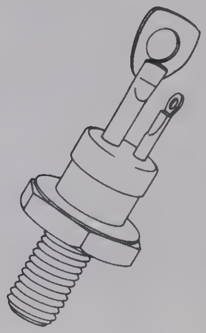
Forward Current Transfer Ratio ($V_{CE} = 5V$, $I_C = 10$ mA, f = 1 kHz		h_{fe}			
	2N5174		40	900	
	2N5175		55	240	
	2N5176		140	450	
Output Capacitance, Common Base ($V_{CB} = 10V$, $I_E = 0$, f = 1 MHz)		C_{ob}		5	pF

SCR

2N5204-07

The 2N5204-07 series of silicon controlled rectifiers are reverse blocking triode thyristor semiconductor devices for use in medium power switching and phase control applications requiring blocking voltage up to 1200 volts, and average load current (single-phase, 180° conduction angle) up to 22 amperes.

General Electric's C137 SCR (Publication #160.45) is recommended where a higher level of performance is required for a device of this size.



MAXIMUM ALLOWABLE RATINGS

Type	Repetitive Peak Off-State Voltage, V_{DRM}(1) (2) $T_C = -40°C$ to $+125°C$	Repetitive Peak Reverse Voltage V_{RRM}(1) (2) $T_C = -40°C$ to $+125°C$	Non-repetitive Peak Reverse Voltage V_{RSM}(1) (3) $T_C = -40°C$ to $+125°C$
2N5204	600 Volts†	600 Volts†	720 Volts†
2N5205	800 Volts†	800 Volts†	960 Volts†
2N5206	1000 Volts†	1000 Volts†	1200 Volts†
2N5207	1200 Volts†	1200 Volts†	1440 Volts†

(1) Values apply for gate terminal open-circuited. (Negative gate bias is permissible.)
(2) Maximum case-to-ambient thermal resistance for which maximum V_{DRM} and V_{RRM} ratings apply equals 5.0°C per watt for full sine wave or full-wave rectified sinusoidal voltage waveform. (3.0°C per watt is maximum case-to-ambient thermal resistance for pure dc voltage waveform.)
(3) Half sine wave voltage pulse, 10 millisecond maximum duration.
(4) di/dt rating is established in accordance with JEDEC Suggested Standard No. 7, Section 5.1.2.4. Off-state (blocking) voltage capability may be temporarily lost immediately after each current pulse for duration less than the period of the applied pulse repetition rate. The pulse repetition rate for this test is 400 Hz. The duration of the JEDEC di/dt test condition is 5.0 seconds (minimum).

RMS On-State Current, $I_{T(RMS)}$	35 Amperes (all conduction angles)
Average On-State Current, $I_{T(AV)}$	Depends on conduction angle (See Charts 3 and 5)
Critical Rate-of-Rise of On-State Current, di/dt:(4)	
Gate triggered operation	(See Chart 6)
Switching from 1200 volts	75 Amperes per microsecond†
1000 volts	80 Amperes per microsecond†
800 volts	90 Amperes per microsecond†
600 volts	100 Amperes per microsecond†
Breakover voltage triggered operation	10 Amperes per microsecond
Peak One Cycle Surge (non-rep) On-State Current, I_{TSM}	300 Amperes†
I^2t (for fusing), for time = 1.0 milliseconds (See Chart 9)	200 Ampere² seconds
for time = 8.3 milliseconds (See Chart 9)	375 Ampere² seconds
Peak Gate Power Dissipation, P_{GM}	60 Watts for 500 microseconds†
Average Gate Power Dissipation, $P_{G(AV)}$	10 Watts†
Peak Negative Gate Voltage, V_{GM}	5 Volts†
Storage Temperature, T_{STG}	−40°C to +150°C†
Operating Temperature, T_J	−40°C to +125°C†
Maximum Stud Torque	30 Lb-in (35 Kg-cm)

†Indicates data included on JEDEC Type Number Registration.

CHARACTERISTICS

Test	Symbol	Min.	Max.	Units	Test Conditions
Peak Off-State or Reverse Current (1) (2)	I_{DRM} or I_{RRM}			mA	$T_C = -40°$ to $+125°C$
2N5204		—	3.3†		$V_{DRM} = V_{RRM} =$ 600 Volts Peak
2N5205		—	2.5†		800
2N5206		—	2.0†		1000
2N5207		—	1.7†		1200
D.C. Gate Trigger Current	I_{TG}	—	40	mAdc	$T_C = +25°C$, $V_D = 12$ Vdc, $R_L = 12$ ohms
		—	80†		$T_C = -40°C$, $V_D = 12$ Vdc, $R_L = 12$ ohms
D.C. Gate Trigger Voltage	V_{GT}	—	3.0	Vdc	$T_C = +25°C$, $V_D = 12$ Vdc, $R_L = 12$ ohms
		—	3.0†		$T_C = -40°C$, $V_D = 12$ Vdc, $R_L = 12$ ohms
		0.25†	—		$T_C = +125°C$, Rated V_{DRM}, $R_L = 1000$ ohms
Peak On-State Voltage	V_{TM}	—	2.3†	Volts	$T_C = +25°C$, $I_{TM} = 70$ A peak, 1 msec wide pulse. Duty cycle $\leqq 2\%$.
Holding Current	I_H			mAdc	Anode supply = 24 Vdc, Gate supply = 10 V, 20 ohms. Initial Forward Current Pulse = 0.5 A, 0.1 to 10.0 msec. wide.
		—	100		$T_C = +25°C$
		—	200†		$T_C = -40°C$
Critical Rate of Rise of Forward Blocking Voltage. (Higher values may cause device switching.)	dv/dt	100†	—	Volts/μsec	$T_C = +125°C$, Rated V_{DRM}, Gate open circuited.
Thermal Resistance	$\Theta_{J\text{-}C}$	—	1.5†	°C/watt	Junction-to-case, dc

(1) Values apply for gate terminal open-circuited. (Negative gate bias is permissible.)

(2) Maximum case-to-ambient thermal resistance for which maximum V_{DRM} and V_{RRM} ratings apply equals 5.0°C per watt for full sine wave or full-wave rectified sinusoidal voltage waveform. (3.0°C per watt is maximum case-to-ambient thermal resistance for pure dc voltage waveform.)

†Indicates data included on JEDEC Type Number Registration.

OUTLINE DRAWING

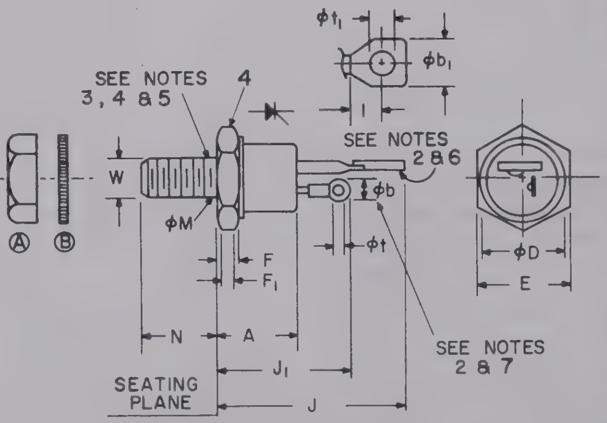
(COMPLIES WITH JEDEC TO-48)

NOTES:

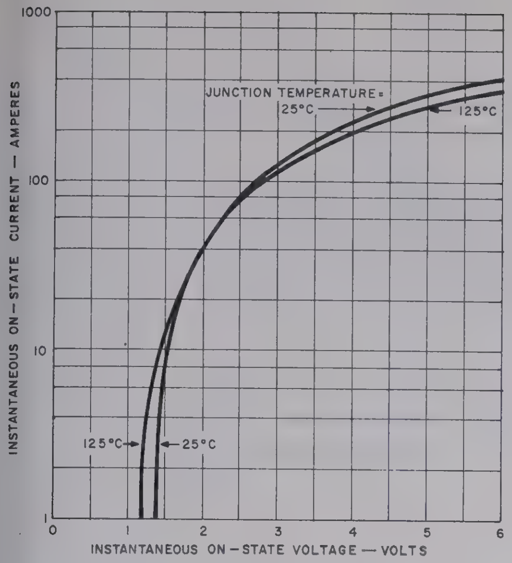
1. Complete threads to extend within 2½ threads of seating plane. Diameter of unthreaded portion. 249" (6.32MM) Maximum, .220" (5.59MM) Minimum.
2. Angular orientation of these terminals is undefined.
3. ¼-28 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter .2268" (5.76MM), minimum pitch diameter .2225" (5.66MM), reference: screw thread standards for Federal Service 1957, Handbook H28, 1957, P1.
4. A chamfer (or undercut) on one or both ends of hexagonal portions is optional.
5. Case is anode connection.
6. Large terminal is cathode connection.
7. Small terminal is gate connection.
8. Insulating kit available upon request.

A. ¼-28 steel nut, Ni. plated, .178 min. thk.

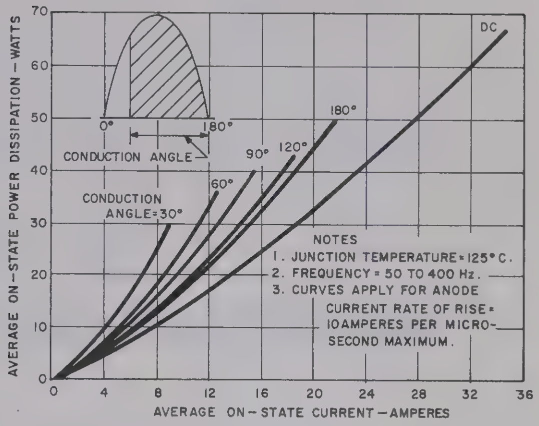
B. Ext. tooth lockwasher, steel, Ni. plated, .023 min. thk.



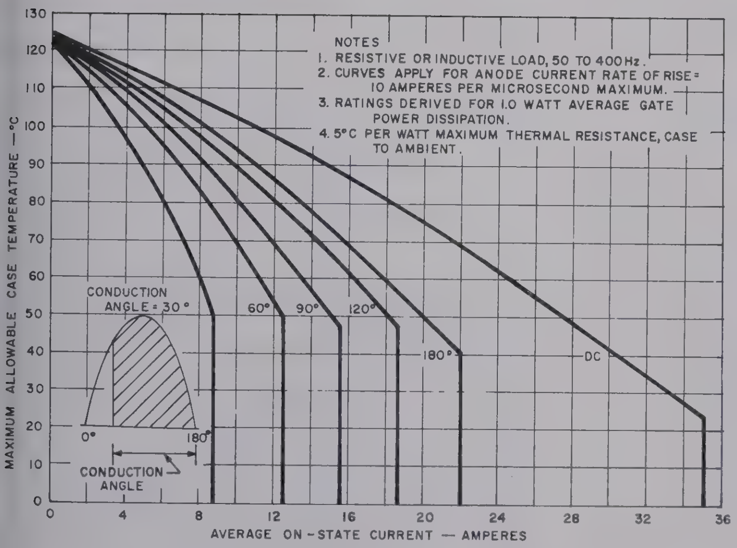
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	.330	.505	8.38	12.83	
φb	.115	.140	2.92	3.56	2
φb₁	.210	.300	5.33	7.62	2
φD		.544		13.82	
E	.544	.562	13.82	14.27	
F	.113	.200	2.87	5.08	4
F₁	.060		1.52		
J		1.193		30.30	
J₁		.875		22.23	
I	.120		3.05		
φM					1
N	.422	.453	10.72	11.51	
φt	.060	.075	1.52	1.91	
φt₁	.125	.165	3.18	4.19	
W					3



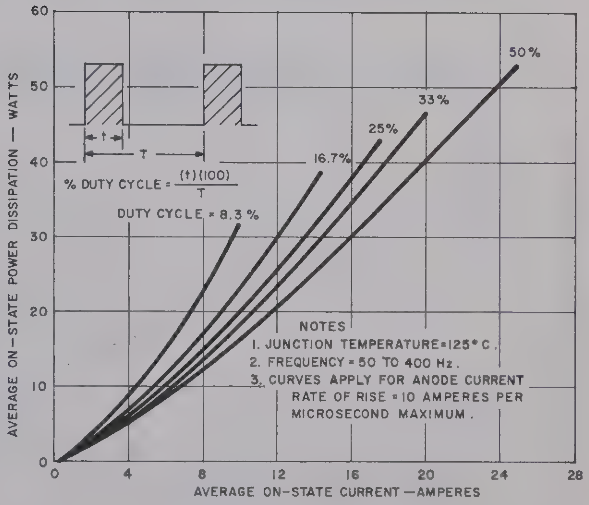
1. MAXIMUM ON-STATE CHARACTERISTICS



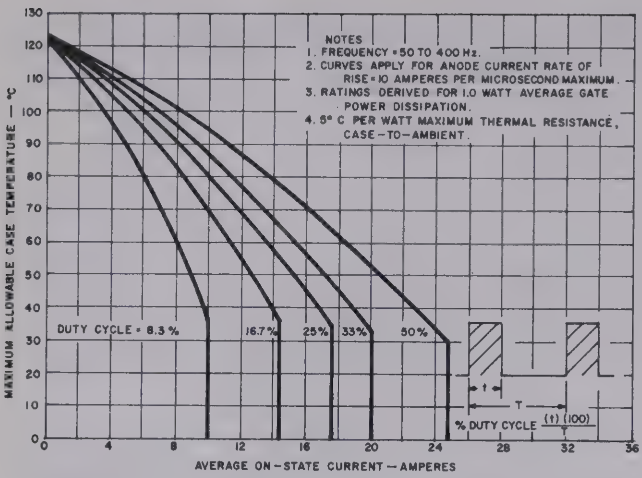
2. MAXIMUM ON-STATE POWER DISSIPATION FOR HALF-WAVE RECTIFIED SINE WAVE OF CURRENT



3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR HALF-WAVE RECTIFIED SINE WAVE OF CURRENT

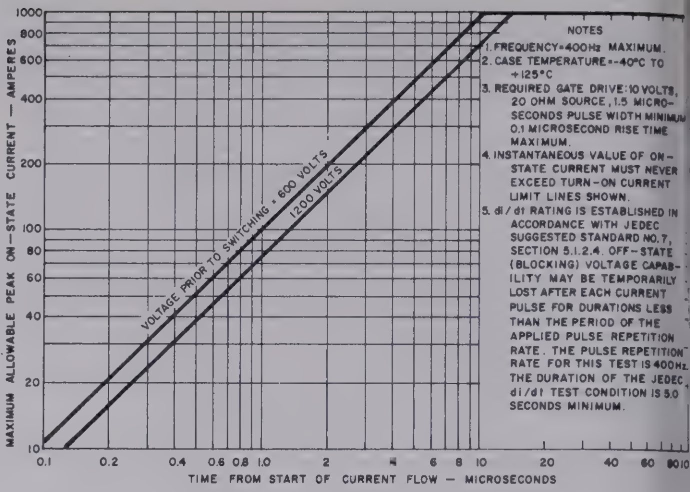


4. MAXIMUM ON-STATE POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



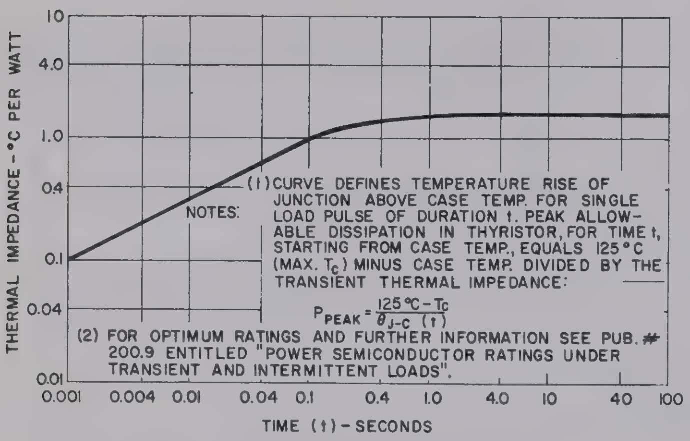
NOTES
1. FREQUENCY = 50 TO 400 Hz.
2. CURVES APPLY FOR ANODE CURRENT RATE OF RISE = 10 AMPERES PER MICROSECOND MAXIMUM.
3. RATINGS DERIVED FOR 1.0 WATT AVERAGE GATE POWER DISSIPATION.
4. 5° C PER WATT MAXIMUM THERMAL RESISTANCE, CASE-TO-AMBIENT.

5. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



NOTES
1. FREQUENCY = 400Hz MAXIMUM.
2. CASE TEMPERATURE = -40°C TO +125°C
3. REQUIRED GATE DRIVE: 10 VOLTS, 20 OHM SOURCE, 1.5 MICROSECONDS PULSE WIDTH MINIMUM 0.1 MICROSECOND RISE TIME MAXIMUM.
4. INSTANTANEOUS VALUE OF ON-STATE CURRENT MUST NEVER EXCEED TURN-ON CURRENT LIMIT LINES SHOWN.
5. dI/dt RATING IS ESTABLISHED IN ACCORDANCE WITH JEDEC SUGGESTED STANDARD NO. 7, SECTION 5.1.2.4. OFF-STATE (BLOCKING) VOLTAGE CAPABILITY MAY BE TEMPORARILY LOST AFTER EACH CURRENT PULSE FOR DURATIONS LESS THAN THE PERIOD OF THE APPLIED PULSE REPETITION RATE. THE PULSE REPETITION RATE FOR THIS TEST IS 400Hz. THE DURATION OF THE JEDEC di/dt TEST CONDITION IS 5.0 SECONDS MINIMUM.

6. TURN-ON CURRENT LIMIT



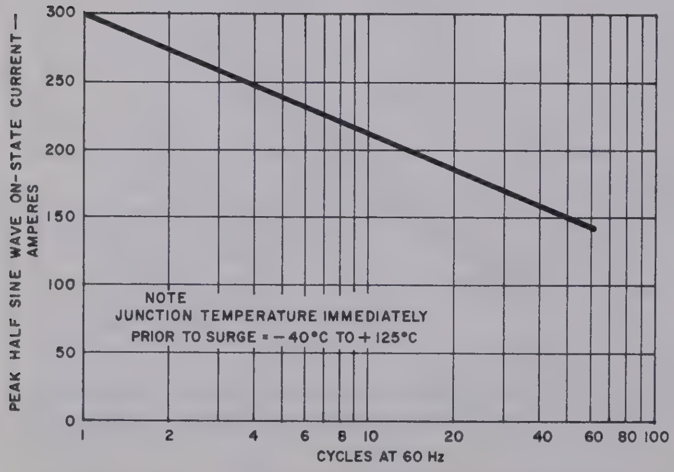
NOTES:

(1) CURVE DEFINES TEMPERATURE RISE OF JUNCTION ABOVE CASE TEMP. FOR SINGLE LOAD PULSE OF DURATION t. PEAK ALLOWABLE DISSIPATION IN THYRISTOR, FOR TIME t, STARTING FROM CASE TEMP., EQUALS 125 °C (MAX. T_C) MINUS CASE TEMP. DIVIDED BY THE TRANSIENT THERMAL IMPEDANCE:

$$P_{PEAK} = \frac{125\,^{\circ}C - T_C}{\theta_{J-C}\ (t)}$$

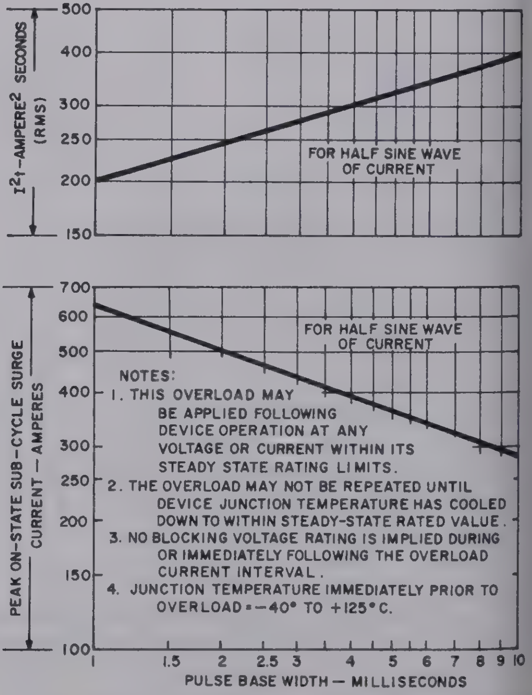
(2) FOR OPTIMUM RATINGS AND FURTHER INFORMATION SEE PUB. # 200.9 ENTITLED "POWER SEMICONDUCTOR RATINGS UNDER TRANSIENT AND INTERMITTENT LOADS".

7. MAXIMUM TRANSIENT THERMAL IMPEDANCE, JUNCTION-TO-CASE



NOTE
JUNCTION TEMPERATURE IMMEDIATELY PRIOR TO SURGE = −40°C TO +125°C

8. MAXIMUM ALLOWABLE SURGE (NON-REPETITIVE) ON-STATE CURRENT



NOTES:
1. THIS OVERLOAD MAY BE APPLIED FOLLOWING DEVICE OPERATION AT ANY VOLTAGE OR CURRENT WITHIN ITS STEADY STATE RATING LIMITS.
2. THE OVERLOAD MAY NOT BE REPEATED UNTIL DEVICE JUNCTION TEMPERATURE HAS COOLED DOWN TO WITHIN STEADY-STATE RATED VALUE.
3. NO BLOCKING VOLTAGE RATING IS IMPLIED DURING OR IMMEDIATELY FOLLOWING THE OVERLOAD CURRENT INTERVAL.
4. JUNCTION TEMPERATURE IMMEDIATELY PRIOR TO OVERLOAD = −40° TO +125° C.

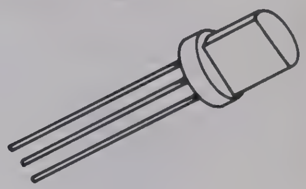
9. MAXIMUM ALLOWABLE SUB-CYCLE SURGE (NON-REPETITIVE) ON-STATE CURRENT AND I^2T RATING

Silicon
Transistors

NPN

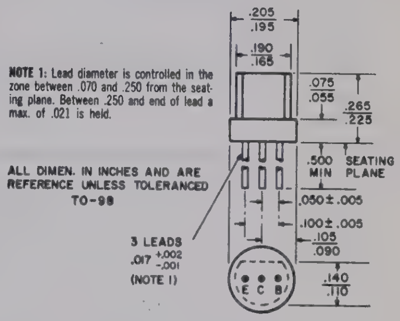
2N5232,A

The General Electric 2N5232 and 2N5232A are NPN silicon, planar, epitaxial, passivated transistors designed especially for low noise preamplifier and small signal industrial amplifier applications. The units feature low collector saturation voltage, tight beta control and excellent low noise characteristics. The 2N5232A includes a noise figure specification.



absolute maximum ratings: (25°C) (unless otherwise specified)

oltages		
Collector to Emitter	V_{CEO}	50 V
Emitter to Base	V_{EBO}	5 V
Collector to Base	V_{CBO}	70 V
urrent		
Collector (Steady State) *	I_C	100 mA
issipation		
Total Power (Free Air at 25°C) †	P_T	360 mW
emperature		
Storage	T_{stg}	−55 to +150°C
Operating	T_J	+125°C
Lead Soldering, 1/16" ± 1/32" from case for 10 seconds maximum	T_L	+260°C



NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED
TO-98

Determined from power limitations due to saturation voltages at this current.
Derate 3.6 mW/°C increase in ambient temperature above 25°C.

electrical characteristics: (25°C) (unless otherwise specified)

tatic Characteristics

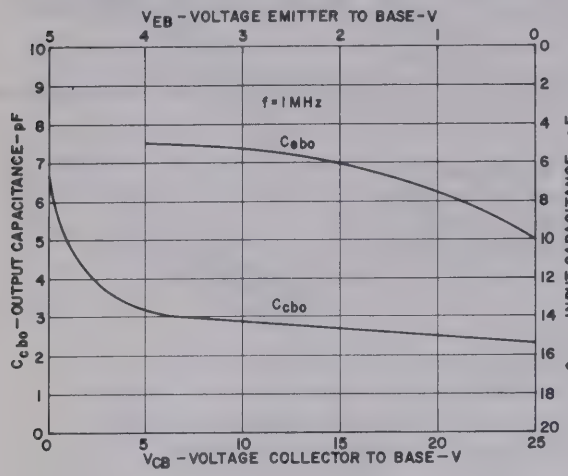
		Min.	Typ.	Max.	
ollector Cutoff Current ($V_{CB} = 50V$)	I_{CBO}			30	nA
($V_{CB} = 50V$, $T_A = 100°C$)	I_{CBO}			10	μA
ollector Cutoff Current ($V_{CB} = 50V$)	I_{CES}			30	nA
mitter Cutoff Current ($V_{EB} = 5V$)	I_{EBO}			50	nA
orward Current Transfer Ratio ($V_{CE} = 5V$, $I_C = 2$ mA)	h_{FE}	250		500	
($V_{CE} = 5V$, $I_C = 100\ \mu A$)	h_{FE}		170‡		
ollector Emitter Breakdown Voltage ($I_C = 10$ mA)	$V_{(BR)CEO}$¶	50			Volts
ollector Base Breakdown Voltage ($I_C = 10\ \mu A$)	$V_{(BR)CBO}$	70			Volts
mitter Base Breakdown Voltage ($I_E = 10\ \mu A$)	$V_{(BR)EBO}$	5			Volts
ollector Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)	$V_{CE(sat)}$¶			.125	Volts
ase Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)	$V_{BE(sat)}$¶			.78	Volts
ase Emitter Voltage ($V_{CE} = 10V$, $I_C = 2$ mA)	V_{BE}	0.5		0.9	Volts

ynamic Characteristics

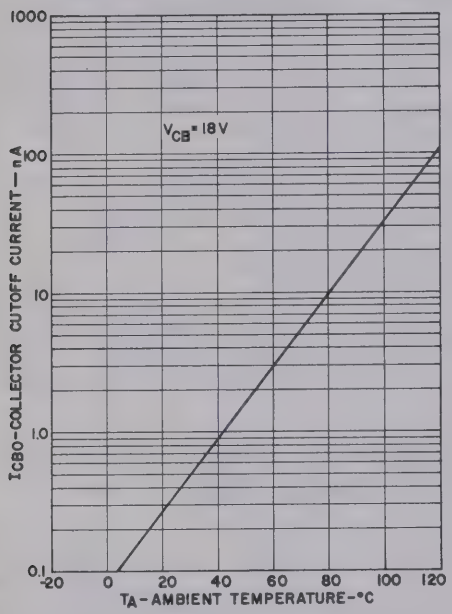
		Min.	Typ.	Max.	
orward Current Transfer Ratio ($V_{CE} = 5V$, $I_C = 2$ mA, f = 1 kHz)	h_{fe}	250		750	
utput Capacitance, Common Base ($V_{CB} = 10V$, $I_E = 0$, f = 1 MHz)	C_{cb}			4.0	pF
oise Figure ($I_C = 100\ \mu A$, $V_{CE} = 5V$, $R_g = 5\ k\Omega$, f = 1 kHz, BW = 15.7 kHz) (2N5232A only)	NF		1.9	5	dB

Typically, a minimum of 95% of the distribution is above this value.
Pulse conditions: 300 μsec. duration, 2% duty cycle.

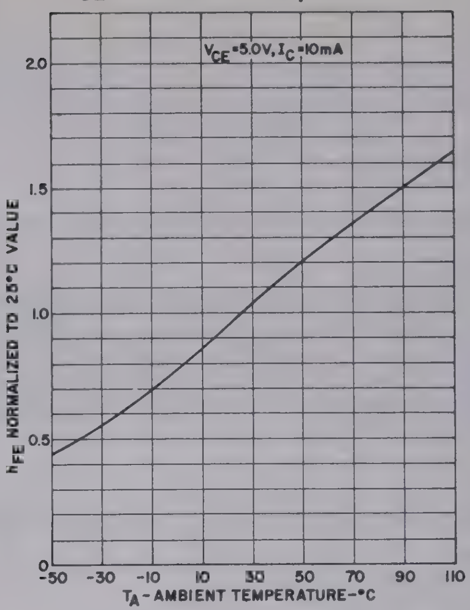
2N5232,A



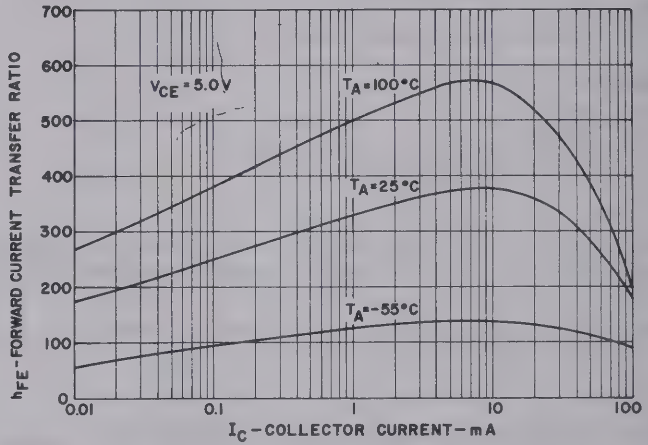
Input and Output Capacitance vs. Bias Voltage



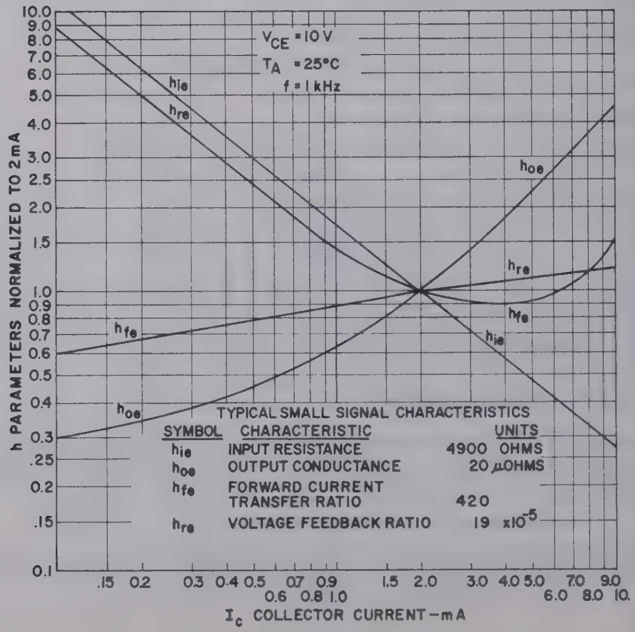
I_{CBO} vs. Ambient Temperature



h_{FE} vs. Ambient Temperature



Forward Current Transfer Ratio vs. Collector Current



Normalized h Parameters vs. I_C

TYPICAL SMALL SIGNAL CHARACTERISTICS

SYMBOL	CHARACTERISTIC		UNITS
h_{ie}	INPUT RESISTANCE	4900	OHMS
h_{oe}	OUTPUT CONDUCTANCE	20	μOHMS
h_{fe}	FORWARD CURRENT TRANSFER RATIO	420	
h_{re}	VOLTAGE FEEDBACK RATIO	19	$\times 10^{-5}$

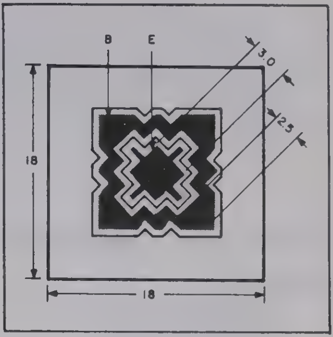
Silicon
Transistor Chips

NPN

2N5232 (Chip)

(M26P-X517)

This General Electric NPN silicon planar passivated epitaxial transistor chip s designed primarily for low noise preamplifier and small signal amplifier applica-ions. The chip features low collector saturation voltage, tight Beta control and xcellent low noise characteristics.



General specifications:
- Gold collector contact backing, minimum thickness—3000Å
- Aluminum base and emitter contact metalization
- Maximum conditions for mounting chips—425°C for 5 minutes (Max.) in an inert atmosphere
- Shipping containers: Glass vials sealed with a nitrogen back-fill
  Maximum of 10k chips per vial
  Egg crate containers available at extra cost
- Chip drawing dimensions are in mils
- Chip thickness $= 5.4 \begin{smallmatrix}+0.8\\-0.9\end{smallmatrix}$ mils

absolute maximum ratings: ($T_A = 25°C$)

	Symbol		
Voltages			
Collector to Base	V_{CBO}	70	V
Collector to Emitter	V_{CEO}	50	V
Emitter to Base	V_{EBO}	5	V
Current			
Collector	I_C	100	mA
Temperature			
Storage	T_{STG}	−65°C to +200°C	
Operating	T_J	−65°C to +200°C	

electrical characteristics: 100% Probe ($T_A = 25°C$)

Tested at outgoing acceptance to a 10% LTPD with a maximum accept number of 3.

	Symbol	Min.	Max.	
Collector Base Breakdown Voltage ($I_C = 10\ \mu A$)	BV_{CBO}	70	—	V
Collector Emitter Breakdown Voltage ($I_C = 10$ mA)	BV_{CEO}	50	—	V
Emitter Base Breakdown Voltage ($I_E = 10\ \mu A$)	BV_{EBO}	5	—	V
Collector Cutoff Current ($V_{CB} = 50V$)	I_{CBO}	—	50	nA
Forward Current Transfer Ratio ($I_C = 2$ mA, $V_{CE} = 5V$)	h_{FE}	250	500	

specifications: ($T_A = 25°C$)

Product yield is at least 93% to each of the following parameters:

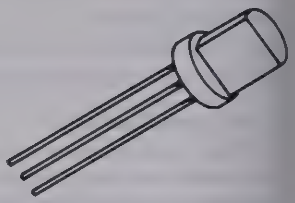
	Symbol	Min.	Max.	
Collector Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)	$V_{CE(SAT)}$	—	0.125	V
Base Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)	$V_{BE(SAT)}$	—	0.78	V
Forward Current Transfer Ratio ($I_C = 2$ mA, $V_{CE} = 5V$, f = 1 kHz)	h_{fe}	250	750	
Forward Current Transfer Ratio ($I_C = 2$ mA, $V_{CE} = 10V$, f = 10 MHz)	$\lvert h_{fe} \rvert$	18.5	31	dB
Gain Bandwidth Product ($I_C = 2$ mA, $V_{CE} = 10V$, f = 10 MHz)	f_t	90	350	MHz
Collector Base Capacitance ($V_{CB} = 10V$, f = 1 MHz)	C_{cb}	1	4	pF

Silicon
Transistors

NPN

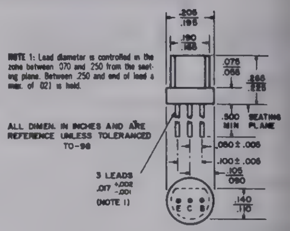
2N5249,A

The General Electric 2N5249 and 2N5249A are NPN silicon, planar, epitaxial, passivated transistors designed especially for low noise preamplifier and small signal industrial amplifier applications. The units feature low collector saturation voltage, tight beta control and excellent low noise characteristics. The 2N5249A includes a noise figure specification.



absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	50	V
Emitter to Base	V_{EBO}	5	V
Collector to Base	V_{CBO}	70	V
Current			
Collector (Steady State)*	I_C	100	mA
Dissipation			
Total Power (Free Air at 25°C)†	P_T	360	mW
Total Power (Free Air at 55°C)†	P_T	260	mW
Temperature			
Storage	T_{stg}	−55 to +150°C	
Operating	T_J	+125°C	
Lead Soldering, 1/16" ± 1/32" from case for 10 seconds maximum	T_L	+260°C	


NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.
ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED
TO-98
.205
.195
.190
.185
.075
.055
.265
.225
.500 MIN
SEATING PLANE
.050 ± .005
.100 ± .005
.105
.090
3 LEADS
.017 +.002 −.001
(NOTE 1)
.140
.110
E C B

*Determined from power limitations due to saturation voltages at this current.
†Derate 3.3 mW/°C increase in ambient temperature above 25°C.

electrical characteristics: (25°C) (unless otherwise specified)

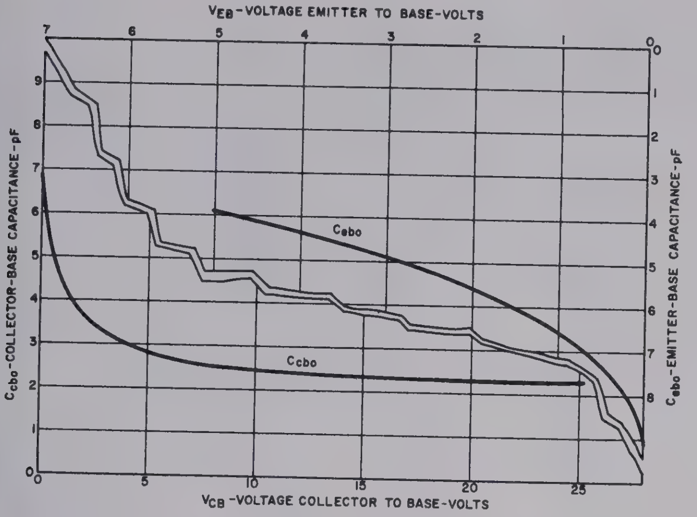
Static Characteristics		**Min.**	**Typ.**	**Max.**	
Collector Cutoff Current ($V_{CB} = 50V$)	I_{CBO}			30	nA
($V_{CB} = 50V$, $T_A = 100°C$)	I_{CBO}			10	μA
Collector Cutoff Current ($V_{CB} = 50V$)	I_{CES}			30	nA
Emitter Cutoff Current ($V_{EB} = 5V$)	I_{EBO}			50	nA
Forward Current Transfer Ratio ($V_{CE} = 5V$, $I_C = 2$ mA)	h_{FE}	400		800	
($V_{CE} = 5V$, $I_C = 100\ \mu A$)	h_{FE}		300‡		
Collector Emitter Breakdown Voltage ($I_C = 10$ mA)	$V_{(BR)CEO}$¶	50			Volts
Collector Base Breakdown Voltage ($I_C = 10\ \mu A$)	$V_{(BR)CBO}$	70			Volts
Emitter Base Breakdown Voltage ($I_E = 10\ \mu A$)	$V_{(BR)EBO}$	5			Volts
Collector Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)	$V_{CE(sat)}$¶			.125	Volts
Base Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)	$V_{BE(sat)}$¶			.78	Volts
Base Emitter Voltage ($V_{CE} = 10V$, $I_C = 2$ mA)	V_{BE}	0.5		0.9	Volts

Dynamic Characteristics

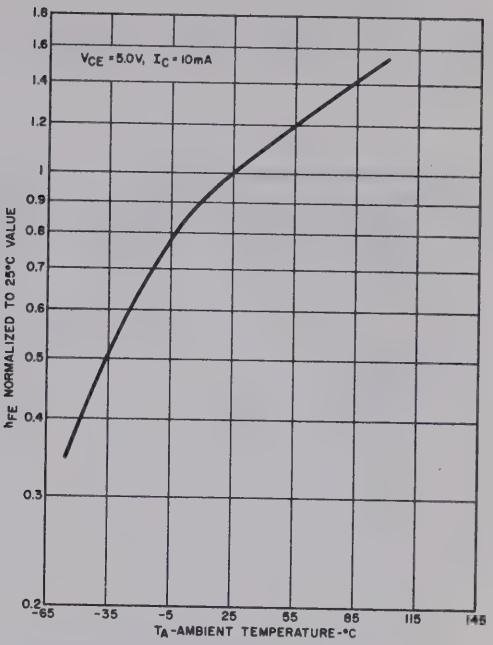
Forward Current Transfer Ratio ($V_{CE} = 5V$, $I_C = 2$ mA, f = 1 kHz)	h_{fe}	400		1200	
Output Capacitance, Common Base ($V_{CB} = 10V$, $I_E = 0$, f = 1 MHz)	C_{cb}			4.0	pF
Noise Figure ($I_C = 100\ \mu A$, $V_{CE} = 5V$, $R_g = 5$ kΩ, f = 1 kHz, BW = 15.7 kHz) (2N5249A only)	NF			3	dB

‡Typically, a minimum of 95% of the distribution is above this value.
¶Pulse conditions: 300 μsec. duration, 2% duty cycle.

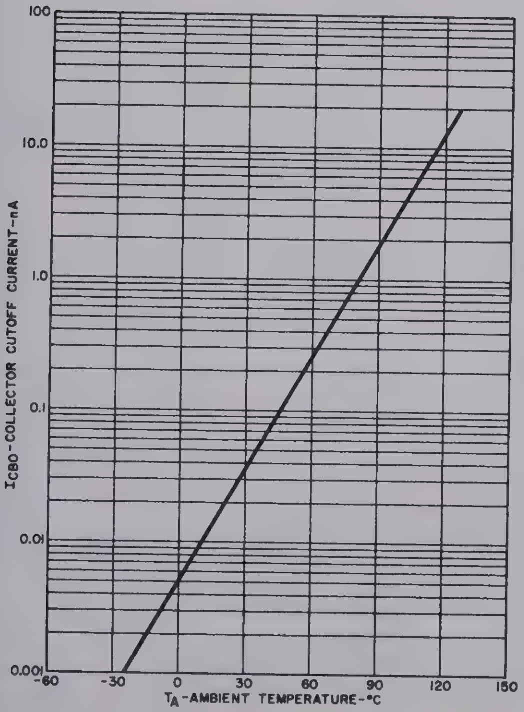
Input and Output Capacitance vs. Bias Voltage



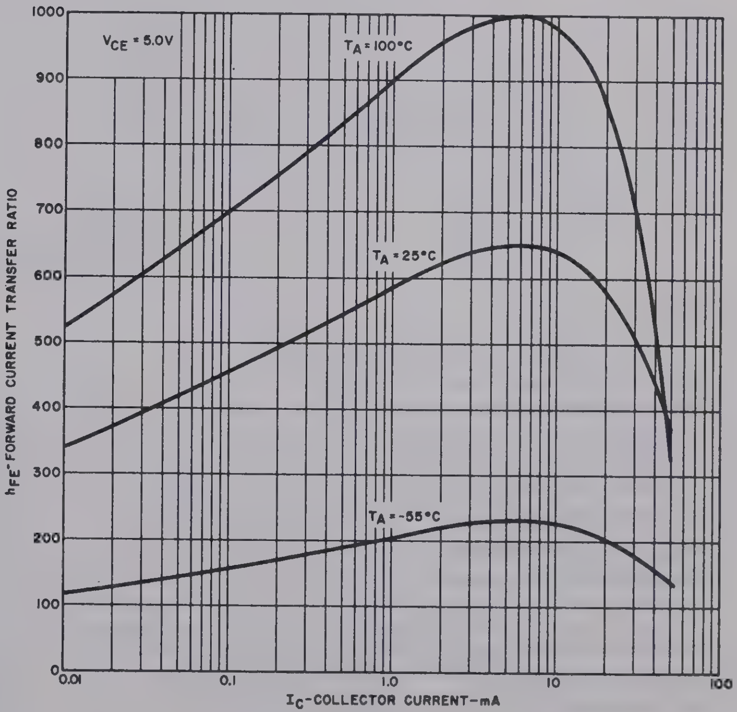
h_{FE} vs. Ambient Temperature



I_{CBO} vs. Ambient Temperature



Forward Current Transfer Ratio vs. Collector Current

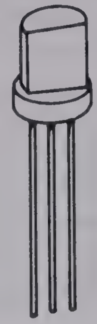


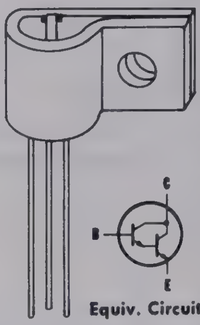
Silicon
Transistors

NPN

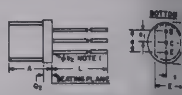
2N5305,6,6A

The General Electric 2N5305, 2N5306 and 2N5306A are NPN, silicon, planar, epitaxial, passivated Darlington monolithic amplifiers. These devices are especially suited for preamplifier input stages requiring input impedances of several megohms or extremely low level, high gain, low noise amplifier applications. Additional applications include medium speed switching circuits in consumer and industrial control applications.



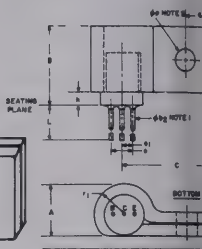


Equiv. Circuit



SYMBOL	INCHES MIN	INCHES MAX.	MILLIMETERS MIN
A	.170	.266	4.32
φb2	.016	.019	.406
φD	.165	.205	4.19
E	.110	.156	2.79
e	.095	.106	2.41
e1	.045	.055	1.14
L	.500		12.70
Q2		.079	
s	.080	.115	2.03

NOTE 1: LEAD DIAMETER IS CONTROLLED IN ZONE BETWEEN .070 AND .250 FROM THE PLANE BETWEEN .250 AND END OF LEAD OF .021 IS HELD



SYMBOL	INCHES MIN	INCHES MAX.	MILLIMETERS MIN.
A		.263	
B		.438	
φb2	.016	.019	.407
C		.520	
e	.095	.105	2.42
e1	.045	.056	1.15
F		.140	
h		.103	
L	.500		12.70
φP		.143	
q	.156 REF		3.96
q1	.187 REF		2.21
r1		.186	

NOTE 1: LEAD DIAMETER IS CONTROLLED IN BETWEEN .070 AND .250 FROM THE SEATING BETWEEN .250 AND END OF LEAD A MAX IS HELD

NOTE 2: HOLE FOR #4 SCREW - WILL ACC

ORDER HEATSINK VERSIONS AS: HS5305 HS5306

absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Base	V_{CBO}	25	Volts
Collector to Emitter	V_{CEO}	25	Volts
Emitter to Base	V_{EBO}	12	Volts
Current			
Collector (Steady State)	I_C	300	mA
Collector (Pulsed)*	I_C	500	mA
Base (Steady State)	I_B	50	mA
Dissipation			
Total Power ($T_A \leq 25°$ C)†	P_T	400	mW
Total Power with Heatsink ($T_A \leq 25°$ C)††	P_T	600	mW
Total Power with Heatsink ($T_C \leq 25°$ C)†††	P_T	900	mW
Temperature			
Storage	T_{stg}	−65 to +150° C	
Operating	T_J	−65 to +125° C	
Lead, 1/16" ± 1/32" from case for 10 sec. max.	T_L	+260° C	

*Pulse conditions: 300 μsec. pulse width, 2% duty cycle.

†Derate 4.0 mW/° C for increase in ambient temperature above 25° C.

††Derate 6.0 mW/° C for increase in ambient temperature above 25° C.

†††Derate 9.0 mW/° C for increase in case temperature above 25° C.

STATIC CHARACTERISTICS			Min.	Max.	
Collector to Base Breakdown Voltage ($I_C = 0.1\ \mu A, I_E = 0$)		$V_{(BR)CBO}$	25		Volts
Collector to Emitter Breakdown Voltage ($I_C = 10mA, I_B = 0$)		$V_{(BR)CEO}$	25		Volts
Emitter to Base Breakdown Voltage ($I_E = 0.1\mu A, I_E = 0$)		$V_{(BR)EBO}$	12		Volts
Forward Current Transfer Ratio					
($V_{CE} = 5V, I_C = 2mA$)	2N5305	h_{FE}	2000	20000	
($V_{CE} = 5V, I_C = 100mA$)	2N5305	h_{FE}	6000		
($V_{CE} = 5V, I_C = 2mA$)	2N5306, A	h_{FE}	7000	70000	
($V_{CE} = 5V, I_C = 100mA$)	2N5306, A	h_{FE}	20000		
Collector Cutoff Current					
($V_{CB} = 25V, I_E = 0$)		I_{CBO}		100	nA
($V_{CB} = 25V, I_E = 0, T_A = 100°$ C)		I_{CBO}		20	μA
Emitter Cutoff Current ($V_{EB} = 12V, I_C = 0$)		I_{EBO}		100	nA
Collector Emitter Saturation Voltage ($I_C = 200mA, I_B = 0.2mA$)		$V_{CE(SAT)}$		1.4	Volts
Base Emitter Saturation Voltage ($I_C = 200mA, I_B = 0.2mA$)		$V_{BE(SAT)}$		1.6	Volts
Base Emitter Voltage ($V_{CE} = 5V, I_C = 200mA$)		V_{BE}		1.5	Volts

DYNAMIC CHARACTERISTICS			Min.	Typ.	Max.	
Forward Current Transfer Ratio						
($V_{CE} = 5V, I_C = 2mA, f = 1kHz$)	2N5305	h_{fe}	2000			
($V_{CE} = 5V, I_C = 2mA, f = 1kHz$)	2N5306, A	h_{fe}	7000			
($V_{CE} = 5V, I_C = 2mA, f = 10$ MHz)		$\|h_{fe}\|$	15.6			dB
Gain Bandwidth Product ($V_{CE} = 5V, I_C = 2mA, f = 10$ MHz)		f_T	60			MHz
Input Impedance ($V_{CE} = 5V, I_C = 2mA, f = 1$ kHz)		h_{ie}		650		kohms
Collector Base Capacitance ($V_{CB} = 10V, f = 1$ MHz)		C_{cb}		7.6	10	pF
Emitter Capacitance ($V_{EB} = 0.5V, f = 1$ MHz)		C_{eb}		10.5		pF

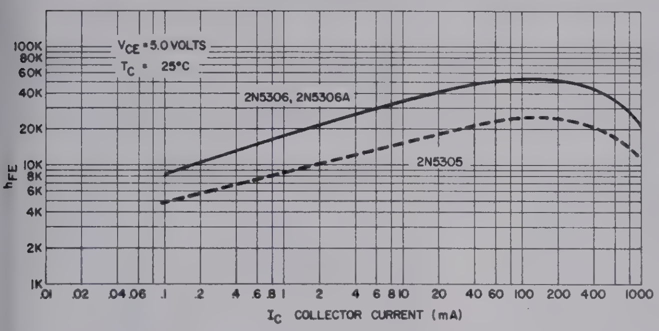
N5306A only

			Min.	Typ.	Max.	Units
oise Voltage	($I_C = 0.6$ mA, $V_{CE} = 5$V, $R_G = 160$kΩ f = 10 Hz to 10kHz, B.W. = 15.7 kHz)	$e_{\bar{n}}$		195	230	n V/√Hz

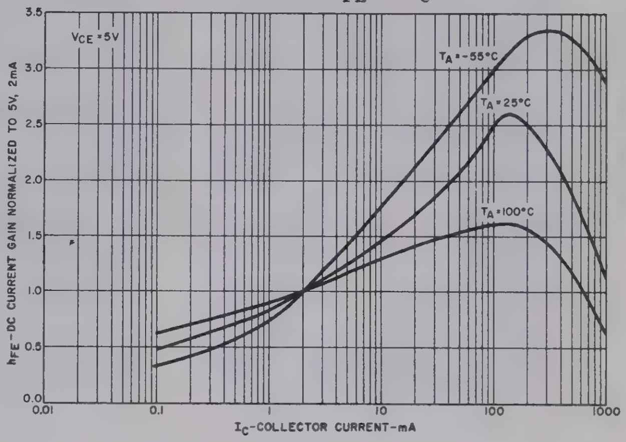
OTE: As measured on a Quan-Tech Model 2283/2181M test set with 10 Hz filter modified by Quan-Tech to a wideband (f = 10 Hz to 10 kHz, B.W. = 15.7 kHz) filter.

Typical Curves

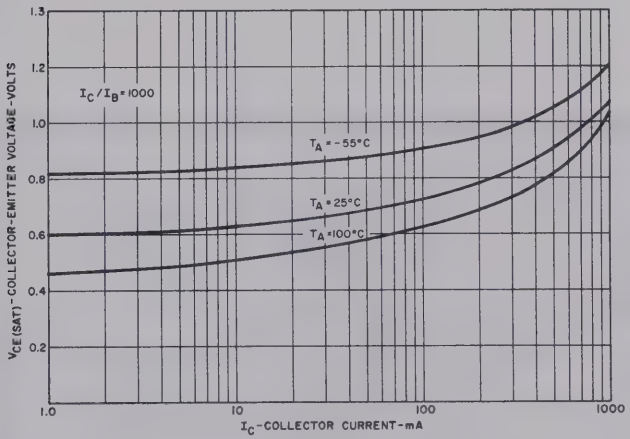
Typical h_{FE} vs. I_C



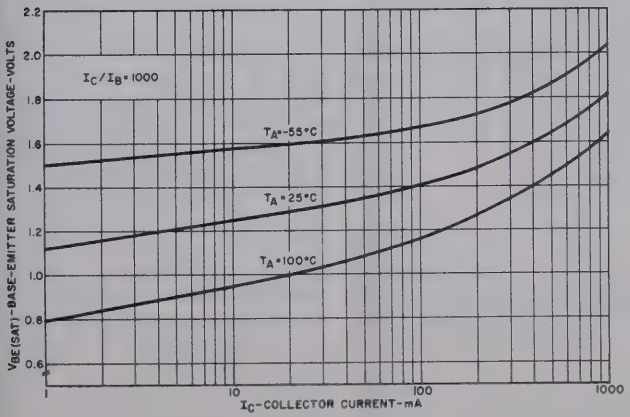
Normalized h_{FE} vs. I_C



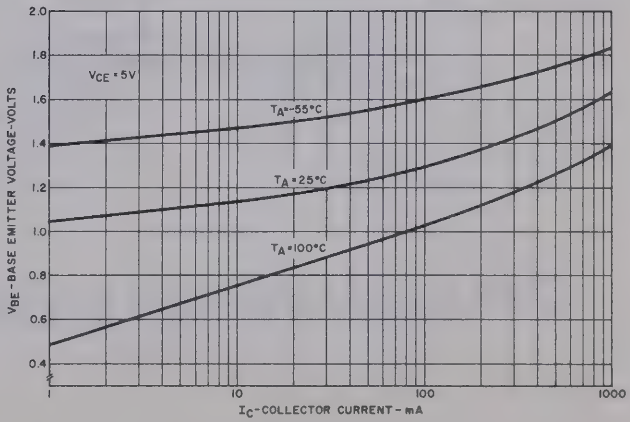
V_{CE} vs. I_C



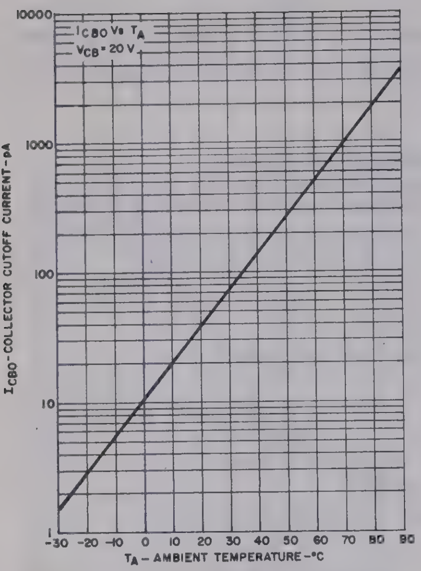
$V_{BE(SAT)}$ vs. I_C



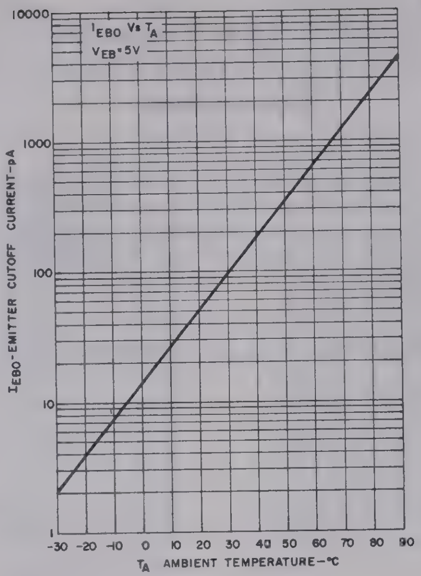
Transconductance Characteristic, V_{BE} vs. I_C



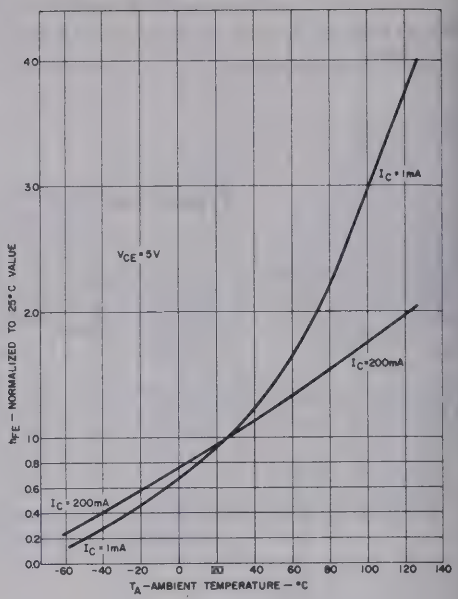
I_{CBO} vs. T_A



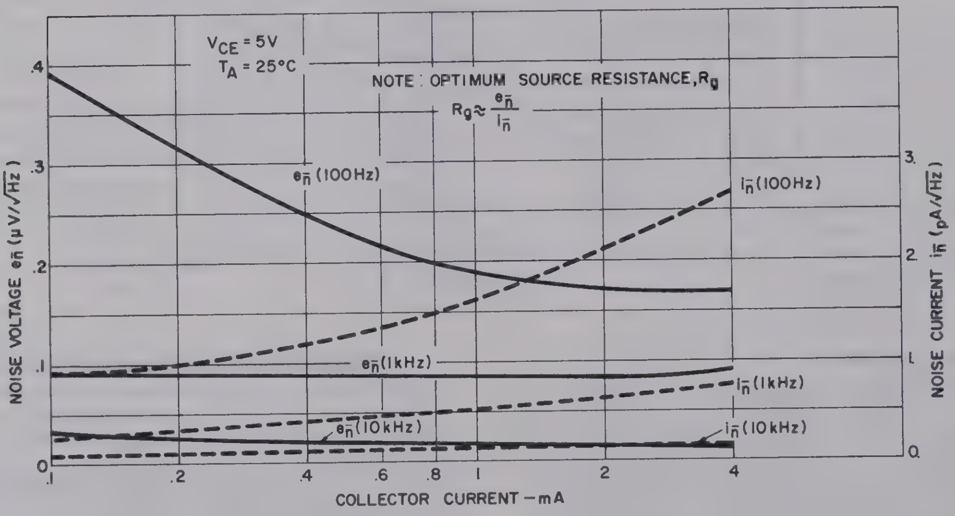
I_{EBO} vs. T_A



h_{FE} vs. T_A

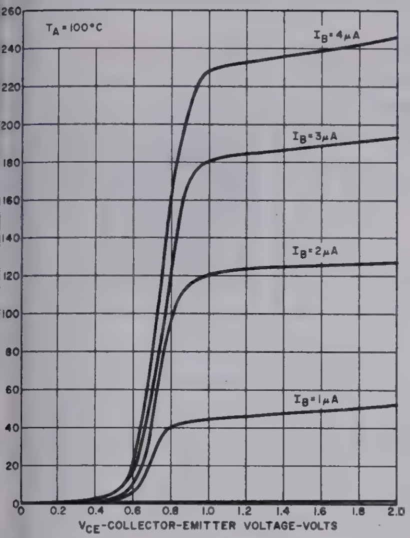


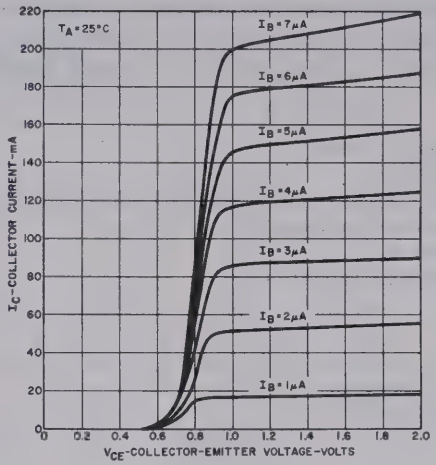
Equivalent Input Noise Voltage and Current vs. Bias Current

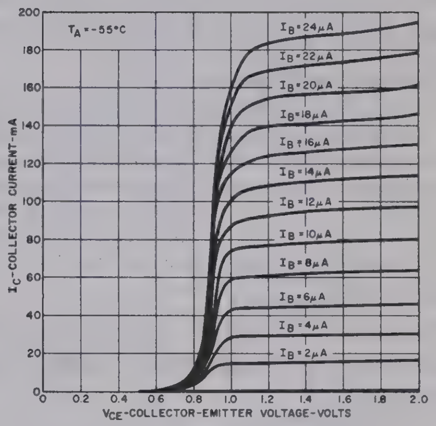


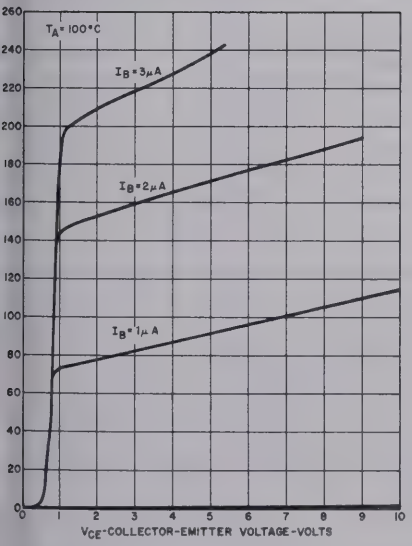
NOTE: Due to the noise characteristics of this device versus frequency, calculation of noise figure (N.F.) from $e_{\bar{n}}$, $i_{\bar{n}}$ values is not accurate [as is the case with field effect transistors (F.E.T.'s)].

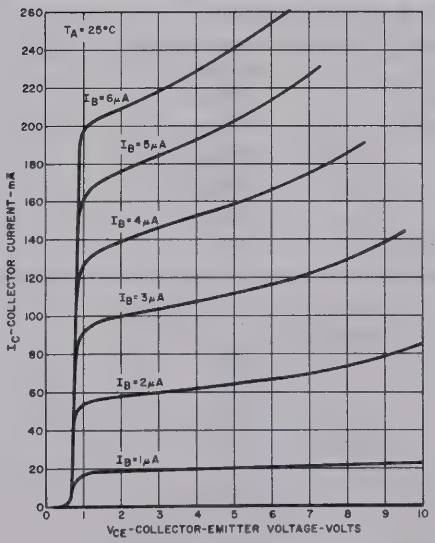
Typical Collector Characteristics

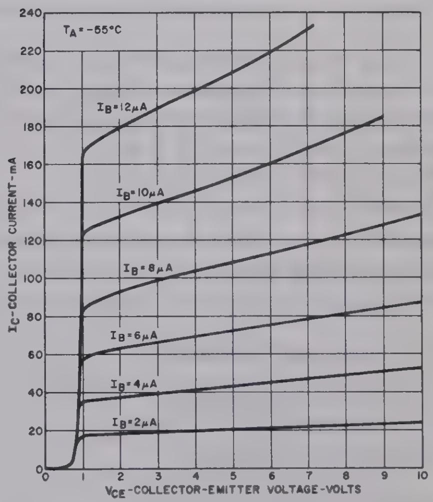












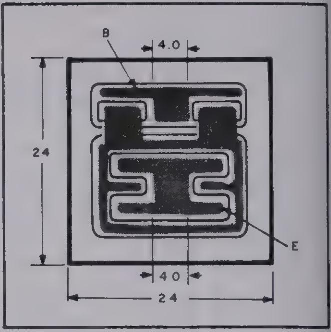
Silicon
Darlington Chips

NPN

2N5306 (Chip)

(M73P-X502)

This General Electric NPN silicon planar passivated epitaxial monolithic Darlington chip is especially suited for preamplifier input stages requiring impedances of several megohms, or extremely low-level, high gain, low noise amplifier applications. The chip can also be used in medium-speed switching control circuits.



General specifications:

- Gold collector contact backing, minimum thickness—3000Å
- Aluminum base and emitter contact metalization
- Maximum conditions for mounting chips—425°C for 5 minutes (Max.) in an inert atmosphere
- Shipping containers: Glass vials sealed with a nitrogen back-fill
  Maximum of 10k chips per vial
  Egg crate containers available at extra cost
- Chip drawing dimensions are in mils
- Chip thickness = 5.4 $^{+0.8}_{-0.9}$ mils

absolute maximum ratings: ($T_A = 25°C$)

	Symbol		
Voltages			
Collector to Base	V_{CBO}	25	V
Collector to Emitter	V_{CEO}	25	V
Emitter to Base	V_{EBO}	12	V
Current			
Collector (steady state)	I_C	200	mA
Collector (pulsed)*	I_C	500	mA
Base (steady state)	I_B	50	mA
Temperature			
Storage	T_{STG}	−65°C to +200°C	
Operating	T_J	−65°C to +200°C	

*Pulse conditions: pulse width ≤300 μsec, duty cycle ≤2%.

electrical characteristics: 100% Probe ($T_A = 25°C$)

Tested at outgoing acceptance to a 10% LTPD with a maximum accept number of 3.

	Symbol	Min.	Max.	
Collector Base Breakdown Voltage ($I_C = 0.1\ \mu A$)	BV_{CBO}	25	—	V
Collector Emitter Breakdown Voltage ($I_C = 10$ mA)	BV_{CEO}	25	—	V
Emitter Base Breakdown Voltage ($I_E = 0.1\ \mu A$)	BV_{EBO}	12	—	V
Collector Cutoff Current ($V_{CB} = 25V$)	I_{CBO}	—	100	nA
Emitter Cutoff Current ($V_{EB} = 12V$)	I_{EBO}	—	100	nA
Forward Current Transfer Ratio ($I_C = 2$ mA, $V_{CE} = 5V$)	h_{FE}	7K	70K	

specifications: ($T_A = 25°C$)

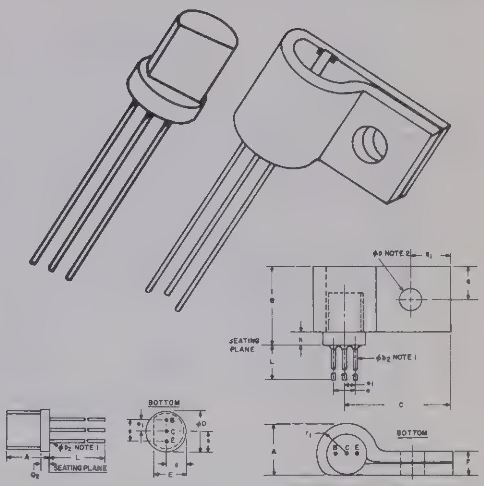
Product yield is at least 93% to each of the following parameters:

	Symbol	Min.	Max.	
Forward Current Transfer Ratio ($I_C = 100$ mA, $V_{CE} = 5V$)	h_{FE}	20K	—	
Collector Saturation Voltage ($I_C = 200$ mA, $I_B = 0.2$ mA)	$V_{CE(SAT)}$	—	1.4	V
Base Saturation Voltage ($I_C = 200$ mA, $I_B = 0.2$ mA)	$V_{BE(SAT)}$	—	1.6	V
Forward Current Transfer Ratio ($I_C = 2$ mA, $V_{CE} = 5V$, f = 10 MHz)	$\|h_{fe}\|$	15.6	—	dB
Gain Bandwidth Product ($I_C = 2$ mA, $V_{CE} = 5V$, f = 10 MHz)	f_t	60	—	MHz
Input Impedance ($I_C = 2$ mA, $V_{CE} = 5V$, f = 1 KHz)	h_{ie}	50K	—	Ohms
Collector Base Capacitance ($V_{CB} = 10V$, f = .1 MHz)	C_{cb}	—	10	pF

Silicon
Transistors

NPN
2N5307,8,8A

he General Electric 2N5307, 2N5308 and 2N5308A are NPN, silicon, planar, epitaxial, passivated Dar-ngton monolithic amplifiers. These devices are especially suited for preamplifier input stages requiring ıput impedances of several megohms or extremely low level, high gain, low noise amplifier applications. dditional applications include medium speed switching circuits in consumer and industrial control appliations.



SYMBOL	INCHES		MILLIMETERS	
	MIN	MAX.	MIN.	MAX.
A	.170	265	4.32	6.73
ϕb2	.016	019	406	483
ϕD	.165	.205	4.19	5 21
E	.110	.155	2 79	3.94
e	.095	.105	2.41	2 67
e1	.045	055	1 14	1 40
L	500		12.70	
Q2		.075		1.90
s	.080	.115	2.03	2.92

NOTE 1: LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .070 AND 250 FROM THE SEATING PLANE BETWEEN 250 AND END OF LEAD A MAX OF 021 IS HELD

SYMBOL	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A		263		6 68
B		435		11 04
ϕb2	016	019	407	482
C		520		13 20
e	095	105	2 42	2 66
e1	045	055	1 15	1 39
F		140		3 55
h		103		2 61
L	500		12 70	
ϕp		143		3 63
q	156 REF		3 96 REF	
q1	187 REF		2 21 REF	
r1		.156		3.96

NOTE 1: LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN 070 AND 250 FROM THE SEATING PLANE BETWEEN 250 AND END OF LEAD A MAX OF 020 IS HELD

NOTE 2 HOLE FOR #4 SCREW – WILL ACCEPT 113 PIN

ORDER HEATSINK VERSIONS AS. HS5307
HS5308

bsolute maximum ratings: (25°C) (unless otherwise specified)

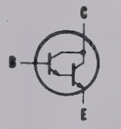
oltages			
Collector to Base	V_{CBO}	40	Volts
Collector to Emitter	V_{CEO}	40	Volts
Emitter to Base	V_{EBO}	12	Volts
urrent			
Collector (Steady State)	I_C	300	mA
Collector (Pulsed)*	I_C	500	mA
Base (Steady State)	I_B	50	mA
issipation			
Total Power ($T_A \leqq 25°$ C)†	P_T	400	mW
Total Power with Heatsink ($T_A \leqq 25°$ C)††	P_T	600	mW
Total Power with Heatsink ($T_C \leqq 25°$ C)†††	P_T	900	mW
emperature			
Storage	T_{stg}	−65 to +150° C	
Operating	T_J	−65 to +125° C	
Lead, 1/16″ ± 1/32″ from case for 10 sec. max.	T_L	+260° C	

*Pulse conditions: 300 μsec. pulse width, 2% duty cycle.

†Derate 4.0 mW/° C for increase in ambient temperature above 25° C.

††Derate 6.0 mW/° C for increase in ambient temperature above 25° C.

††Derate 9.0 mW/° C for increase in case temperature above 25° C.



Equiv. Circuit

TATIC CHARACTERISTICS

			Min.	Max.	
Collector to Base Breakdown Voltage ($I_C = 0.1\mu A, I_C = 0$)		$V_{(BR)CBO}$	40		Volts
Collector to Emitter Breakdown Voltage ($I_C = 10mA, I_B = 0$)		$V_{(BR)CEO}$	40		Volts
mitter to Base Breakdown Voltage ($I_E = 0.1\mu A, I_E = 0$)		$V_{(BR)EBO}$	12		Volts
orward Current Transfer Ratio					
($V_{CE} = 5V, I_C = 2mA$)	2N5307	h_{FE}	2000	20000	
($V_{CE} = 5V, I_C = 100mA$)	2N5307	h_{FE}	6000		
($V_{CE} = 5V, I_C = 2mA$)	2N5308, A	h_{FE}	7000	70000	
($V_{CE} = 5V, I_C = 100mA$)	2N5308, A	h_{FE}	20000		
ollector Cutoff Current					
($V_{CB} = 40V, I_E = 0$)		I_{CBO}		100	nA
($V_{CB} = 40V, I_E = 0, T_A = 100°$ C)		I_{CBO}		20	μA
mitter Cutoff Current ($V_{EB} = 12V, I_C = 0$)		I_{EBO}		100	nA
ollector Emitter Saturation Voltage					
($I_C = 200mA, I_B = 0.2mA$)		$V_{BE(SAT)}$		1.4	Volts
ase Emitter Saturation Voltage					
($I_C = 200mA, I_B = 0.2mA$)		$V_{CE(SAT)}$		1.6	Volts
ase Emitter Voltage ($V_{CE} = 5V, I_C = 200mA$)		V_{BE}		1.5	Volts

YNAMIC CHARACTERISTICS

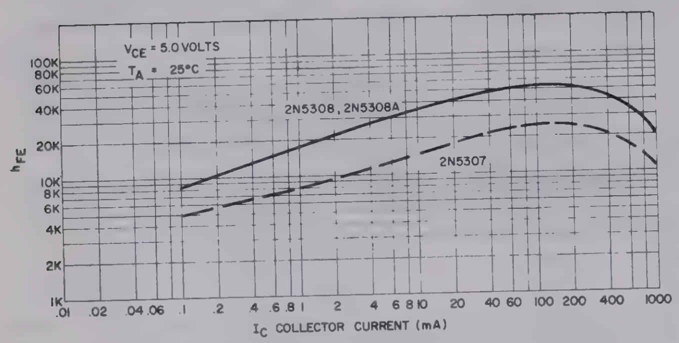
			Min.	Typ.	Max.	
orward Current Transfer Ratio						
($V_{CE} = 5V, I_C = 2mA, f = 1kHz$)	2N5307	h_{fe}	2000			
($V_{CE} = 5V, I_C = 2mA, f = 1kHz$)	2N5308, A	h_{fe}	7000			
($V_{CE} = 5V, I_C = 2mA, f = 1kHz$)		$\|h_{fe}\|$	15.6			dB
ain Bandwidth Product ($V_{CE} = 5V, I_C = 2mA, f = 10$ MHz)		f_T	60			MHz
nput Impedance ($V_{CE} = 5V, I_C = 2mA, f = 1$ kHz)		h_{ie}		650		kohms
ollector Base Capacitance ($V_{CB} = 10V, f = 1$ MHz)		C_{cb}		7.6	10	pF
mitter Capacitance ($V_{EB} = 0.5V, f = 1$ MHz)		C_{eb}		10.5		pF

			Min.	Typ.	Max.	Units
2N5308A only **Noise Voltage**	($I_C = 0.6$ mA, $V_{CE} = 5$V, $R_G = 160$kΩ $f = 10$Hz to 10kHz, B.W. = 15.7 kHz)	$e_{\overline{n}}$		195	230	n V/$\sqrt{\text{Hz}}$

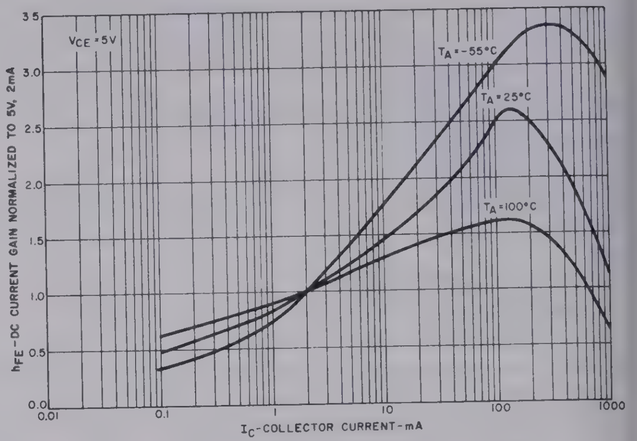
NOTE: As measured on a Quan-Tech Model 2283/2181M test set with 10 Hz filter modified by Quan-Tech to a wideband (f = 10 Hz to 10 kHz, B.W. = 15.7 kHz) filter.

Typical Curves

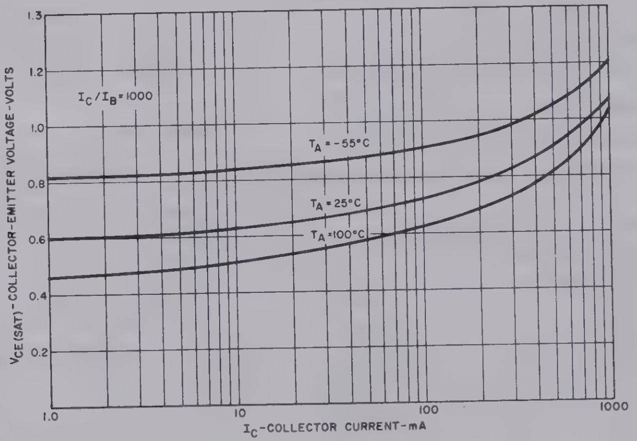
Typical h_{FE} vs. I_C



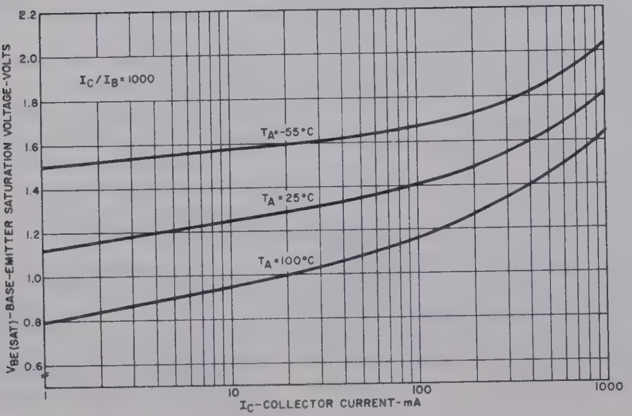
Normalized h_{FE} vs. I_C



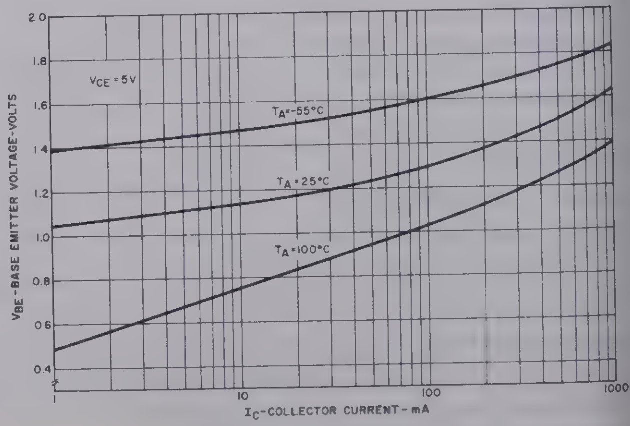
V_{CE} vs. I_C



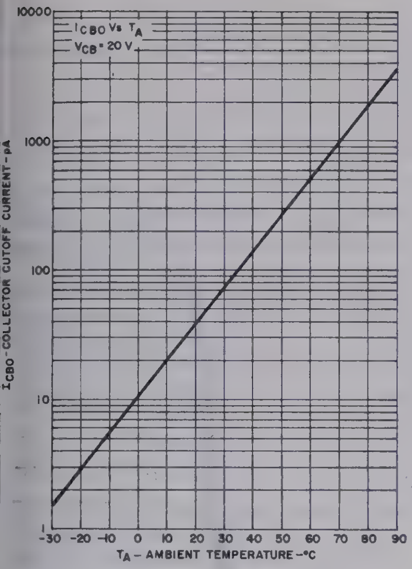
$V_{BE(SAT)}$ vs. I_C



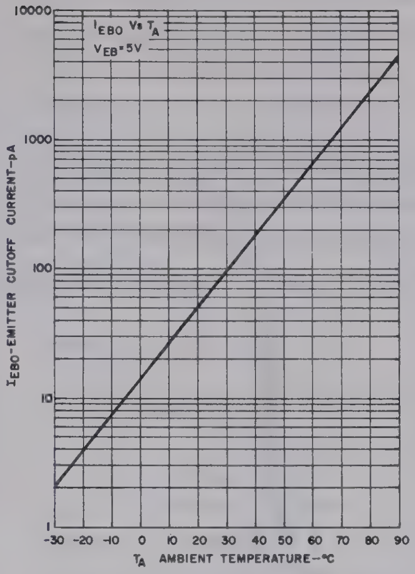
Transconductance Characteristic, V_{BE} vs. I_C



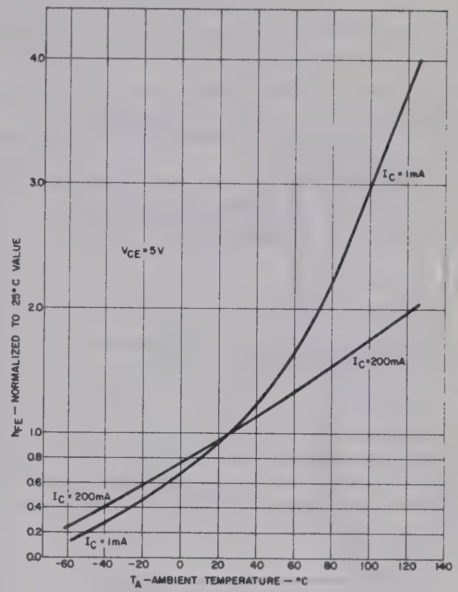
I_{CBO} vs. T_A



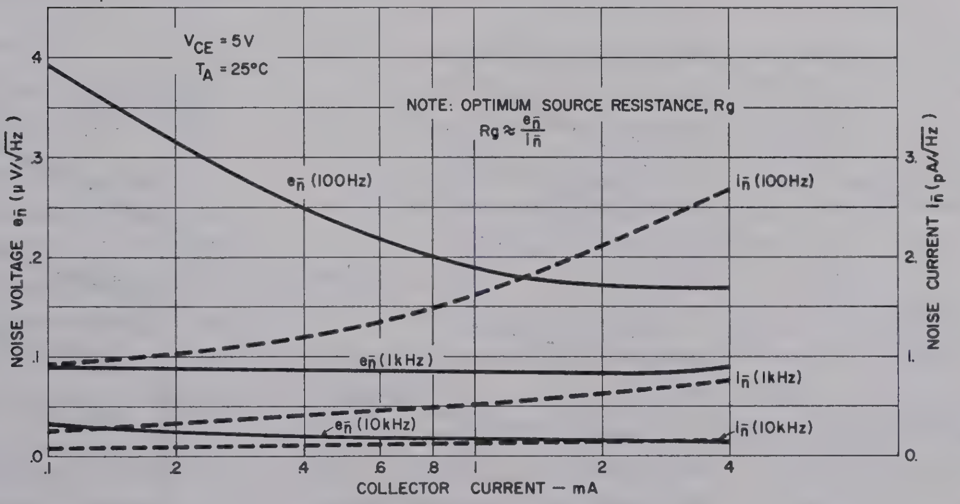
I_{EBO} vs. T_A



h_{FE} vs. T_A

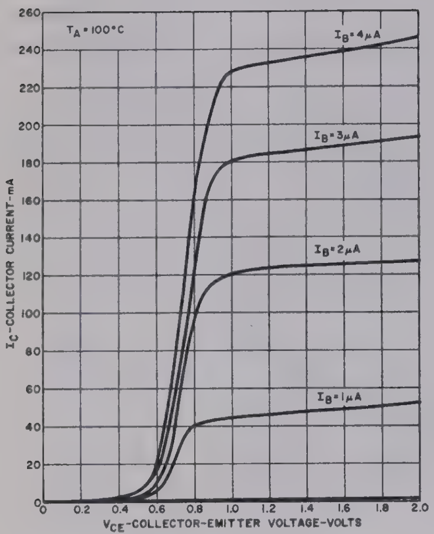


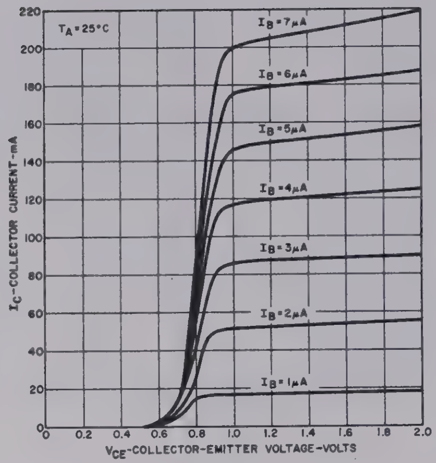
Equivalent Input Noise Voltage and Current vs. Bias Current

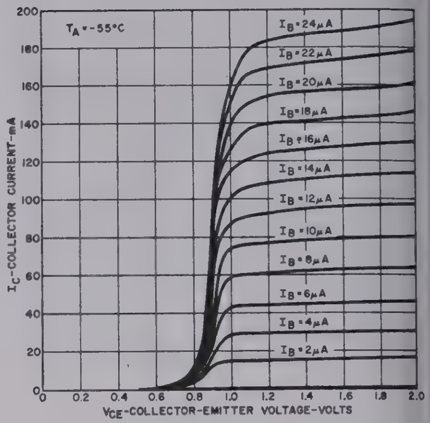


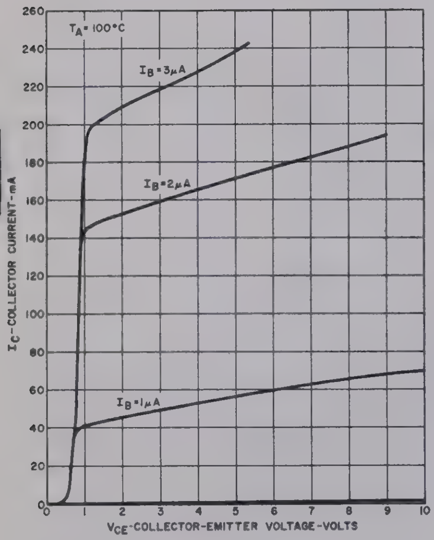
NOTE: Due to the noise characteristics of this device versus frequency, calculation of noise figure (N.F.) from $e_{\bar{n}}$, $i_{\bar{n}}$ values is not accurate [as is the case with field effect transistors (F.E.T.'s)].

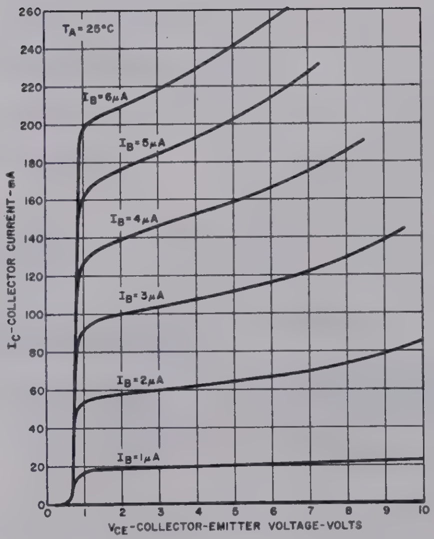
Typical Collector Characteristics

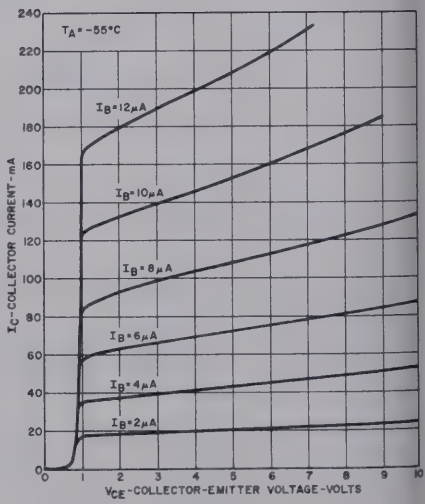










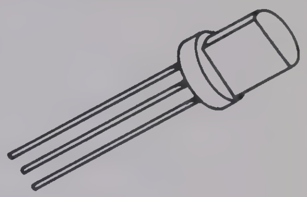


Silicon Transistors

NPN

2N5309,10

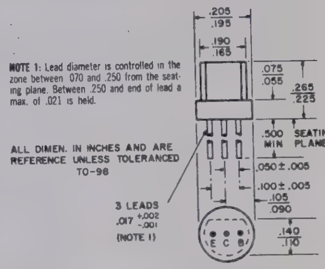
The General Electric 2N5309 and 2N5310 are NPN, silicon, planar, epitaxial, passivated transistors. These devices feature very high gain at extremely low collector currents, low leakage currents and inherent low noise characteristics. These transistors are ideally suited for low level amplifier applications and, with leads formed to a TO-18 pin configuration, are intended to be epoxy replacements for the 2N929 and 2N930 type devices.



absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	50	Volts
Emitter to Base	V_{EBO}	5	Volts
Collector to Base	V_{CBO}	70	Volts
Current			
Collector (Steady State)*	I_C	100	mA
Dissipation			
Total Power (Free Air @ 25°C)†	P_T	360	mW
Total Power (Free Air @ 55°C)†	P_T	250	mW
Temperature			
Storage	T_{stg}		−55 to +150°C
Operating	T_J		+125°C
Lead Soldering, 1/16″ ± 1/32″ from case for 10 sec. max.	T_L		+260°C

*Determined from power limitations due to saturation voltage at this current.
†Derate 3.6 mW/°C increase in ambient temperature above 25°C.



NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED
TO-98

electrical characteristics: (25°C) (unless otherwise specified)

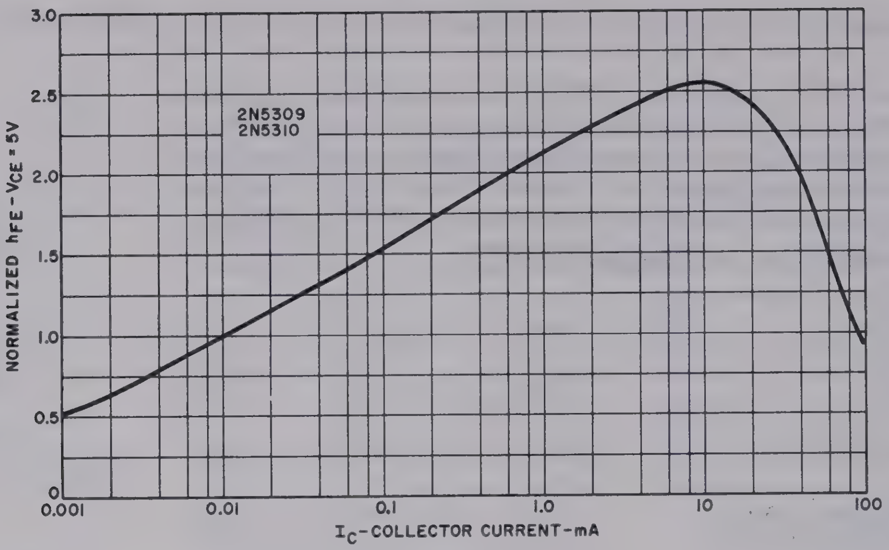
Static Characteristics			**Min.**	**Max.**	
Collector Cutoff Current ($V_{CB} = 50V$)		I_{CBO}		10	nA
($V_{CB} = 50V$, TA = 100°C)		I_{CBO}		10	μA
($V_{CB} = 50V$)		I_{CES}		10	nA
Emitter Cutoff Current ($V_{EB} = 5V$)		I_{EBO}		50	nA
Forward Current Transfer Ratio ($V_{CE} = 5V$, $I_C = 10\ \mu A$)	2N5309	h_{FE}	60	120	
	2N5310	h_{FE}	100	300	
Collector Emitter Breakdown Voltage ($I_C = 10$ mA)‡		$V_{(BR)\,CEO}$	50		Volts
Collector Base Breakdown Voltage ($I_C = 10\ \mu A$)		$V_{(BR)\,CBO}$	70		Volts
Emitter Base Breakdown Voltage ($I_E = 10\ \mu A$)		$V_{(BR)\,EBO}$	5		Volts
Collector Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)‡		$V_{CE\,(sat)}$		.125	Volts
Base Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)‡		$V_{BE\,(sat)}$		.78	Volts
Base Emitter Voltage ($V_{CE} = 10V$, $I_C = 2$ mA)		V_{BE}	.5	.9	Volts

Dynamic Characteristics

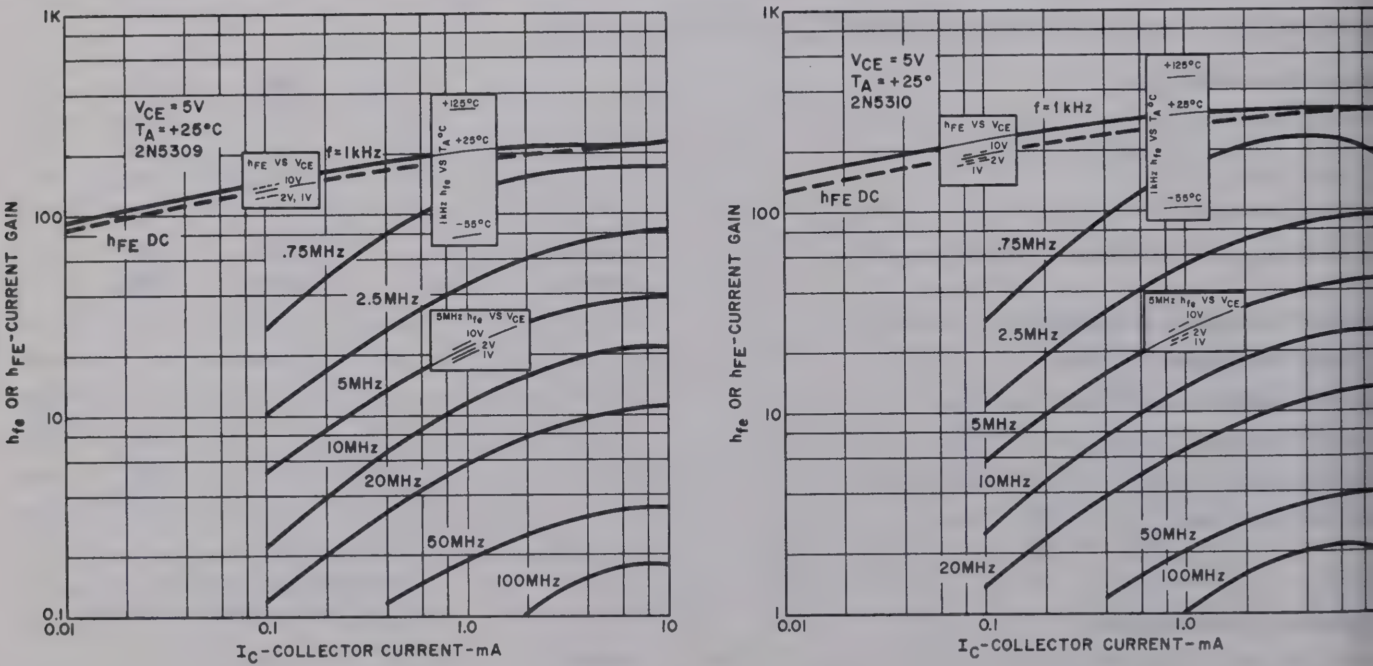
Forward Current Transfer Ratio ($V_{CE} = 10V$, $I_C = 10\ \mu A$, f = 1 kHz)	2N5309	h_{fe}	66		
	2N5310	h_{fe}	110		
Output Capacitance, Common Base ($V_{CB} = 10V$, $I_E = 0$, f = 1 MHz)		C_{cb}	1.0	4.0	pF

‡Pulse conditions 300 μsec. 2% duty cycle.

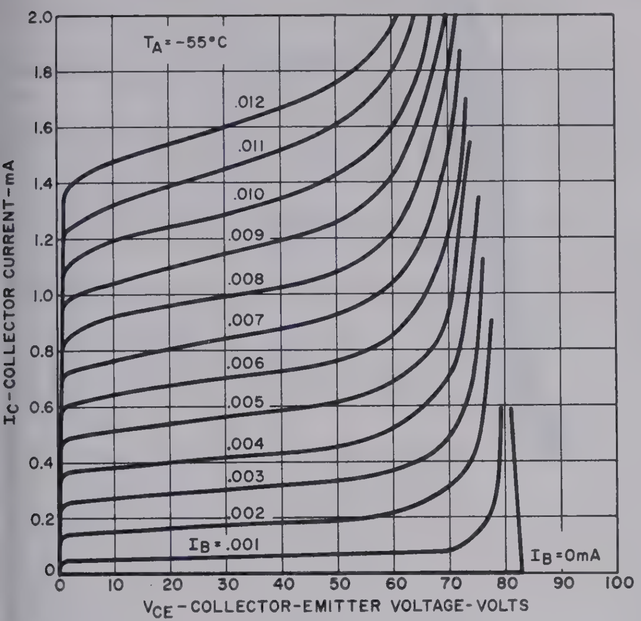
Normalized h_{FE} vs. I_C

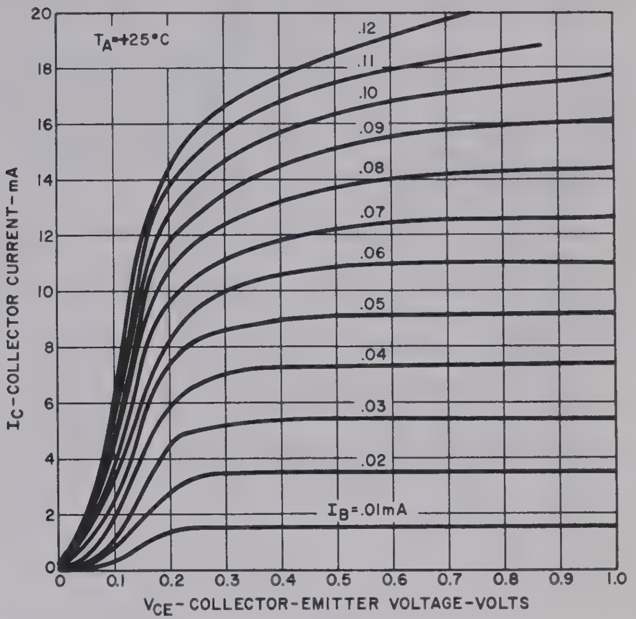


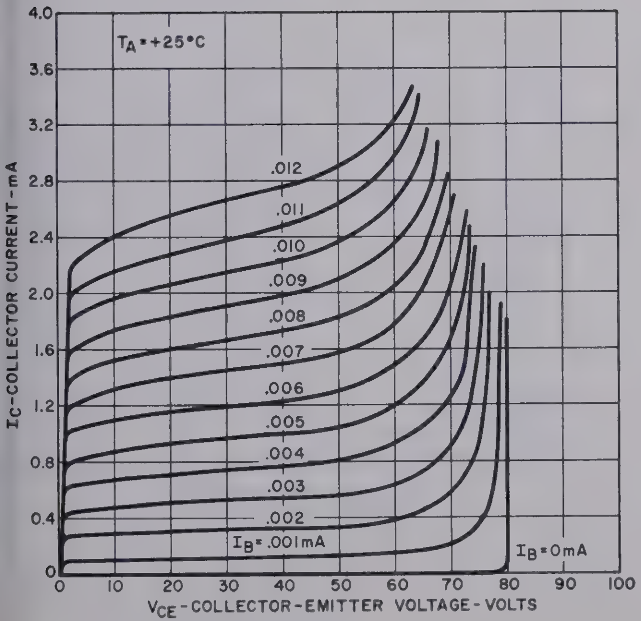
Small Signal Current Gain vs. Collector Current

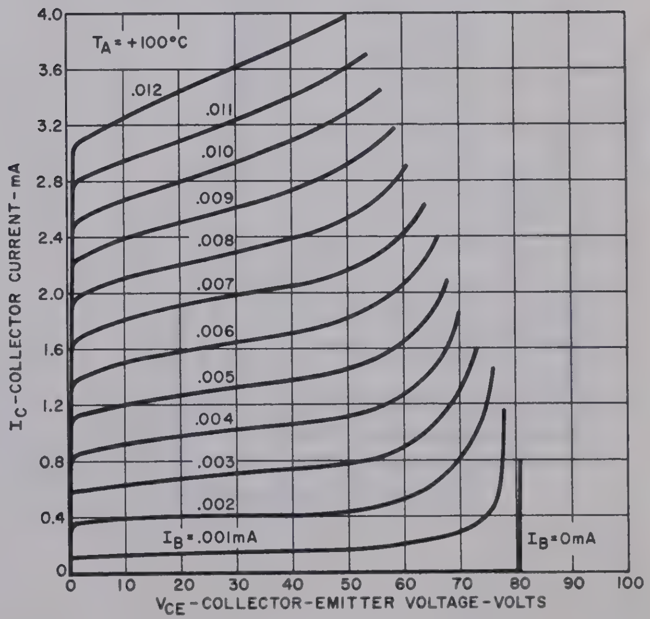


Typical Collector Characteristics
2N5309

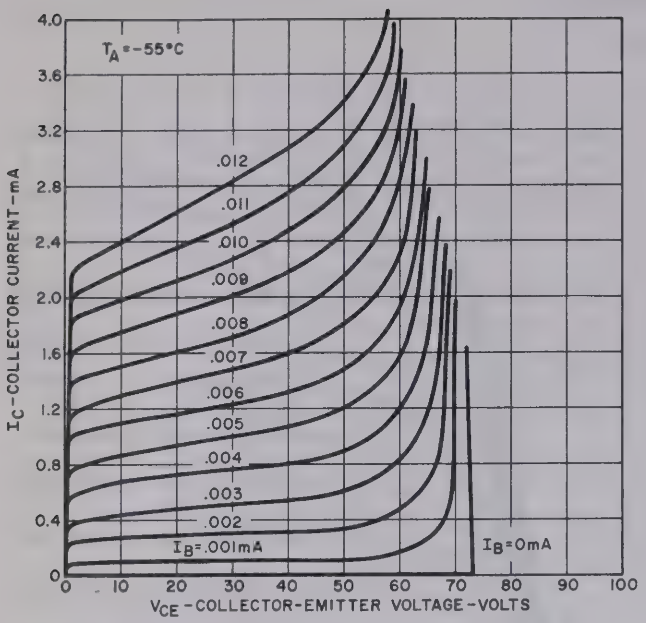


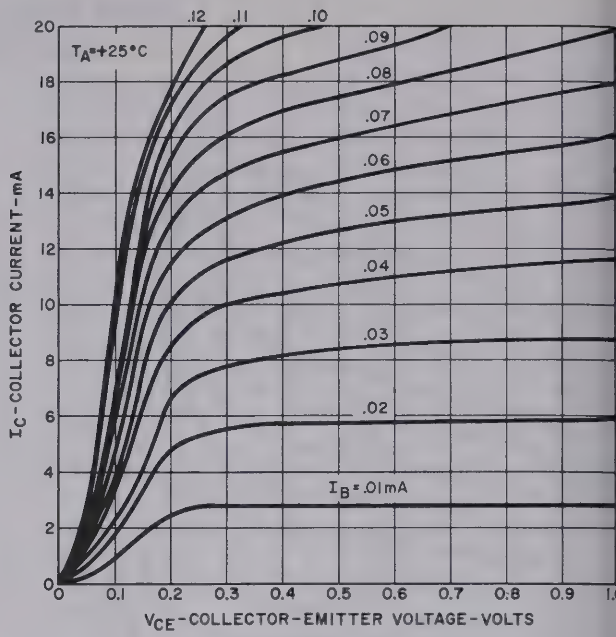


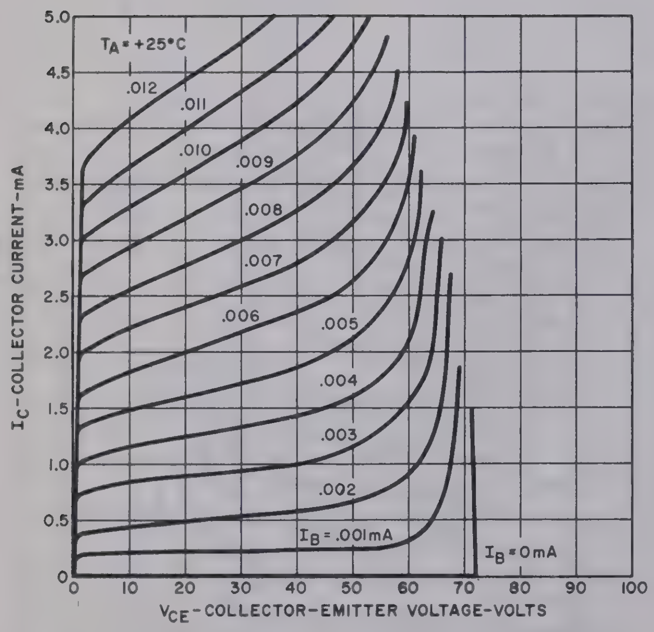


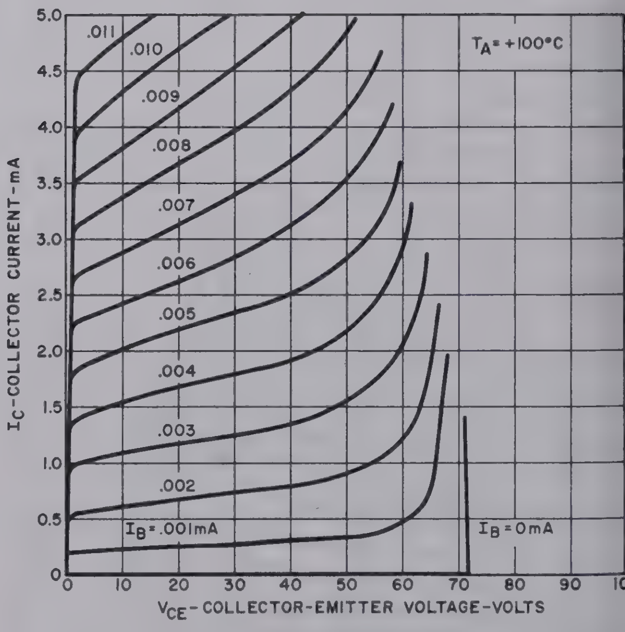


Typical Collector Characteristics
2N5310







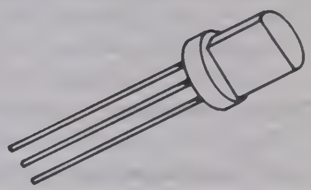


Silicon
Transistors

PNP

2N5354,5,6

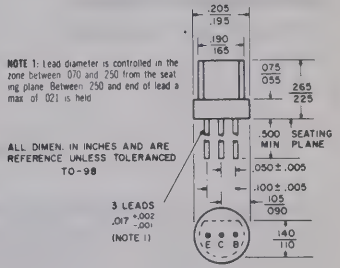
This series of economy transistors are PNP, silicon, planar, epitaxial, passivated devices. These units feature low collector saturation voltage, good current gain linearity over a wide collector current range, high gain-bandwidth product, and low noise. These characteristics make these units excellent for use in general purpose consumer and industrial amplifier and switching applications.



bsolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	-25	Volts
Emitter to Base	V_{EBO}	- 4	Volts
Collector to Base	V_{CBO}	-25	Volts
Current			
Collector (Continuous)	I_C	350	mA
Collector (Pulsed, 10 μsec pulse width, = 2% Duty Cycle)	I_C	700	mA
Dissipation			
Total Power (Free Air at 25°C)*	P_T	360	mW
Total Power (Free Air at 55°C)*	P_T	260	mW
Temperature			
Storage	T_{stg}	-65 to +150	°C
Operating	T_j	+125	°C
Lead temperature, 1/16" ± 1/32" from case for ten seconds maximum	T_L	+260	°C

* *Derate 3.6 mW/°C increase in ambient temperature above 25°C.*


.205
.195
.190
165
NOTE 1: Lead diameter is controlled in the zone between 070 and 250 from the seating plane Between 250 and end of lead a max of 021 is held
075
055
265
225
.500 MIN
SEATING PLANE
ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED
TO-98
.050 ± .005
.100 ± .005
105
090
3 LEADS
.017 +.002 -.001
(NOTE 1)
E C B
140
110

lectrical characteristics: (25°C) (unless otherwise specified)

Static Characteristics			Min.	Typ.	Max.	
Collector Cutoff Current						
(V_{CB}=-25V)		I_{CBO}			-100	nA
(V_{CB}= -25V, T_A=100°C)		I_{CBO}			- 10	μA
(V_{CB}=-25V)		I_{CES}			-100	nA
Emitter Cutoff Current (V_{EB}=-4V)		I_{EBO}			- 10	μA
Forward Current Transfer Ratio						
(V_{CE}=-10V, I_C=-2 mA)	2N5354	h_{FE}	32			
(V_{CE} =-1V, I_C=-50 mA)	2N5354	h_{FE}	40		120	
(V_{CE} = -5V, I_C= -300 mA)	2N5354	h_{FE}	20			
(V_{CE} =-10V, I_C=-2 mA)	2N5355	h_{FE}	80			
(V_{CE}=-1V, I_C=-50 mA)	2N5355	h_{FE}	100		300	
(V_{CE} = -5V, I_C= -300 mA)	2N5355	h_{FE}	40			
(V_{CE}=-10V, I_C=-2 mA)	2N5356	h_{FE}	200			
(V_{CE}=-1V, I_C=-50 mA)	2N5356	h_{FE}	250		500	
(V_{CE} = -5V, I_C= -300 mA)	2N5356	h_{FE}	75			
Collector Emitter Breakdown Voltage						
(I_C=-10 mA)		$V_{(BR)CEO}$	- 25			Volts
Collector Saturation Voltage						
(I_C=-50 mA, I_B=-2.5 mA)		$V_{CE(sat)}$			-.250	Volts
(I_C=-300 mA, I_B=-30 mA)		$V_{CE(sat)}$			-1.0	Volts

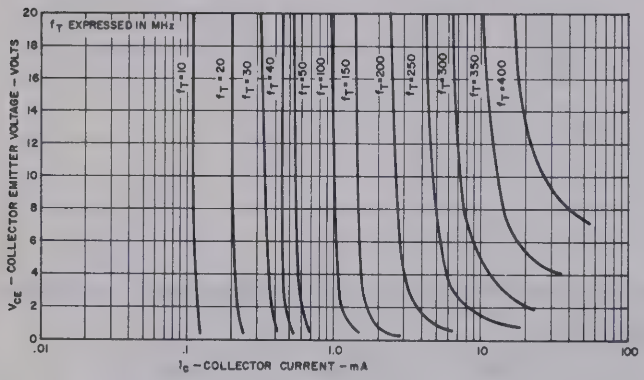
			Min.	Typ.	Max.	
Base Saturation Voltage						
(I_C=-50 mA, I_B=-2.5 mA)		$V_{BE(sat)}$			-1.1	Volt
(I_C=-300 mA, I_B=-30 mA)		$V_{BE(sat)}$			-2.0	Volt
Base Emitter Voltage						
(V_{CE}=-10V, I_C=-2 mA)		V_{BE}	-0.5		-0.8	Volt

Dynamic Characteristics

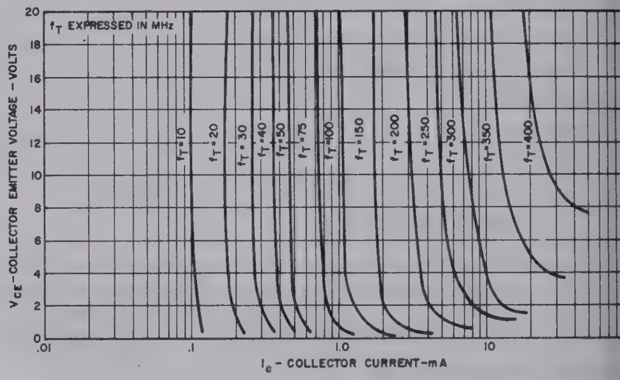
Forward Current Transfer Ratio						
(V_{CE}=-10V, I_C=-2 mA, f=1 kHz)	2N5354	h_{fe}	32		180	
(V_{CE}=-10V, I_C=-2 mA, f=1 kHz)	2N5355	h_{fe}	80		450	
(V_{CE}=-10V, I_C=-2 mA, f=1 kHz)	2N5356	h_{fe}	200		750	
Output Capacitance, Common Base						
(V_{CB}=-10V, I_E=0, f=1 MHz)		C_{cb}			8	p
Input Capacitance, Common Base						
(V_{EB}=-0.5V, I_C=0, f=1 MHz)		C_{eb}			35	p
Gain Bandwidth Product						
(V_{CE}=-10V, I_C=-2 mA)		f_T		250		M

TYPICAL CONTOURS OF GAIN BANDWIDTH PRODUCT, (f_T) VS. COLLECTOR CURRENT

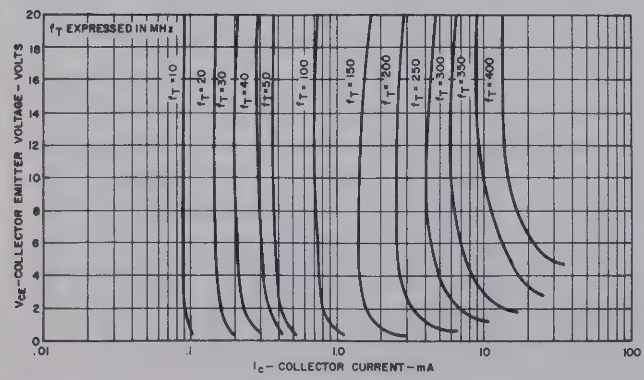
2N5354



2N5355

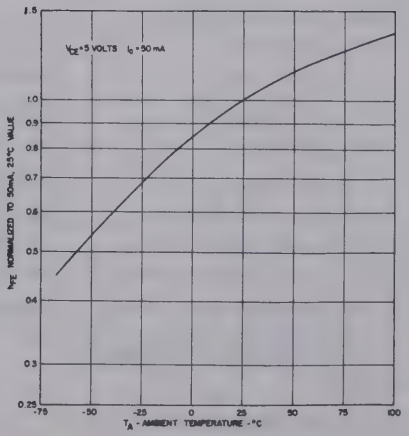


2N5356



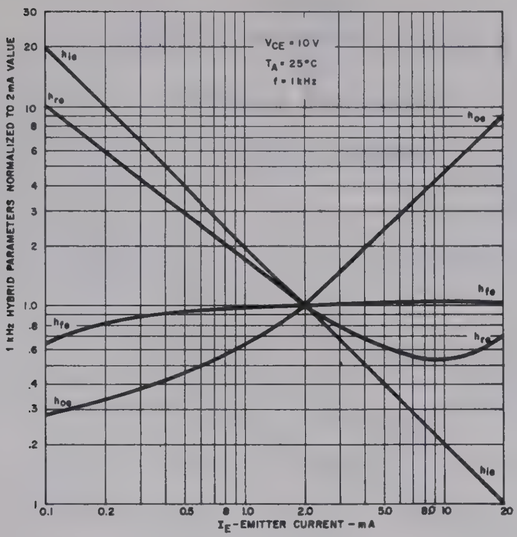
TYPICAL NORMALIZED H_{FE} VS. TEMPERATURE

2N5354, 5355, 5356



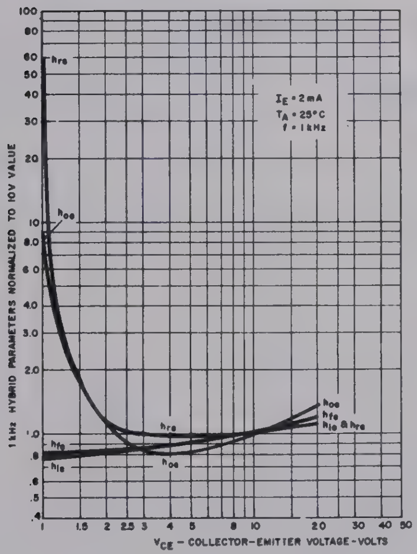
TYPICAL SMALL SIGNAL CHARACTERISTICS VS. EMITTER CURRENT

2N5354, 5355, 5356



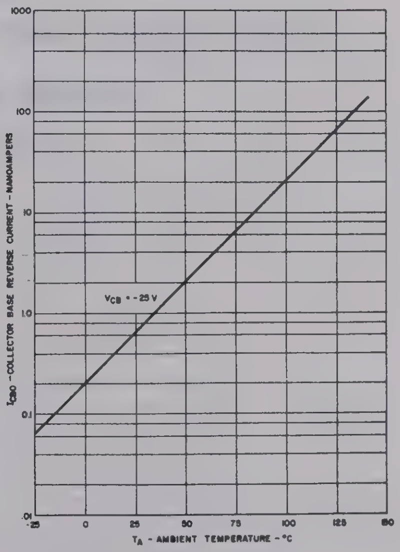
TYPICAL SMALL SIGNAL CHARACTERISTICS VS. COLLECTOR VOLTAGE

2N5354, 5355, 5356



TYPICAL COLLECTOR CUTOFF CURRENT (I_{cbo}) VS. TEMPERATURE

2N5354, 5355, 5356



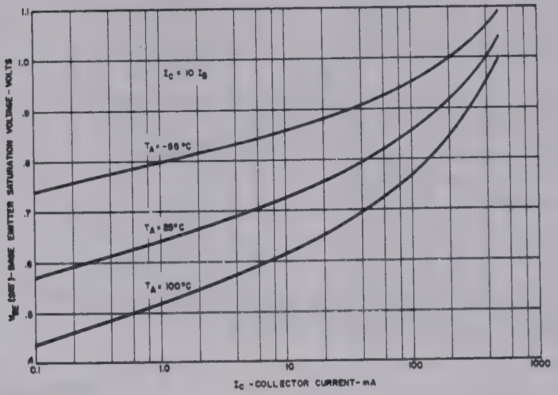
TYPICAL SMALL SIGNAL CHARACTERISTICS

f = 1 kHz, V_{CE} = 10V, I_E = 2 mA

Symbol	Characteristic	2N5354	2N5355	2N5356	Units
h_{ie}	Input Resistance	1300	2000	8700	ohms
h_{oe}	Output Conductance	24	37	100	μmhos
h_{fe}	Forward current transfer ratio	100	150	450	
h_{re}	Reverse voltage feedback ratio	1.5	2.0	4.0	$\times 10^{-4}$

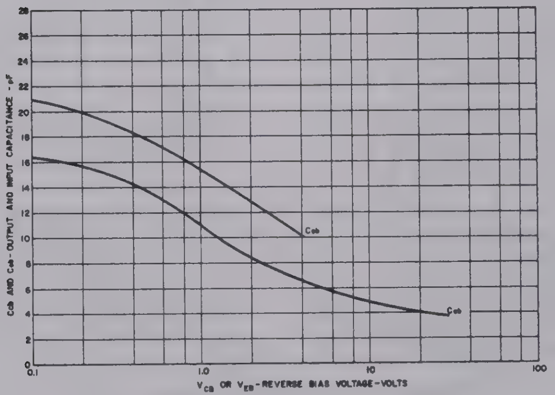
TYPICAL BASE SATURATION VOLTAGE VS. COLLECTOR CURRENT

2N5354, 5355, 5356



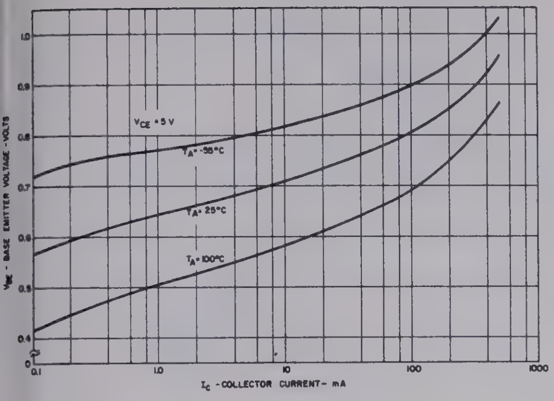
TYPICAL OUTPUT CAPACITANCE AND INPUT CAPACITANCE VS. REVERSE BIAS VOLTAGE

2N5354, 5355, 5356

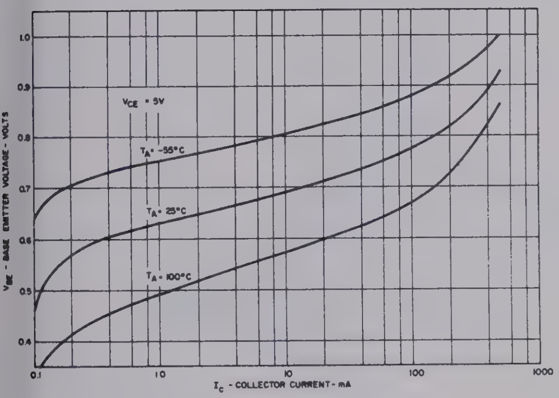


TYPICAL TRANSFER CHARACTERISTICS

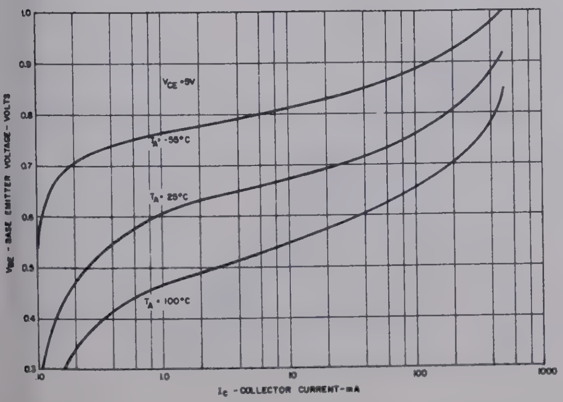
2N5354



2N5355

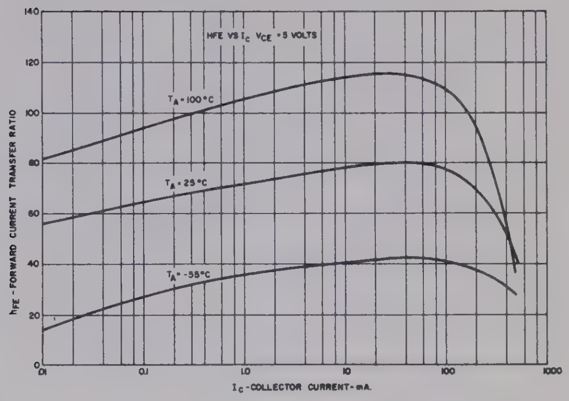


2N5356

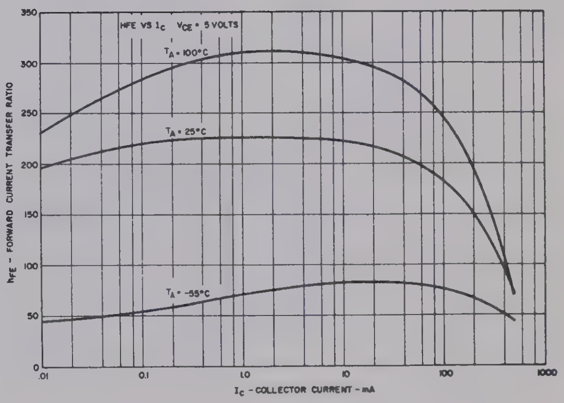


TYPICAL FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT

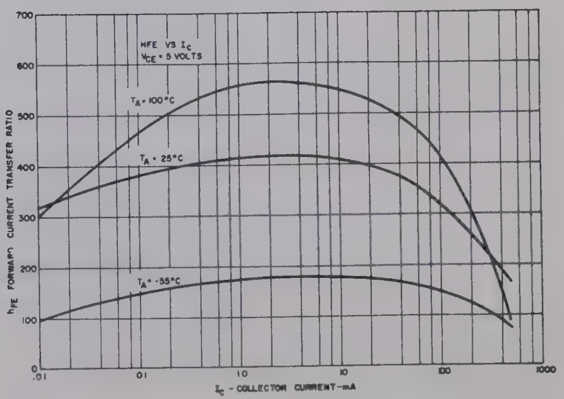
2N5354



2N5355

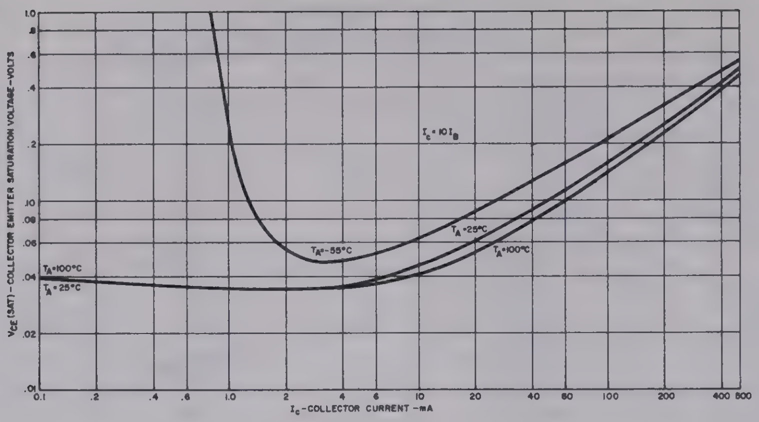


2N5356

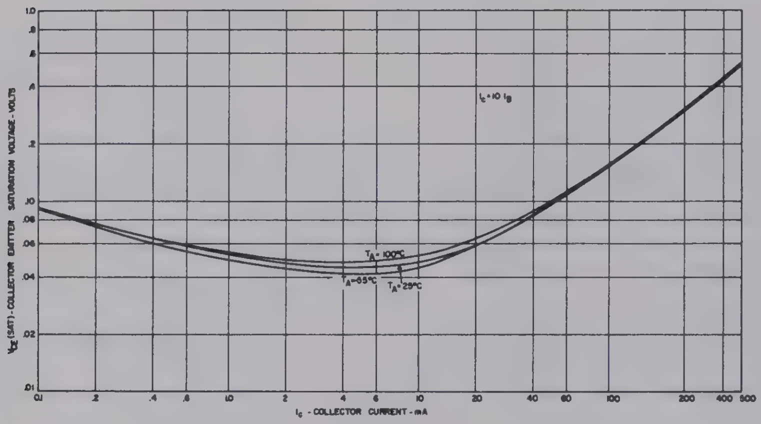


TYPICAL COLLECTOR SATURATION VOLTAGE
VS.
COLLECTOR CURRENT

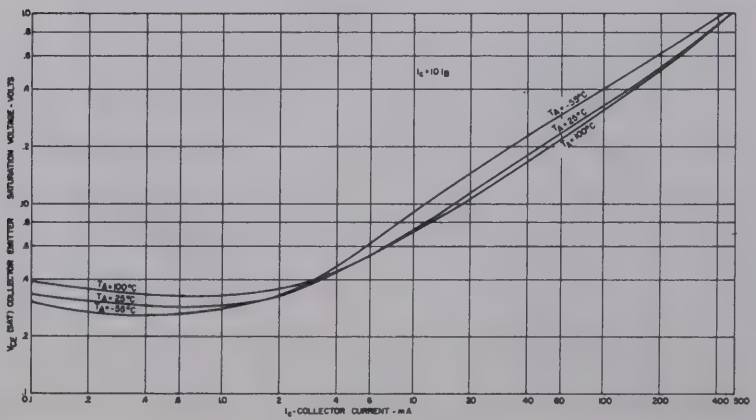
2N5354



2N5355

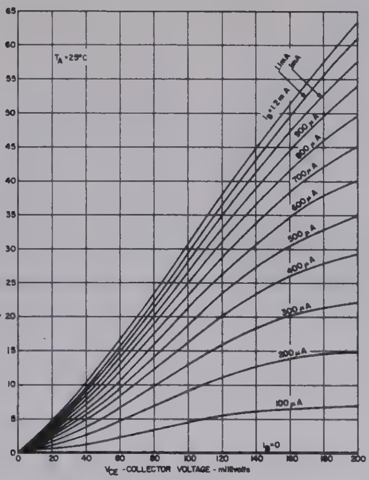


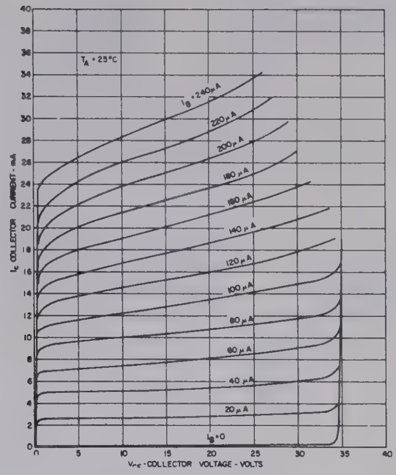
2N5356



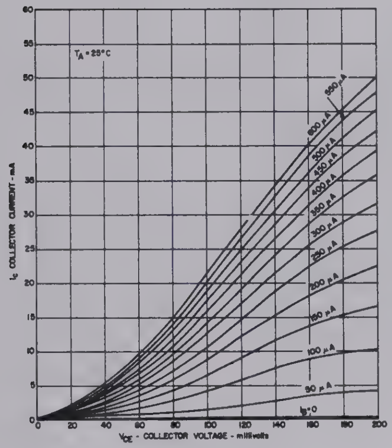
TYPICAL COLLECTOR CHARACTERISTICS

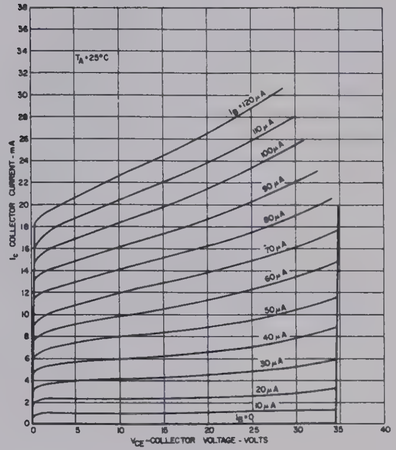
2N5354



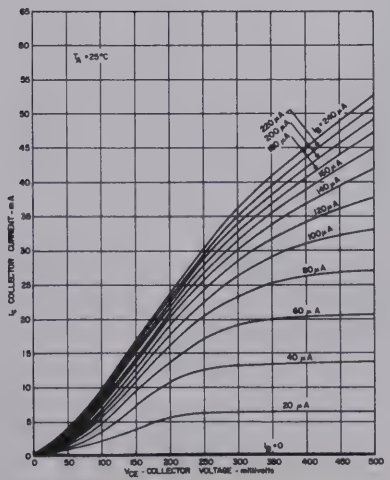


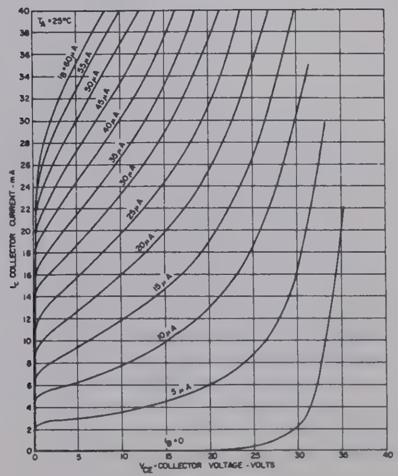
2N5355



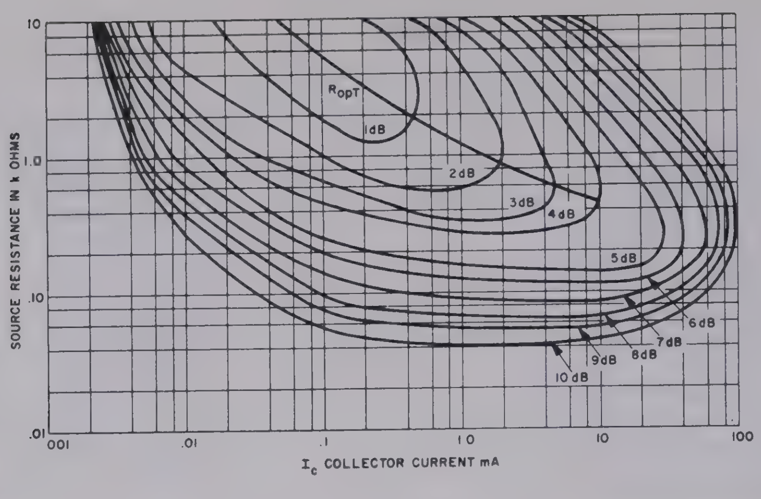


2N5356

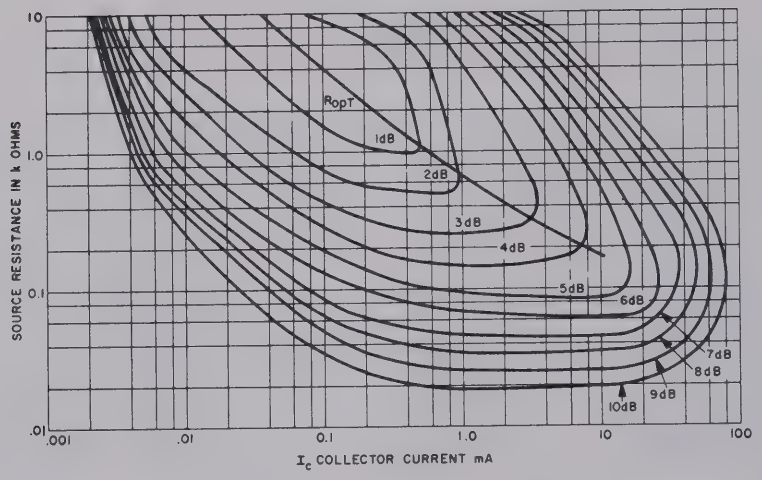




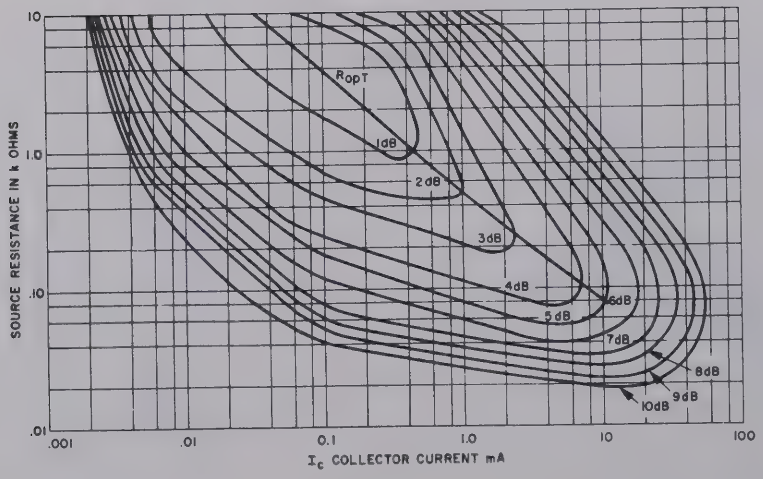
2N5354



2N5355



2N5356

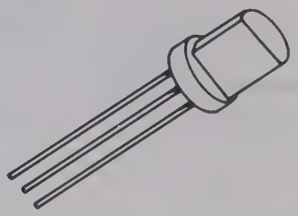


Silicon
Transistors

PNP

2N5365,6,7

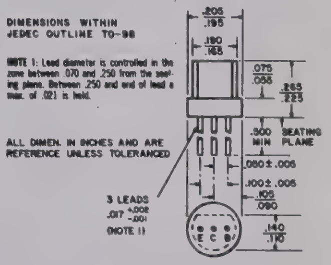
This series of economy transistors are PNP, silicon, planar, epitaxial, passivated devices. These units feature low collector saturation voltage, good current gain linearity over a wide collector current range, high gain-bandwidth product, and low noise. These characteristics make these units excellent for use in general purpose consumer and industrial amplifier and switching applications.



absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	−40	Volts
Emitter to Base	V_{EBO}	−4	Volts
Collector to Base	V_{CBO}	−40	Volts
Current			
Collector (Continuous)	I_C	300	mA
Collector (Pulsed, 10 μsec pulse width, = 2% Duty Cycle)	I_C	700	mA
Dissipation			
Total Power (Free Air at 25°C)*	P_T	360	mW
Total Power (Free Air at 55°C)*	P_T	260	mW
Temperature			
Storage	T_{stg}	−65 to +150	°C
Operating	T_J	+125	°C
Lead temperature, 1/16″ ± 1/32″ from case for ten seconds maximum	T_L	+260	°C

Derate 3.6 mW/°C increase in ambient temperature above 25°C.



DIMENSIONS WITHIN JEDEC OUTLINE TO-98

NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

---

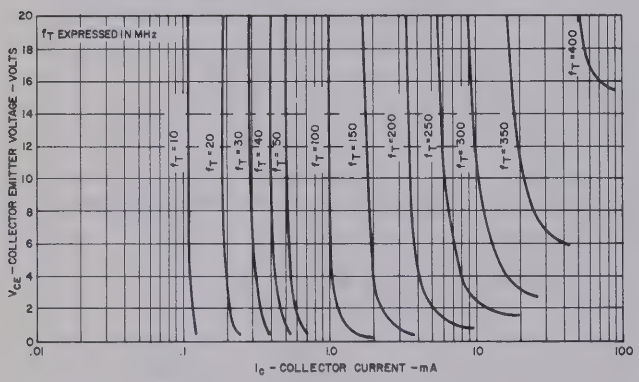
electrical characteristics: (25°C) (unless otherwise specified)

Static Characteristics			**Min.**	**Max.**	
Collector Cutoff Current					
($V_{CB} = -40V$)		I_{CBO}		−100	nA
($V_{CB} = -40V$, $T_A = 100°C$)		I_{CBO}		−10	μA
($V_{CB} = -40V$)		I_{CES}		−100	nA
Emitter Cutoff Current ($V_{EB} = -4V$)		I_{EBO}		−10	μA
Forward Current Transfer Ratio					
($V_{CE} = -10V$, $I_C = -2$ mA)	2N5365	h_{FE}	32		
($V_{CE} = -1V$, $I_C = -50$ mA)	2N5365	h_{FE}	40	120	
($V_{CE} = -5V$, $I_C = -300$ mA)	2N5365	h_{FE}	20		
($V_{CE} = -10V$, $I_C = -2$ mA)	2N5366	h_{FE}	80		
($V_{CE} = -1V$, $I_C = -50$ mA)	2N5366	h_{FE}	100	300	
($V_{CE} = -5V$, $I_C = -300$ mA)	2N5366	h_{FE}	40		
($V_{CE} = -10V$, $I_C = -2$ mA)	2N5367	h_{FE}	200		
($V_{CE} = -1V$, $I_C = -50$ mA)	2N5367	h_{FE}	250	500	
($V_{CE} = -5V$, $I_C = -300$ mA)	2N5367	h_{FE}	75		
Collector Emitter Breakdown Voltage					
($I_C = -10$ mA)		$V_{(BR)CEO}$	−40		Volts
Collector Saturation Voltage					
($I_C = -50$ mA, $I_B = -2.5$ mA)		$V_{CE(sat)}$		−.250	Volts
($I_C = -300$ mA, $I_B = -30$ mA)		$V_{CE(sat)}$		−1.0	Volts
Base Saturation Voltage					
($I_C = -50$ mA, $I_B = -2.5$ mA)		$V_{BE(sat)}$		−1.1	Volts
($I_C = -300$ mA, $I_B = -30$ mA)		$V_{BE(sat)}$		−2.0	Volts
Base Emitter Voltage					
($V_{CE} = -10V$, $I_C = -2$ mA)		V_{BE}	−0.5	−0.8	Volts

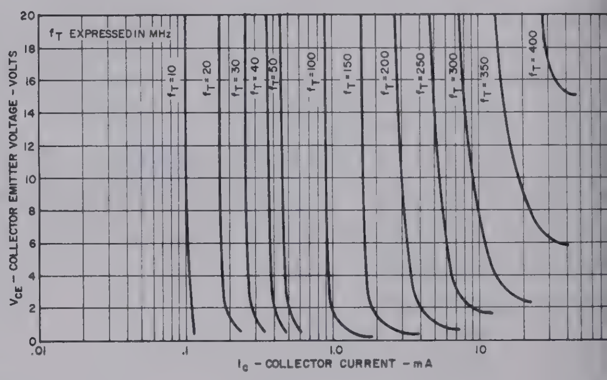
Dynamic Characteristics			Min.	Typ.	Max.	
Forward Current Transfer Ratio						
($V_{CE} = -10V, I_C = -2$ mA, f = 1 kHz)	2N5365	h_{fe}	32		180	
($V_{CE} = -10V, I_C = -2$ mA, f = 1 kHz)	2N5366	h_{fe}	80		450	
($V_{CB} = -10V, I_C = -2$ mA, f = 1 kHz)	2N5367	h_{fe}	200		750	
Output Capacitance, Common Base						
($V_{CB} = -10V, I_E = 0$, f = 1 MHz)		C_{cb}			8	pF
Input Capacitance, Common Base						
($V_{EB} = -0.5V, I_C = 0$, f = 1 MHz)		C_{eb}			35	pF
Gain Bandwidth Product						
($V_{CE} = -10V, I_C = -2$ mA)		f_T		250		MHz

TYPICAL CONTOURS OF GAIN BANDWIDTH PRODUCT, (f_T) VS. COLLECTOR CURRENT

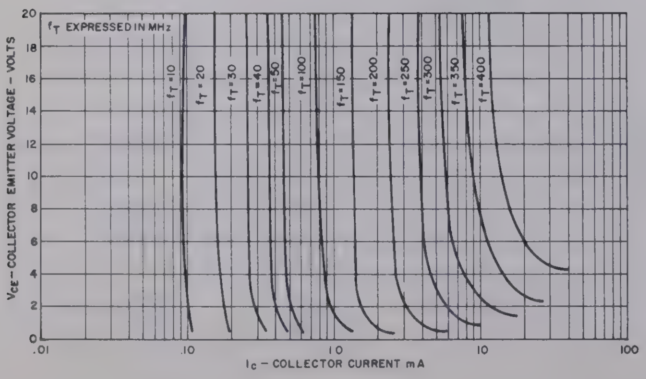
2N5365



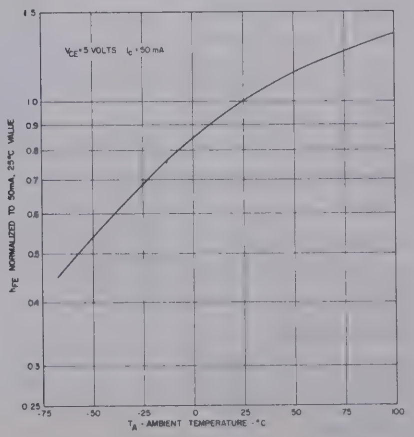
2N5366



2N5367



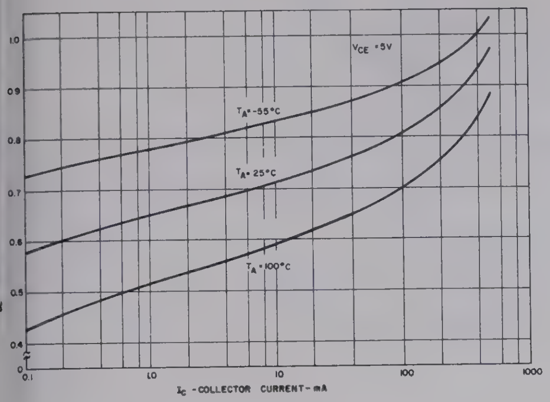
TYPICAL NORMALIZED H_{FE} VS. TEMPERATURE 2N5365, 5366, 5367



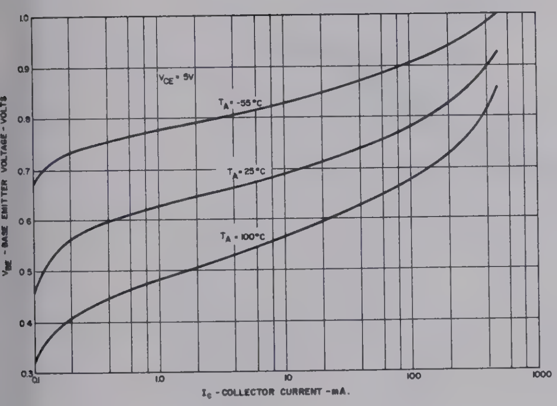
2N5365,6,7

TYPICAL TRANSFER CHARACTERISTICS

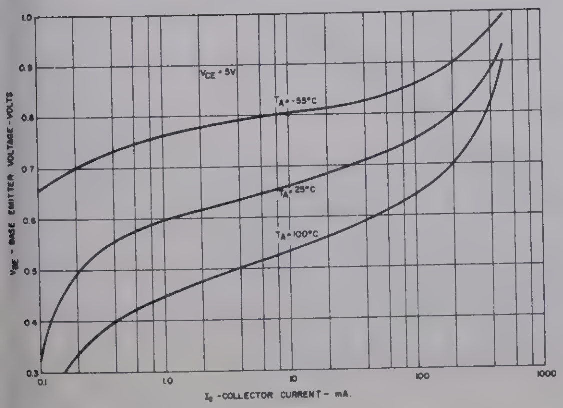
2N5365



2N5366

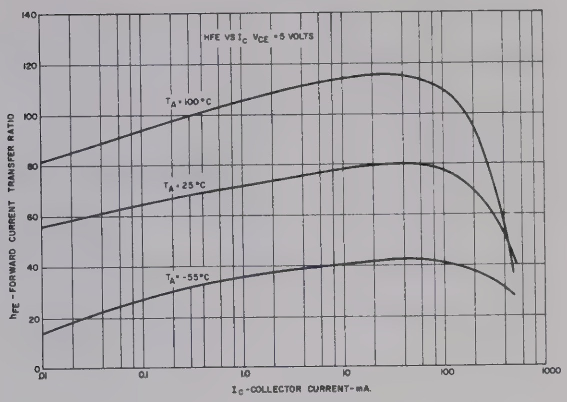


2N5367

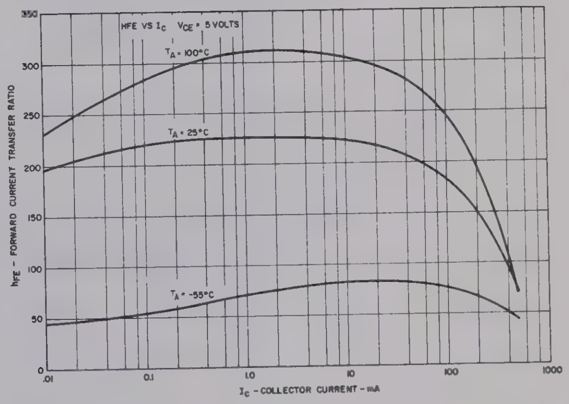


TYPICAL FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT

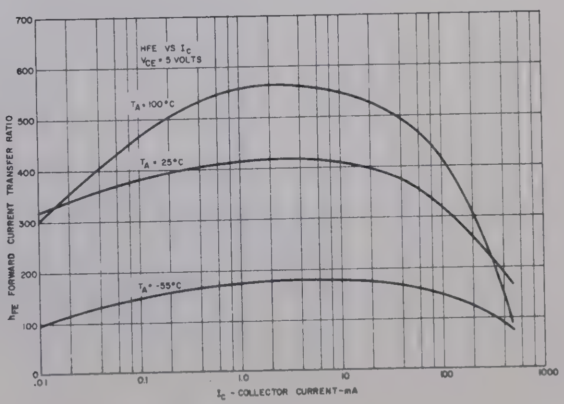
2N5365



2N5366

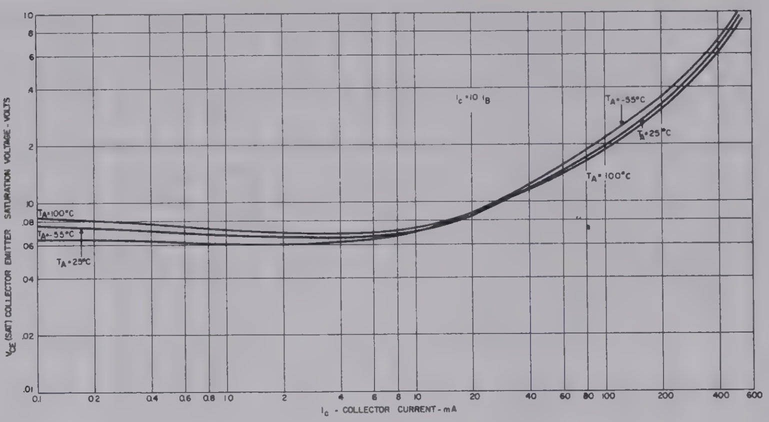


2N5367

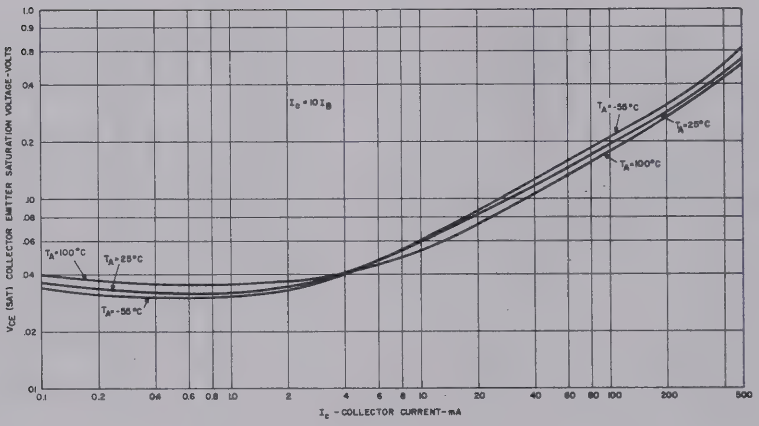


TYPICAL COLLECTOR SATURATION VOLTAGE
VS.
COLLECTOR CURRENT

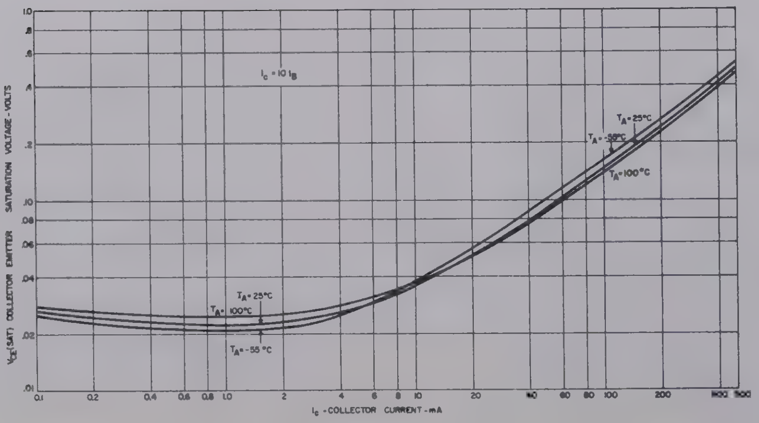
2N5365



2N5366

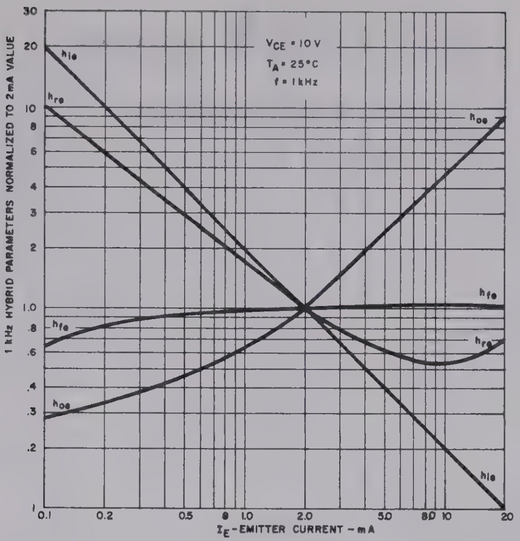


2N5367



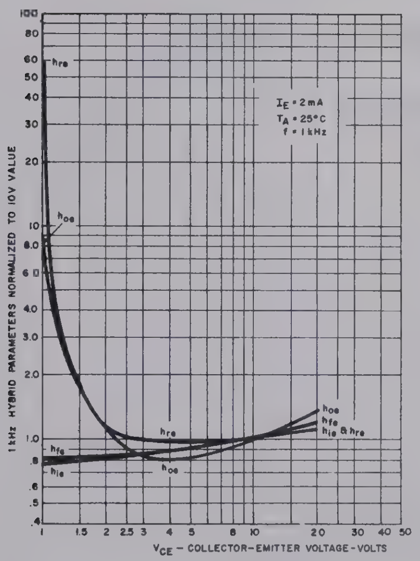
TYPICAL SMALL SIGNAL CHARACTERISTICS VS. EMITTER CURRENT

2N5365, 5366, 5367



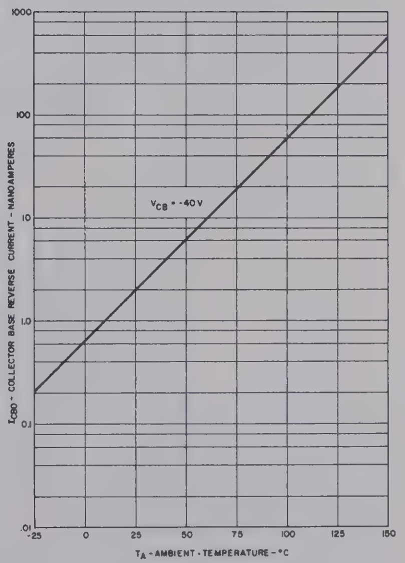
TYPICAL SMALL SIGNAL CHARACTERISTICS VS. COLLECTOR VOLTAGE

2N5365, 5366, 5367



TYPICAL COLLECTOR CUTOFF CURRENT (I_{cbo}) VS. TEMPERATURE

2N5365, 5366, 5367



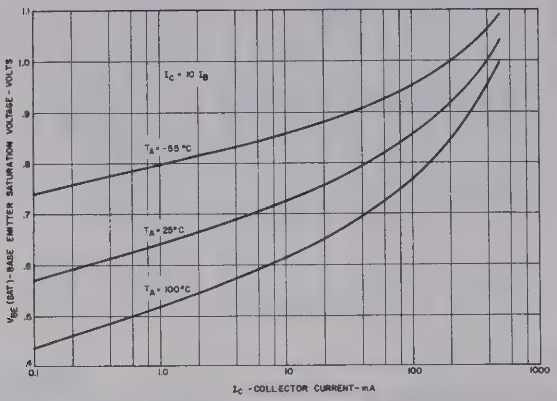
TYPICAL SMALL SIGNAL CHARACTERISTICS

f = 1 kHz, V_{CE} = 10V, I_E = 2 mA

Symbol	Characteristic	2N5365	2N5366	2N5367	Units
h_{ie}	Input Resistance	1100	3200	5800	ohms
h_{oe}	Output Conductance	18	35	58	μmhos
h_{fe}	Forward current transfer ratio	100	200	400	
h_{re}	Reverse voltage feedback ratio	1.2	3.0	5.0	$\times 10^{-4}$

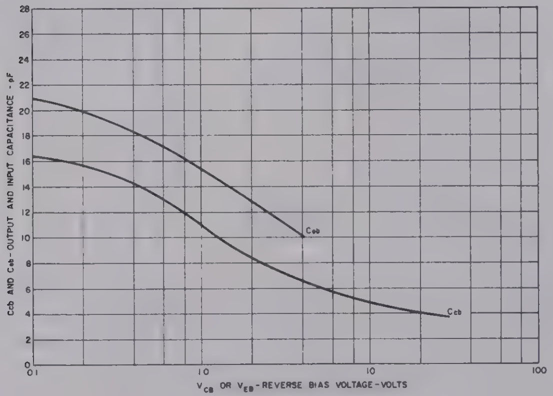
TYPICAL BASE SATURATION VOLTAGE VS. COLLECTOR CURRENT

2N5365, 5366, 5367



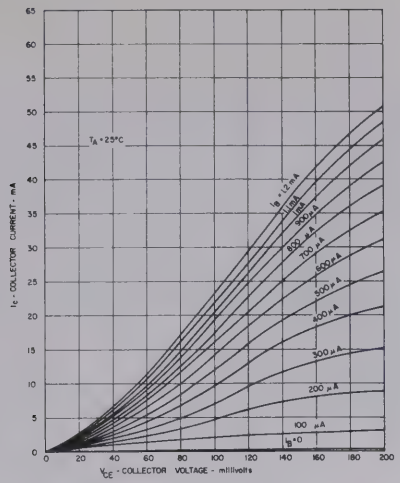
TYPICAL OUTPUT CAPACITANCE AND INPUT CAPACITANCE VS. REVERSE BIAS VOLTAGE

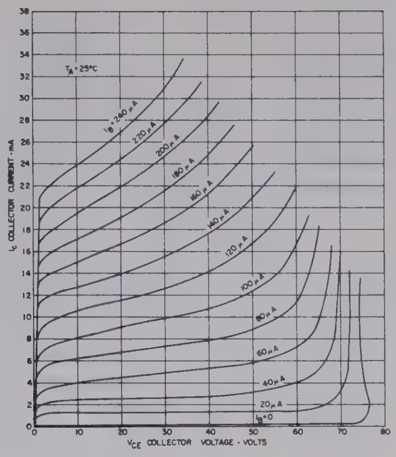
2N5365, 5366, 5367



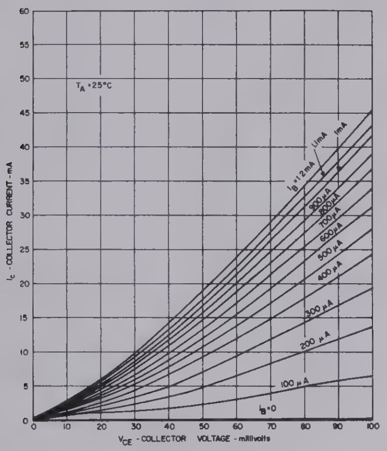
TYPICAL COLLECTOR CHARACTERISTICS

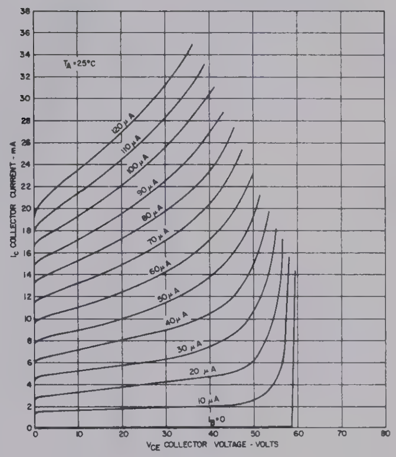
2N5365



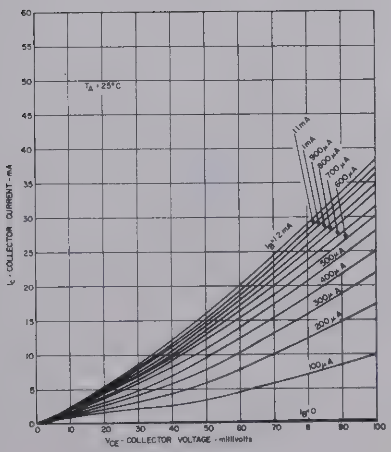


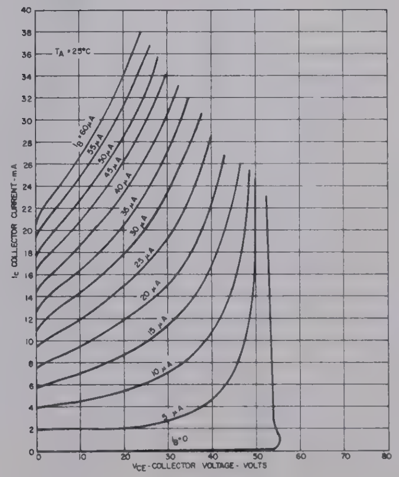
2N5366

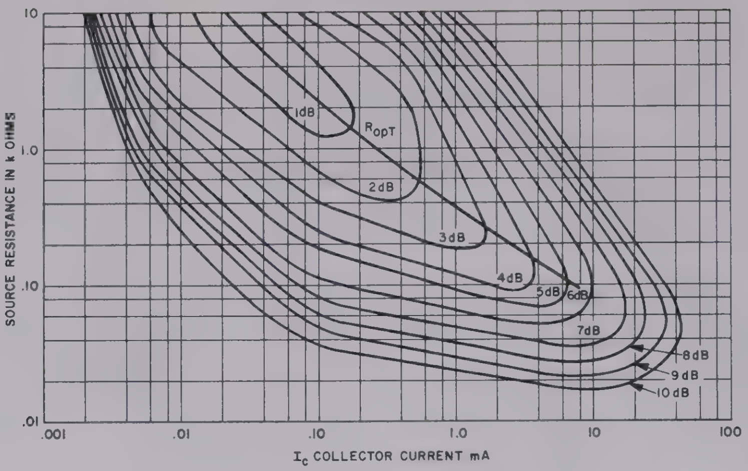


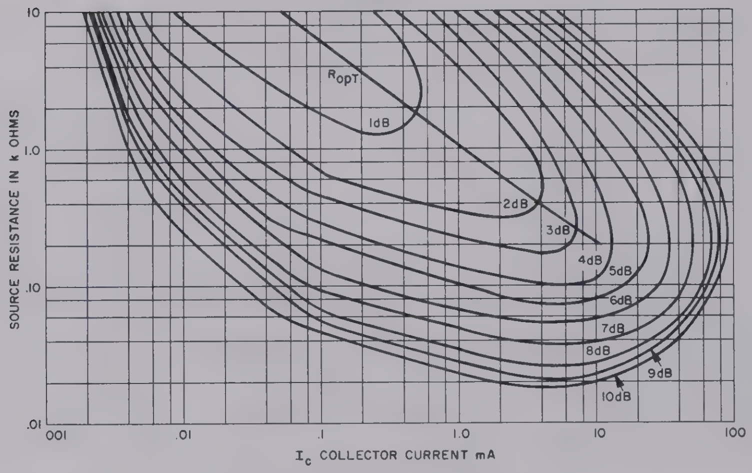


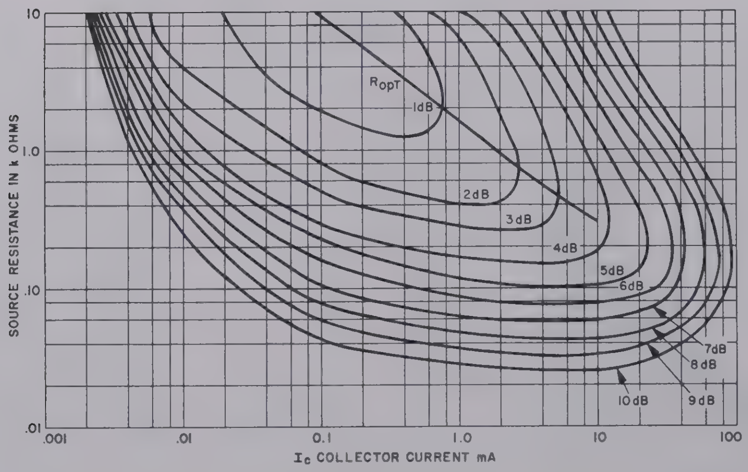
2N5367






SOURCE RESISTANCE IN k OHMS
10
1.0
.10
.01
.001
.01
.10
1.0
10
100
Ic COLLECTOR CURRENT mA
RopT
1dB
2dB
3dB
4dB
5dB
6dB
7dB
8dB
9dB
10dB


SOURCE RESISTANCE IN k OHMS
10
1.0
.10
.01
.001
.01
.1
1.0
10
100
Ic COLLECTOR CURRENT mA
RopT
1dB
2dB
3dB
4dB
5dB
6dB
7dB
8dB
9dB
10dB

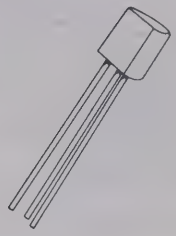

SOURCE RESISTANCE IN k OHMS
10
1.0
.10
.01
.001
.01
0.1
1.0
10
100
Ic COLLECTOR CURRENT mA
RopT
1dB
2dB
3dB
4dB
5dB
6dB
7dB
8dB
9dB
10dB

Silicon
Transistors

NPN

2N5368
2N5369
2N5370
2N5371

The General Electric 2N5368 — 2N5371 are planar, epitaxial, passivated NPN silicon transistors designed as a medium current switch and for general purpose amplifier applications. For complimentary PNP types see 2N5372 — 2N5375 specifications.



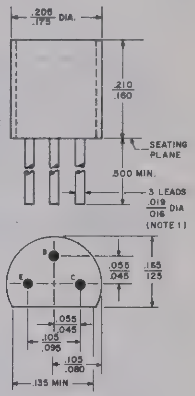
absolute maximum ratings: (T_A = 25°C unless otherwise specified)

		2N5368 2N5369 2N5370	2N5371	
Voltages				
Collector to Emitter	V_{CEO}	30	30	Volts
Collector to Base	V_{CBO}	60	40	Volts
Emitter to Base	V_{EBO}	5	5	Volts
Current				
Collector	I_C	← 500 →		mA
Dissipation				
Total Power $T_A \leq 25°C$	P_T	← 360 →		Watts
Derate Factor $T_A > 25°C$		← 2.87 →		mW/°C
Temperature				
Operating	T_J	-65 to + 150		°C
Storage	T_{STG}	-65 to + 150		°C
Lead (1/16'' ± 1/32'' from case for 10 sec.)	T_L	+260		°C

NOTE 1:
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND .250 FROM THE SEATING PLANE BETWEEN .250 AND END OF LEAD A MAX. OF .021 IS HELD.

ALL DIMENSIONS ARE IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.

TO-18 LEAD SPACING



electrical characteristics: (T_A = 25°C unless otherwise specified)

STATIC CHARACTERISTICS	Symbol	Min.	Max.	Units
Collector-Emitter Breakdown Voltage				
(I_C = 10mA, I_B = 0)	$V_{(BR)CEO*}$	30		Volts
Collector-Base Breakdown Voltage				
(I_C = 10uA, V_{BE} = 0) 2N5368, 2N5369, 2N5370	$V_{(BR)CBO}$	60		Volts
Collector-Base Breakdown Voltage				
(I_C = 10uA, I_E = 0) 2N5371	$V_{(BR)CBO}$	40		Volts
Emitter-Base Breakdown Voltage				
(I_E = 10uA, I_C = 0)	$V_{(BR)EBO}$	5		Volts
Collector Cutoff Current				
(V_{CB} = 40V, I_E = 0) 2N5368, 2N5369, 2N5370	I_{CBO}		50	nA
Collector Cutoff Current				
(V_{CB} = 30V, I_E = 0) 2N5371	I_{CBO}		50	nA
Emitter-Base Reverse Current				
(V_{EB} = 3 V, I_C = 0)	I_{EBO}		50	nA
orward Current Transfer Ratio				
(V_{CE} = 10V, I_C = 1mA) 2N5368	h_{FE}	20		
(V_{CE} = 10V, I_C = 1mA) 2N5369	h_{FE}	50		
(V_{CE} = 10V, I_C = 1mA) 2N5370	h_{FE}	75		
(V_{CE} = 10V, I_C = 1mA) 2N5371	h_{FE}	20		
orward Current Transfer Ratio				
(V_{CE} = 10V, I_C = 10mA) 2N5368	h_{FE*}	40		
(V_{CE} = 10V, I_C = 10mA) 2N5369	h_{FE*}	75		
(V_{CE} = 10V, I_C = 10mA) 2N5370	h_{FE*}	150		
(V_{CE} = 10V, I_C = 10mA) 2N5371	h_{FE*}	40		
Forward Current Transfer Ratio				
(V_{CE} = 10V, I_C = 150mA) 2N5368	h_{FE*}	60	200	
(V_{CE} = 10V, I_C = 150mA) 2N5369	h_{FE*}	100	300	
(V_{CE} = 10V, I_C = 150mA) 2N5370	h_{FE*}	200	600	
(V_{CE} = 10V, I_C = 150mA) 2N5371	h_{FE*}	60	600	

ELECTRICAL CHARACTERISTICS (CONTINUED)

	Symbol	Min.	Max.	Units
Collector-Emitter Saturation Voltage (I_C = 150mA, I_B = 15mA)	$V_{CE(SAT)}$*		.3	Volts
Base-Emitter Saturation Voltage (I_C = 150mA, I_B = 15mA)	$V_{BE(SAT)}$*		1.3	Volts
Base-Emitter Voltage (V_{CE} = 10V, I_C = 150mA)	$V_{BE(ON)}$*		1.2	Volts
DYNAMIC CHARACTERISTICS				
Collector-Base Capacitance (V_{CB} = 10V, I_E = 0, f = 1MHz)	C_{CB}		8	pf
Forward Current Transfer Ratio (V_{CE} = 10V, I_C = 20mA, f = 100MHz)	h_{FE}	2.5		
SWITCHING CHARACTERISTICS				
Turn-on Time, Figure 1 (I_C = 150mA, I_{B1} = 15mA V_{CC} = 30V)	t_{ON}		40	nsec
Turn-off Time, Figure 2 (I_C = 150mA, I_{B1} = I_{B2} = 15mA V_{CC} = 30V)				
2N5368, 2N5369	t_{OFF}		350	nsec
2N5370, 2N5371	t_{OFF}		400	nsec

*Pulse Width ≦ 300 μsec., duty cycle ≦ 2%

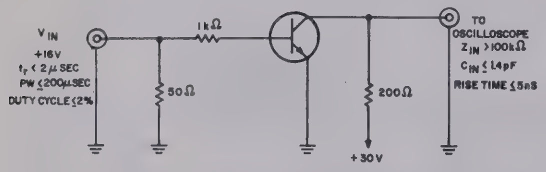

V IN
+16V
t r < 2 μ SEC
PW ≤200μSEC
DUTY CYCLE ≤2%
1kΩ
50Ω
200Ω
+30V
TO
OSCILLOSCOPE
Z IN >100kΩ
C IN ≤ 1.4pF
RISE TIME ≤5nS

FIGURE 1. TEST CIRCUIT FOR DETERMINING TURN-ON TIME

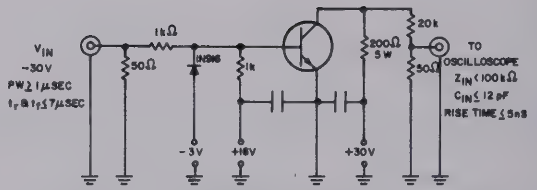
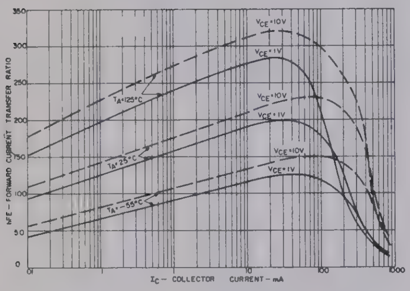
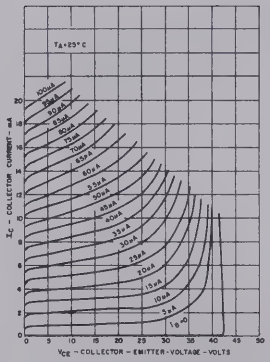

V IN
-30V
PW ≥ 1μSEC
t r & t f ≤ 7μSEC
1kΩ
50Ω
IN916
1k
-3V
+16V
200Ω 5W
+30V
20k
50Ω
TO
OSCILLOSCOPE
Z IN < 100kΩ
C IN ≤ 12 pF
RISE TIME ≤ 5nS

FIGURE 2. TEST CIRCUIT FOR DETERMINING TURN-OFF TIME

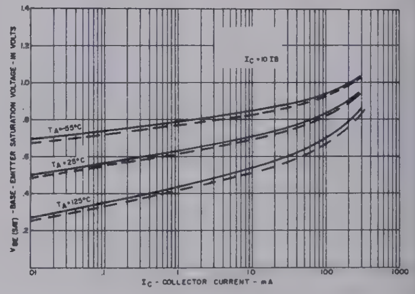
TYPICAL CHARACTERISTIC CURVES



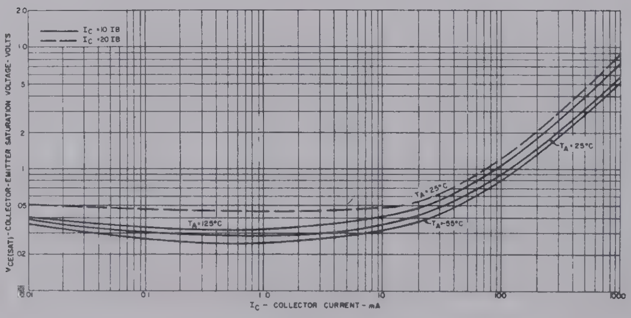
BETA VS. COLLECTOR CURRENT



COLLECTOR CHARACTERISTICS



BASE-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



COLLECTOR-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT

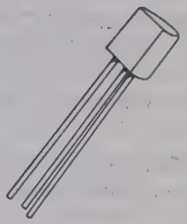
Silicon
Transistors

PNP

2N5372
2N5373
2N5374
2N5375

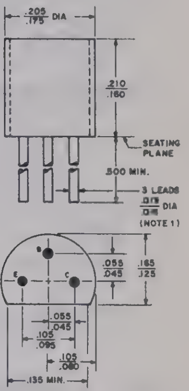
The General Electric 2N5372 — 2N5375 are planar, epitaxial, passivated PNP silicon transistors designed as a medium current switch and for general purpose amplifier applications. For complimentary NPN types see 2N5368 — 2N5371 specifications.

Voltage and current valves for PNP are negative: Observe proper bias polarity.



absolute maximum ratings: (T$_A$ = 25°C unless otherwise specified)

		2N5372 2N5373 2N5374	2N5375	
Voltages				
Collector to Emitter	V_{CEO}	30	30	Volts
Collector to Base	V_{CBO}	60	40	Volts
Emitter to Base	V_{EBO}	5	5	Volts
Current				
Collector	I_C	← 500 →		mA
Dissipation				
Total Power TA ≤ 25°C	P_T	← 360 →		Watts
Derate Factor TA > 25°C		← 2.87 →		mW/°C
Temperature				
Operating	T_J	-65 to + 150		°C
Storage	T_{STG}	-65 to + 150		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	+260		°C



NOTE 1:
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND .250 FROM THE SEATING PLANE BETWEEN .250 AND END OF LEAD A MAX. OF .021 IS HELD.

ALL DIMENSIONS ARE IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.

TO-18 LEAD SPACING

electrical characteristics: (T$_A$ = 25°C unless otherwise specified)

STATIC CHARACTERISTICS	Symbol	Min.	Max.	Units
Collector-Emitter Breakdown Voltage (I_C = 10mA, I_B = 0)	$V_{(BR)CEO}$	30		Volts
Collector-Base Breakdown Voltage (I_C = 10 µA, V_{BE} = 0) 2N5372, 2N5373,2N5374	$V_{(BR)CBO}$	60		Volts
Collector-Base Breakdown Voltage (I_C = 10uA, I_E = 0) 2N5375	$V_{(BR)CBO}$	40		Volts
Emitter-Base Breakdown Voltage (I_E = 10uA, I_C = 0)	$V_{(BR)EBO}$	5		Volts
Collector Cutoff Current (V_{CB} = 40V, I_E = 0) 2N5372, 2N5373, 2N5374	I_{CBO}		50	nA
Collector Cutoff Current (V_{CB} = 30 V, I_E = 0) 2N5375	I_{CBO}		50	nA
Emitter-Base Reverse Current (V_{EB} = 3 V, Ic = 0)	I_{EBO}		50	nA
Forward Current Transfer Ratio				
(V_{CE} = 10 V, I_C = 1mA) 2N5372	h_{FE}	20		
(V_{CE} = 10 V, I_C = 1mA) 2N5373	h_{FE}	50		
(V_{CE} = 10 V, I_C = 1mA) 2N5374	h_{FE}	100		
(V_{CE} = 10 V, I_C = 1mA) 2N5375	h_{FE}	20		
Forward Current Transfer Ratio				
(V_{CE} = 10 V, I_C = 10mA) 2N5372	h_{FE}*	30		
(V_{CE} = 10 V, I_C = 10mA) 2N5373	h_{FE}*	75		
(V_{CE} = 10 V, I_C = 10mA) 2N5374	h_{FE}*	150		
(V_{CE} = 10 V, I_C = 10mA) 2N5375	h_{FE}*	30		

ELECTRICAL CHARACTERISTICS (CONTINUED)

	Symbol	Min.	Max.	Units
Forward Current Transfer Ratio				
(V_{CE} = 10 V, I_C = 150mA) 2N5372	h_{FE}*	40	120	
(V_{CE} = 10 V, I_C = 150mA) 2N5373	h_{FE}*	100	300	
(V_{CE} = 10 V, I_C = 150mA) 2N5374	h_{FE}*	200	400	
(V_{CE} = 10 V, I_C = 150mA) 2N5375	h_{FE}*	40	400	
Collector-Emitter Saturation Voltage				
(I_C = 150mA, I_B = 15mA)	$V_{CE(SAT)}$*		.3	Volts
Base-Emitter Saturation Voltage				
(I_C = 150mA, I_B = 15mA)	$V_{BE(SAT)}$*		1.3	Volts
Base-Emitter Voltage				
(V_{CE} = 10 V, I_C = 150mA)	$V_{BE(ON)}$*		1.2	Volts
DYNAMIC CHARACTERISTICS				
Collector-Base Capacitance				
(V_{CB} = 10V, I_E = 0, f = 1MHz)	C_{CB}		10	pf
Forward Current Transfer Ratio				
(V_{CE} = 10V, I_C = 20mA, F = 100MHz)	h_{FE}	1.5		
SWITCHING CHARACTERISTICS				
Turn-on Time, Figure 1				
(I_C = 150mA, I_{B1}, = 15mA V_{CC} = 30V)	t_{ON}		50	usec.
Turn-off Time, Figure 2				
(I_C = 150mA, I_{B1}, = I_{B2} = 15mA, V_{CC} = 6V) 2N5372, 2N5373,	t_{OFF}		150	nsec.
2N5374, 2N5375	t_{OFF}		175	nsec.

*Pulse Conditions of 300 μs duration, 2% Duty Cycle.

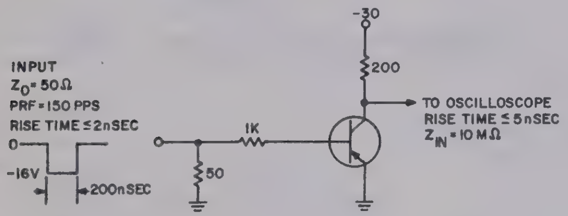

-30
200
INPUT
Z_0 = 50Ω
PRF = 150 PPS
RISE TIME ≤ 2nSEC
0
-16V
200nSEC
1K
50
TO OSCILLOSCOPE
RISE TIME ≤ 5nSEC
Z_{IN} = 10 MΩ

FIGURE 1. TEST CIRCUIT FOR DETERMINING DELAY TIME AND RISE TIME

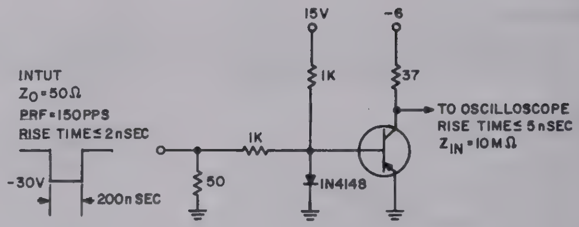
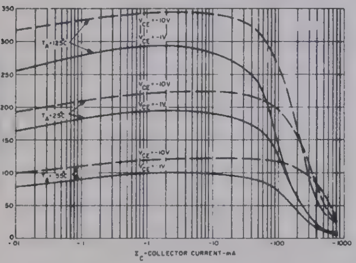
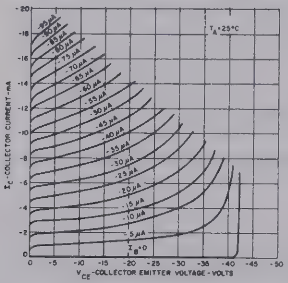

15V
-6
1K
37
INTUT
Z_0 = 50Ω
PRF = 150PPS
RISE TIME ≤ 2nSEC
-30V
200n SEC
1K
50
IN4148
TO OSCILLOSCOPE
RISE TIME ≤ 5nSEC
Z_{IN} = 10 MΩ

FIGURE 2. TEST CIRCUIT FOR DETERMINING STORAGE TIME AND FALL TIME

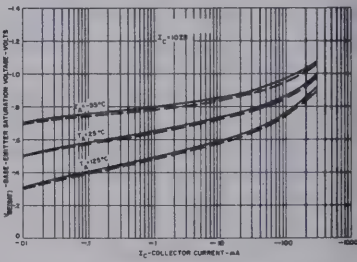
TYPICAL CHARACTERISTIC CURVES



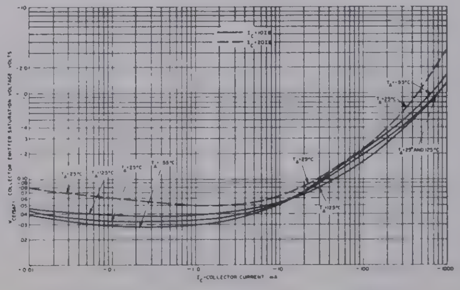
BETA VS. COLLECTOR CURRENT



COLLECTOR CHARACTERISTICS



BASE-EMITTER SATURATION VOLTAG
VS. COLLECTOR CURRENT



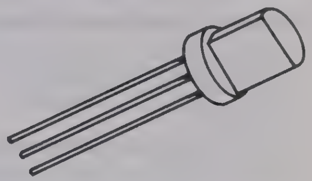
COLLECTER-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT

Silicon Transistors

NPN

2N5418,19,20

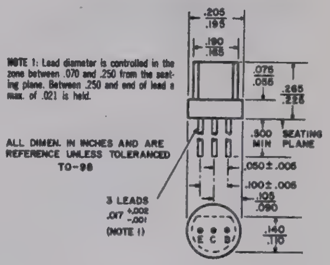
This series of transistors are NPN silicon, planar, epitaxial, passivated devices. These units feature low collector saturation voltage, good current gain linearity over a wide collector current range, high gain-bandwidth product, and low noise. These characteristics make these units excellent for use in general purpose consumer and industrial amplifier and switching applications.



absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	25	Volts
Emitter to Base	V_{EBO}	4	Volts
Collector to Base	V_{CBO}	25	Volts
Current			
Collector (Continuous)	I_C	500	mA
Dissipation			
Total Power (Free Air at 25°C)*	P_T	400	mW
Temperature			
Storage	T_{stg}	−65 to +150	°C
Operating	T_J	+125	°C
Lead temperature, $\frac{1}{16}''\pm\frac{1}{32}''$ from case for ten seconds maximum	T_L	+260	°C

**Derate 4.0 mW/°C increase in ambient temperature above 25°C.*



NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED
TO-98

electrical characteristics: (25°C) (unless otherwise specified)

STATIC CHARACTERISTICS			**Min.**	**Max.**	
Collector Cutoff Current					
($V_{CB} = 25V$)		I_{CBO}		100	nA
($V_{CB} = 25V$, $T_A = 100°C$)		I_{CBO}		10	μA
($V_{CB} = 25V$)		I_{CES}		100	nA
Emitter Cutoff Current					
($V_{EB} = 5V$)		I_{EBO}		10	μA
Forward Current Transfer Ratio					
($V_{CE} = 10V$, $I_C = 2$ mA)	2N5418	h_{FE}	25		
($V_{CE} = 1V$, $I_C = 50$ mA)	2N5418	h_{FE}	40	120	
($V_{CE} = 5V$, $I_C = 300$ mA)	2N5418	h_{FE}	20		
($V_{CE} = 10V$, $I_C = 2$ mA)	2N5419	h_{FE}	70		
($V_{CE} = 1V$, $I_C = 50$ mA)	2N5419	h_{FE}	100	300	
($V_{CE} = 5V$, $I_C = 300$ mA)	2N5419	h_{FE}	40		
($V_{CE} = 10V$, $I_C = 2$ mA)	2N5420	h_{FE}	150		
($V_{CE} = 1V$, $I_C = 50$ mA)	2N5420	h_{FE}	250	500	
($V_{CE} = 5V$, $I_C = 300$ mA)	2N5420	h_{FE}	75		
Collector Emitter Breakdown Voltage					
($I_C = 10$ mA)		$V_{(BR)CEO}$	25		Volts
Collector Saturation Voltage					
($I_C = 50$ mA, $I_B = 2.5$ mA)		$V_{CE(SAT)}$		.250	Volts
($I_C = 300$ mA, $I_B = 30$ mA)		$V_{CE(SAT)}$		1.0	Volts
Base Saturation Voltage					
($I_C = 50$ mA, $I_B = 2.5$ mA)		$V_{BE(SAT)}$		1.1	Volts
($I_C = 300$ mA, $I_B = 30$ mA)		$V_{BE(SAT)}$		2.0	Volts

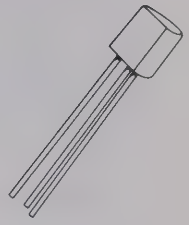
			Min.	Typ.	Max.	
Base Emitter Voltage						
$(V_{CE} = 10V, I_C = 2\ mA)$		V_{BE}	0.5		0.8	Volts
DYNAMIC CHARACTERISTICS						
Forward Current Transfer Ratio						
$(V_{CE} = 10V, I_C = 2\ mA, f = 1\ kHz)$	2N5418	h_{fe}	25		150	
$(V_{CE} = 10V, I_C = 2\ mA, f = 1\ kHz)$	2N5419	h_{fe}	70		400	
$(V_{CE} = 10V, I_C = 2\ mA, f = 1\ kHz)$	2N5420	h_{fe}	150		650	
Output Capacitance, Common Base						
$(V_{CB} = 10V, I_E = 0, f = 1\ MHz)$		C_{cb}		4	6	pF
Input Capacitance, Common Base						
$(V_{EB} = 0.5V, I_C = 0, f = 1\ MHz)$		C_{eb}			35	pF
Gain Bandwidth Product						
$(V_{CE} = 10V, I_C = 2\ mA)$		f_T		250		MHz

Silicon
Transistors

PNP

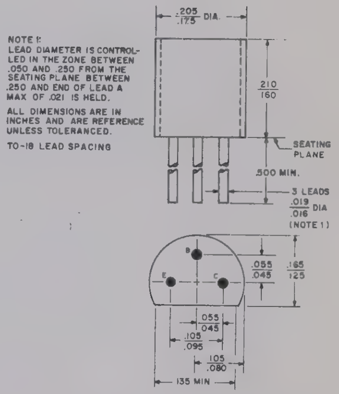
2N5447,8

The General Electric 2N5447 and 2N5448 are silicon, PNP planar, epitaxial, passivated transistors, designed for general audio frequency applications and linear amplifiers. For complimentary NPN types see 2N5449, 2N5450 and 2N5451 specification. Voltage and current valves for PNP are negative, observe proper bias polarity.



absolute maximum ratings: (T_A =25°C unless otherwise specified)

		2N5447	2N5448	
Voltages				
Collector to Emitter	V_{CEO}	25	30	Volts
Collector to Base	V_{CBO}	40	50	Volts
Emitter to Base	V_{EBO}	5	5	Volts
Current				
Collector	I_C	← 200 →		mA
Dissipation				
Total Power $T_A \leqq 25°C$	P_T	← 360 →		Watts
Total Power $T_C \leqq 25°C$	P_T	← 500 →		Watts
Derate Factor $T_A > 25°C$		← 2.88 →		mW/°C
Derate Factor $T_C > 25°C$		← 4 →		mW/°C
Temperature				
Storage	$T_{STG.}$	-65 to + 150		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	+260		°C

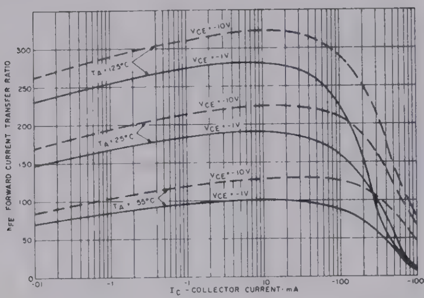

NOTE 1:
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND .250 FROM THE SEATING PLANE BETWEEN .250 AND END OF LEAD A MAX OF .021 IS HELD.
ALL DIMENSIONS ARE IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.
TO-18 LEAD SPACING
.205/.175 DIA.
210/160
SEATING PLANE
.500 MIN.
3 LEADS
.019/.016 DIA
(NOTE 1)
B
E
C
.055/.045
.165/125
055/045
.105/.095
105/.080
135 MIN

electrical characteristics: (T_A =25°C unless otherwise specified)

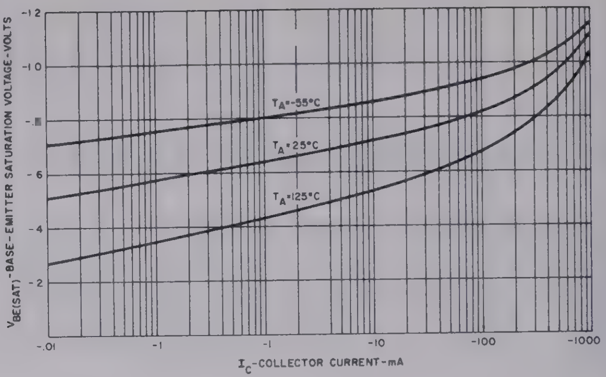
STATIC CHARACTERISTICS	Symbol	2N5447 Min.	2N5447 Max.	2N5448 Min.	2N5448 Max.	Units
Collector-emitter breakdown voltage ($I_C = 10mA, I_B = 0$)	$V_{(BR)CEO*}$	25		30		Volts
Collector-base breakdown voltage ($I_C = 100uA, I_E = 0$)	$V_{(BR)CBO}$	40		50		Volts
Emitter-base breakdown voltage ($I_E = 100uA, I_C = 0$)	$V_{(BR)EBO}$	5		5		Volts
Collector cutoff current ($V_{CB} = 20V, I_E = 0$)	I_{CBO}		100		100	nA
Emitter-base reverse current ($V_{EB} = 3V, I_C = 0$)	I_{EBO}		100		100	nA
Forward current transfer ratio ($V_{CE} = 5V, I_C = 50mA$)	h_{FE*}	60	300	30	150	
Collector-emitter saturation voltage ($I_C = 50mA, I_B = 5mA$)	$V_{CE(sat)*}$		.25		.25	Volts
Base-emitter voltage ($V_{CE} = 5V, I_C = 50mA$)	$V_{BE(on)*}$	.6	1	.6	1	Volts
DYNAMIC CHARACTERISTICS						
Collector-base capacitance ($V_{CB} = 10V, I_E = 0, f = 1MHz$)	C_{cb}		12		12	pf
Forward current transfer ratio ($V_{CE} = 5V, I_C = 50mA, f = 20MHz$)	h_{FE}	5		5		

*Pulse Conditions: Pulse Width ≦ 300 μs and duty cycle ≦ 2%

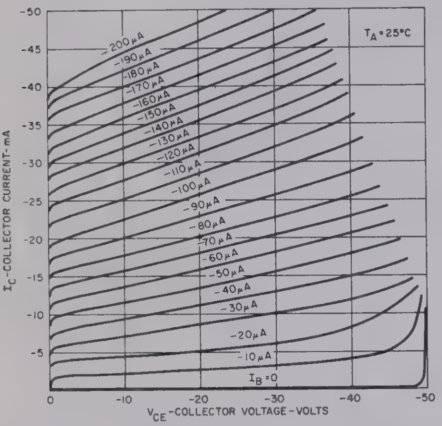
TYPICAL CHARACTERISTIC CURVES



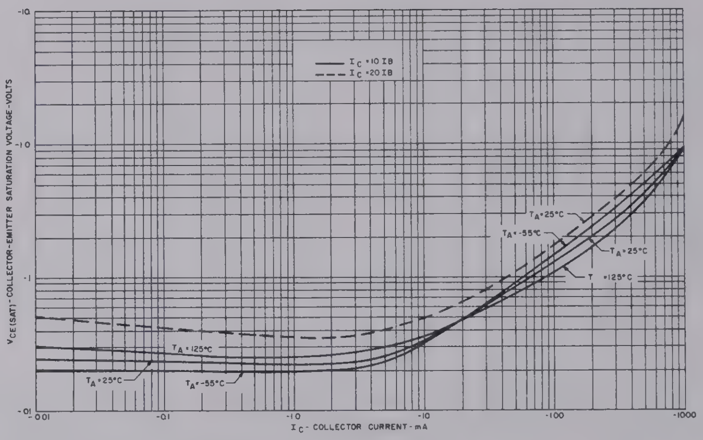
BETA VS. COLLECTOR CURRENT



BASE-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



COLLECTOR CHARACTERISTICS



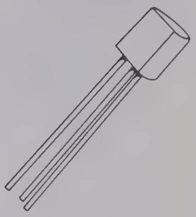
COLLECTOR-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT

Silicon
Transistors

NPN

2N5449,50,51

The General Electric 2N5449, 2N5450 and 2N5451 are silicon NPN planar, epitaxial, passivated transistors designed for general audio frequency applications and linear amplifiers. For complimentary PNP types see 2N5447 and 2N5448 specifications.



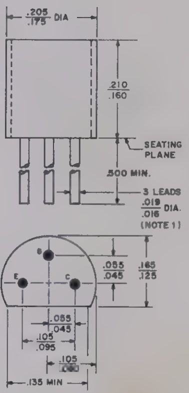
absolute maximum ratings: (T$_A$ = 25°C unless otherwise specified)

		2N5449 2N5450	2N5451	
Voltages				
Collector to Emitter	V_{CEO}	30	20	Volts
Collector to Base	V_{CBO}	50	40	Volts
Emitter to Base	V_{EBO}	5	5	Volts
Current				
Collector	I_C	← 800 →		mA
Dissipation				
Total Power $T_A \leqq 25°C$	P_T	← .360 →		Watts
Total Power $T_C \leqq 25°C$	P_T	← .500 →		Watts
Derate Factor $T_A > 25°C$		← 2.88 →		mW/°C
Derate Factor $T_C > 25°C$		← 4 →		mW/°C
Temperature				
Storage	T_{STG}	-65 to + 150		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	+260		°C

NOTE 1:
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND .250 FROM THE SEATING PLANE BETWEEN .250 AND END OF LEAD A MAX. OF .021 IS HELD.

ALL DIMENSIONS ARE IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

TO-18 LEAD SPACING

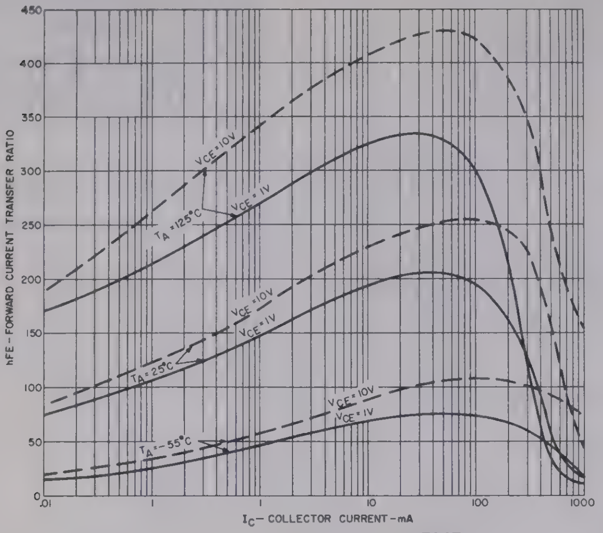


electrical characteristics: (T$_A$ = 25°C unless otherwise specified)

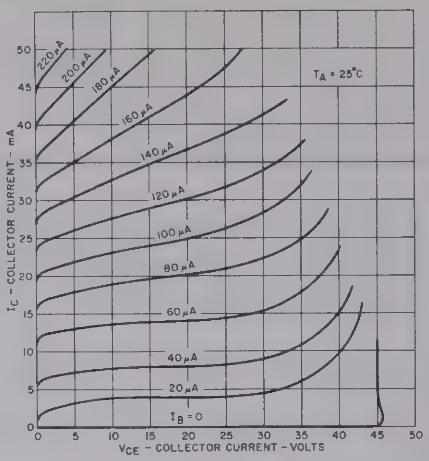
		2N5449		2N5450		2N5451		
STATIC CHARACTERISTICS	**Symbol**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Units**
Collector-Emitter Breakdown Voltage ($I_C = 10mA, I_B = 0$)	$V_{(BR)CEO*}$	30		30		20		Volts
Collector-Base Breakdown Voltage ($I_C = 100 uA, I_E = 0$)	$V_{(BR)CBO}$	50		50		40		Volts
Emitter-Base Breakdown Voltage ($I_E = 100uA, I_C = 0$)	$V_{(BR)EBO}$	5		5		5		Volts
Collector Cutoff Current ($V_{CB} = 20 V, I_E = 0$)	I_{CBO}		100		100		100	nA
Emitter-Base Reverse Current ($V_{EB} = 3 V, I_C = 0$)	I_{EBO}		100		100		100	nA
Forward Current Transfer Ratio ($V_{CE} = 2 V, I_C = 50mA$)	h_{FE*}	100	300	50	150	30	600	
Collector-Emitter Saturation Voltage ($I_C = 100mA, I_B = 5mA$)	$V_{CE(SAT)*}$		.6		.8		1	Volts
Base-Emitter Voltage ($V_{CE} = 2 V, I_C = 100mA$)	$V_{BE(ON)*}$	.5	1	.5	1	.5	1	Volts
DYNAMIC CHARACTERISTICS								
Collector-Base Capacitance ($V_{CB} = 10 V, I_E = 0, f = 1MHz$)	C_{CB}		12		12		12	pf
Forward Current Transfer Ratio ($V_{CE} = 2 V, I_C = 50mA, f = 20MHz$)	h_{FE}	5		5		5		

*Pulse Conditions: Pulse Width ≦ 300 μs and duty cycle ≦ 2%

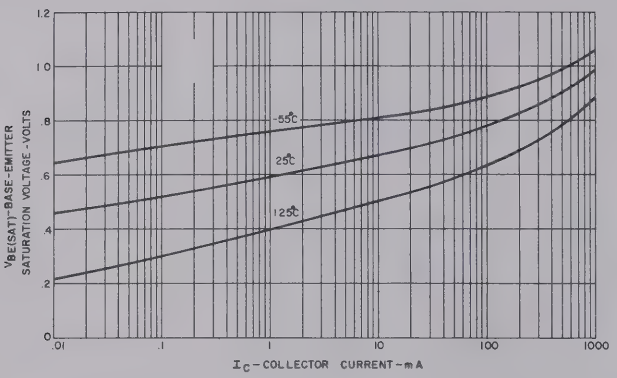
TYPICAL CHARACTERISTIC CURVES



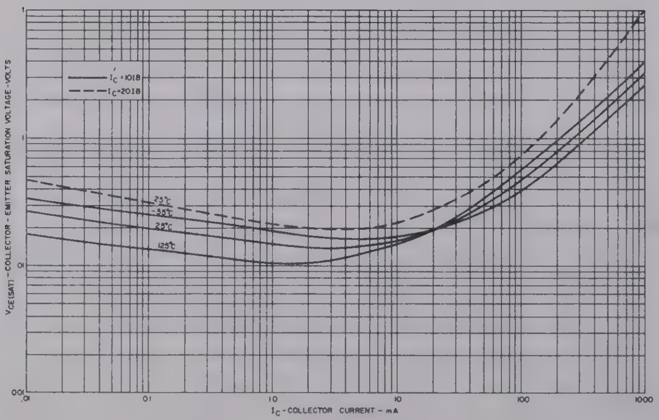
BETA VS. COLLECTOR CURRENT



COLLECTOR CHARACTERISTICS



BASE-EMITTER SATURATION VOLTAGE
VS. COLLECTOR CURRENT



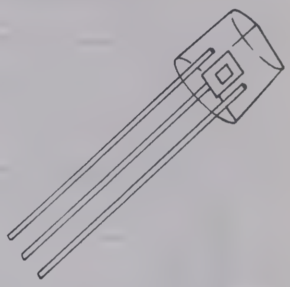
COLLECTOR-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT

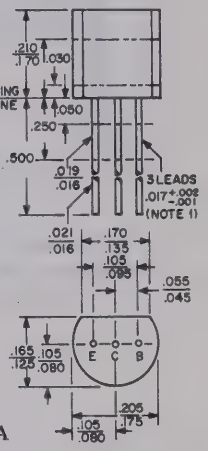
Silicon
Transistors

NPN

2N5777-80

his General Electric Light Sensor Series is an NPN planar silicon photo-darlington amplifier. For nany applications, only the collector and emitter leads are used. A base lead is provided to control ensitivity and the gain of the device. They are packaged in clear epoxy encapsulant and can be ised in industrial and commercial applications requiring a low-cost, general purpose, photo-ensitive device.





DIMENSIONS WITHIN JEDEC OUTLINE TO-92.

NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.

bsolute maximum ratings: (25°C) (unless otherwise specified)

		2N5777, 79 (L14D1,3)	2N5778, 80 (L14D2,4)	
oltages—Dark Characteristics				
Collector to Emitter	V_{CEO}	25	40	Volts
Collector to Base	V_{CBO}	25	40	Volts
Emitter to Base	V_{EBO}	8	12	Volts
urrent				
Light Current	I_L	250	250	mA
issipation				
Power Dissipation*	P_T	200	200	mW
emperature				
Junction Temperature	T_J	←100°C→		
Storage Temperature	T_{stg}	←−65°C to +100°C→		

*Derate 2.67mW/°C above 25°C ambient

lectrical characteristics: (25°C) (unless otherwise specified)

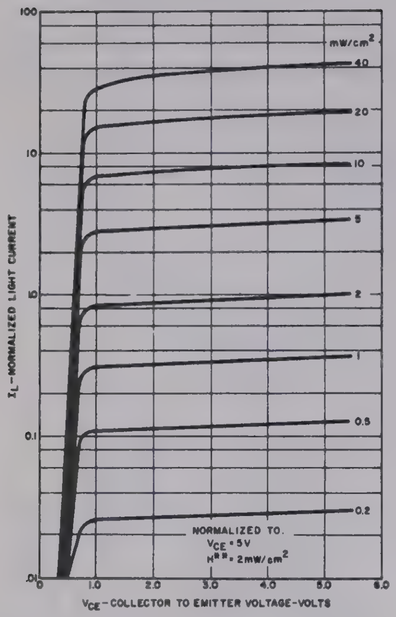
		2N5777, 78		2N5779, 80		
tatic Characteristics		Min.	Max.	Min.	Max.	
ight Current (V_{CE} = 5V, H = 2mW/cm² **)	I_L	0.5	–	2.0	–	mA
orward Current Transfer Ratio (V_{CE} = 5V, I_C = 0.5mA)	h_{FE}	2.5k	–	5k	–	

		2N5777, 79		2N5778, 80		
		Min.	Max.	Min.	Max.	
ark Current (V_{CE} = 12V, I_B = 0)	I_D	–	100	–	100	nA
ollector-Emitter Breakdown Voltage (I_C = 10mA, H = 0)	$V_{(BR)CEO}$	25	–	40	–	Volts
ollector-Base Breakdown Voltage (I_C = 100nA, H = 0)	$V_{(BR)CBO}$	25	–	40	–	Volts
mitter-Base Breakdown Voltage (I_E = 100nA, H = 0)	$V_{(BR)EBO}$	8	–	12	–	Volts

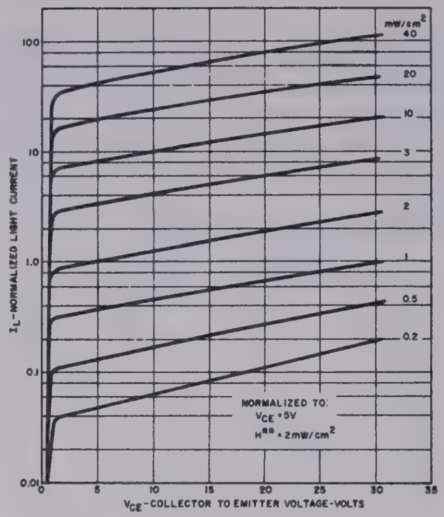
		2N5777-80			
ynamic Characteristics		Min.	Typ.	Max.	
witching Speeds (V_{CE} = 10V, I_L = 10mA, R_L = 100 ohms, GaAs LED source)					
Delay Time	t_d	–	30	100	µsec.
Rise Time	t_r	–	75	250	µsec.
Storage Time	t_s	–	0.5	5	µsec.
Fall Time	t_f	–	45	150	µsec.
ollector-Base Capacitance (V_{CB} = 10V, f = 1MHz)	C_{cb}	–	7.6	10	pF
mitter-Base Capacitance (V_{EB} = 0.5V, f = 1MHz)	C_{eb}	–	10.5	–	pF
ollector-Emitter Capacitance (V_{CEO} = 10V, f - 1MHz)	C_{ceo}	–	3.4	–	pF

*H = Radiation Flux Density. Radiation source is an unfiltered tungsten filament bulb at 2870°K color temperature.

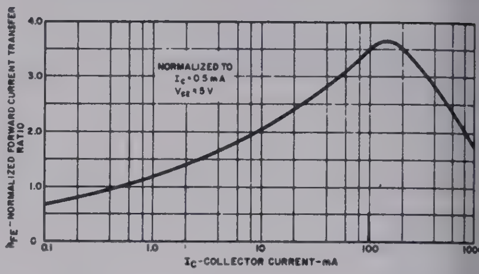
TYPICAL ELECTRICAL CHARACTERISTICS



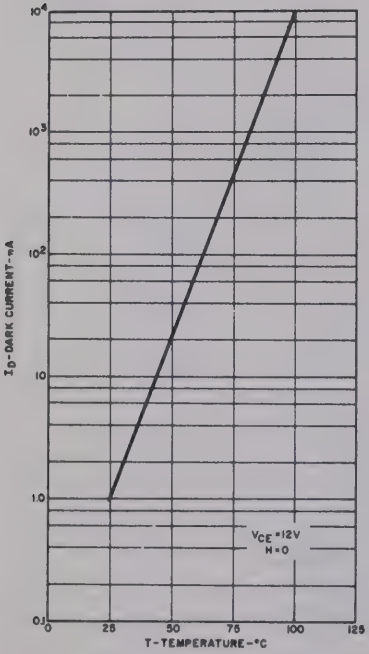
1. NORMALIZED LIGHT CURRENT VS. COLLECTOR TO EMITTER VOLTAGE



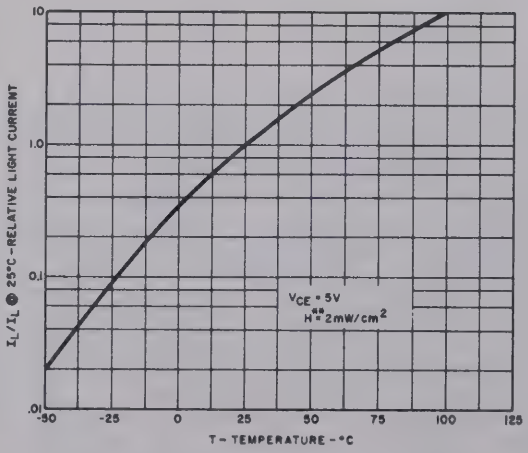
2. NORMALIZED LIGHT CURRENT VS. COLLECTOR TO EMITTER VOLTAGE



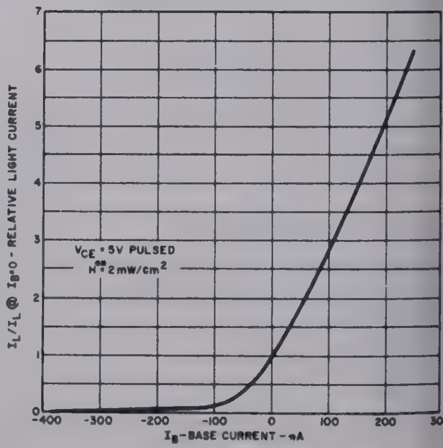
3. NORMALIZED BETA VS. COLLECTOR CURRENT



4. DARK CURRENT VS. TEMPERATURE

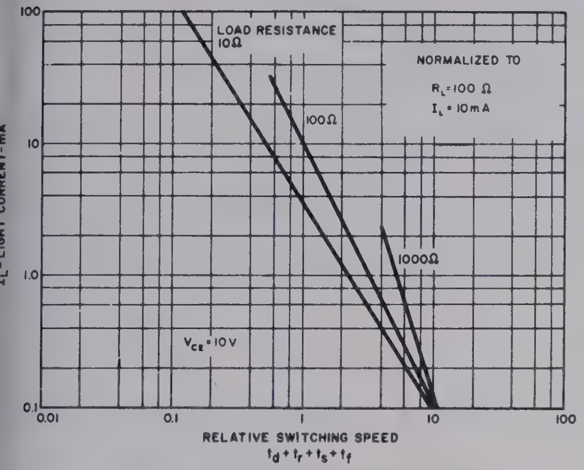


5. RELATIVE LIGHT CURRENT VS. AMBIENT TEMPERATURE

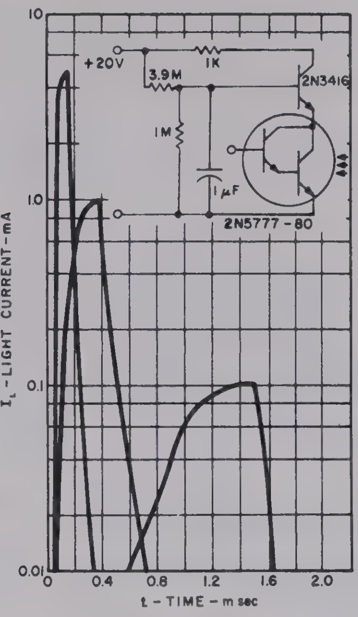


6. RELATIVE LIGHT CURRENT VS. BASE CURRENT

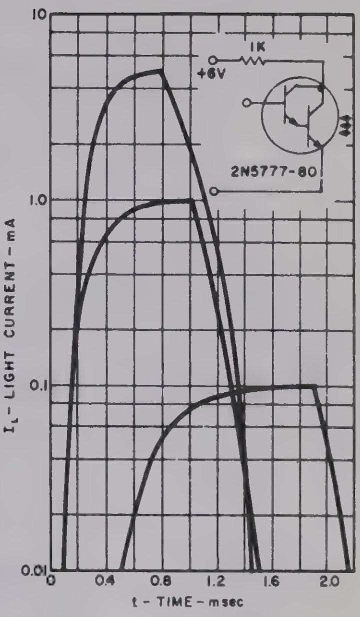
TYPICAL ELECTRICAL CHARACTERISTICS



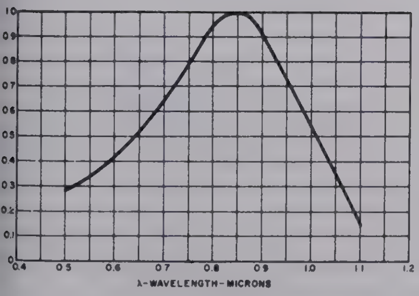
7. LIGHT CURRENT VS. RELATIVE SWITCHING SPEED



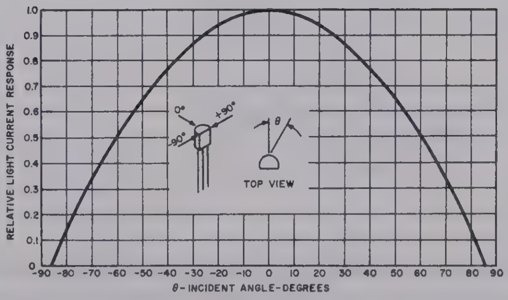
8. TRANSIENT RESPONSE WITH RESISTIVE BIASING



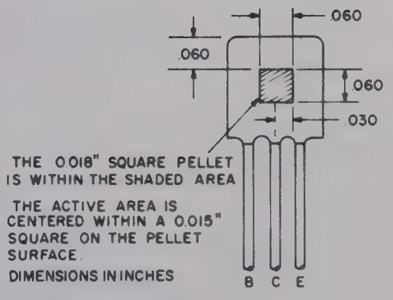
9. TRANSIENT RESPONSE WITH CASCODE BIASING



10. SPECTRAL RESPONSE CURVE



11. RELATIVE RESPONSE VS. INCIDENT ANGLE



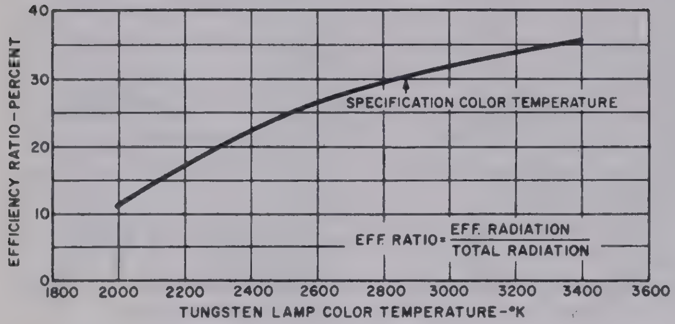
THE 0.018" SQUARE PELLET IS WITHIN THE SHADED AREA

THE ACTIVE AREA IS CENTERED WITHIN A 0.015" SQUARE ON THE PELLET SURFACE.

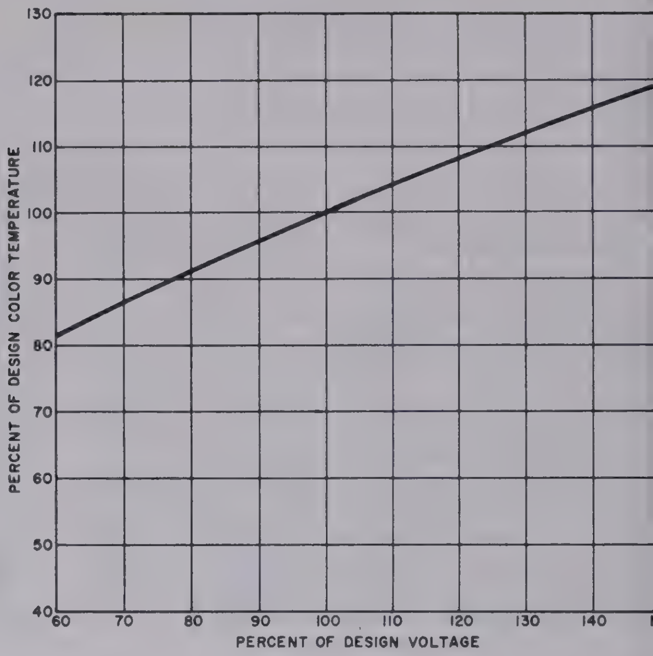
DIMENSIONS IN INCHES

12. PELLET LOCATION

TUNGSTEN LAMP CHARACTERISTICS

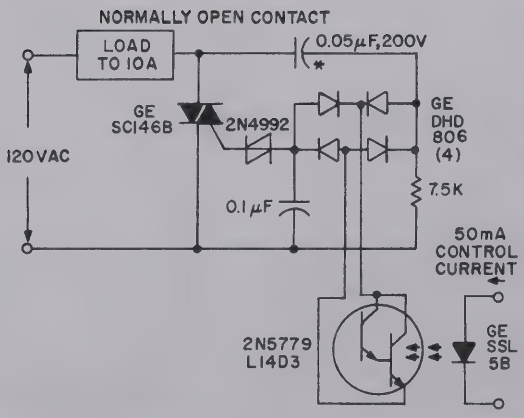


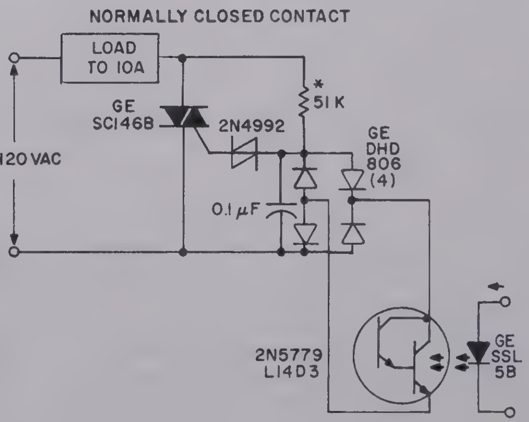
13. TUNGSTEN LAMP COLOR TEMPERATURE EFFECT



14. TUNGSTEN LAMP RELATIVE COLOR TEMPERATURE AS A FUNCTION OF RELATIVE LAMP VOLTAGE

LIGHT ISOLATED SOLID STATE POWER RELAY CIRCUITS


NORMALLY OPEN CONTACT
LOAD TO 10A
0.05μF, 200V
*
GE SC146B
2N4992
GE DHD 806 (4)
120 VAC
7.5K
0.1 μF
50mA CONTROL CURRENT
2N5779 L14D3
GE SSL 5B


NORMALLY CLOSED CONTACT
LOAD TO 10A
*
51 K
GE SC146B
2N4992
GE DHD 806 (4)
120 VAC
0.1 μF
2N5779 L14D3
GE SSL 5B

Both circuits use the G.E. SC146B, 200V, 10A Triac as load current "contacts." These triacs are triggered by normal SBS (2N4992) trigger circuits, which are controlled by the photo-darlington, acting through the DA806 bridge—as an A.C. photo switch. To operate the relays at other line voltages the asterisked (*) components are scaled to supply identical current, and ratings changed as required. Incandescent lamps may be used in place of the light emitting diodes, if desired.

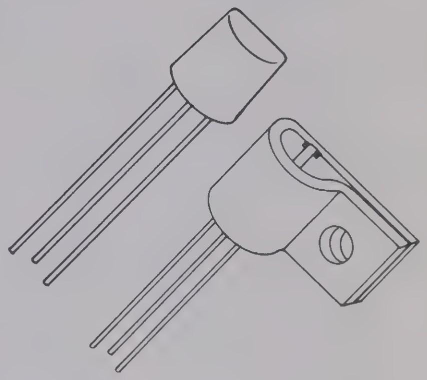
Silicon
Transistors

NPN	PNP
2N5810 2N5812	2N5811 2N5813

These silicon, planar, passivated, epitaxial transistors are intended to satisfy a wide range of general purpose applications at audio and intermediate frequencies.

Features:

- Excellent Gain Linearity over Wide Range of Collector Currents to 500mA and Beyond.
- High Collector Current Ratings: 1000 mA.
- Integral Heat Sinks Available.
- Epoxy Encapsulation with Proved Reliability—excellent characteristic stability under environmental stresses, 85°C—85% RH.

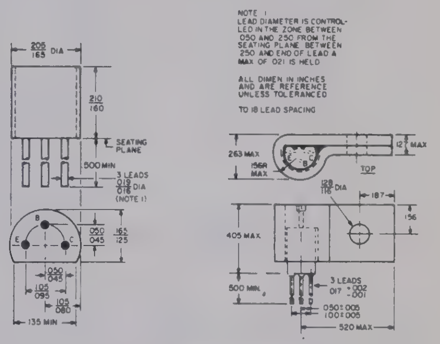


Voltage and current values for PNP devices are negative; observe proper bias polarity.

absolute maximum ratings: (25°C unless otherwise specified)

Voltages			
*Collector to Emitter	V_{CEO}	25	Volts
*Emitter to Base	V_{EBO}	5	Volts
*Collector to Base	V_{CBO}	35	Volts
Collector to Emitter	V_{CES}	35	Volts
Current			
*Collector (Continuous)	I_C	750	mA
Collector (Pulsed, 300 μsec. pulse width, ≦ 2% duty cycle)	I_{CM}	1000	mA
Dissipation			
*Total Power (Free Air, $T_A = 25°C$)[1]	P_T	500	mW
Total Power with Heatsink (Free Air, $T_A \leqq 25°C$)[2]	P_T	700	mW
Total Power with Heatsink (Case Temp., $T_C \leqq 25°C$)[3]	P_T	1000	mW
Temperature			
*Storage	T_{STG}	−65 to +150	°C
*Operating	T_J	−65 to +135	°C
*Lead soldering (1/16" ± 1/32" from case for 10 sec. max.)	T_L	+260	°C

*[1] Derate 4.55 mW/°C increase in ambient temperature above 25°C. [2] Derate 6.36 mW/°C increase in ambient temperature above 25°C. [3] Derate 9.09 mW/°C increase in case temperature above 25°C.
*indicates JEDEC Registered values.


205/165 DIA
210/160
SEATING PLANE
.500 MIN
3 LEADS .019/.016 DIA (NOTE 1)
B
E
C
.050/.045
.165/.125
.050/.045
.105/.095
.105/.080
.135 MIN
NOTE 1
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND .250 FROM THE SEATING PLANE. BETWEEN .250 AND END OF LEAD A MAX OF .021 IS HELD
ALL DIMEN IN INCHES AND ARE REFERENCE UNLESS TOLERANCED
TO 18 LEAD SPACING
.263 MAX
.156R MAX
.12 MAX
TOP
.128/.116 DIA
.187
.156
.405 MAX
.500 MIN.
3 LEADS .017 +.002 −.001
.050±.005
.100±.005
.520 MAX

ORDER HEATSINKED VERSIONS AS: HS5810, HS5811, HS5812, HS5813

electrical characteristics: (25°C unless otherwise specified)

NOTE: Characteristics apply to both heatsinked and non-heatsinked devices.

STATIC CHARACTERISTICS		Min.	Max.	
* Collector Cutoff Current (V_{CB}=25V)	I_{CBO}	—	100	nA
(V_{CB}=25V, T_A=100°C)	I_{CBO}	—	15	μA
Emitter Cutoff Current				
*(V_{EB} = 5V)	I_{EBO}	—	10	μA
Forward Current Transfer Ratio				
*(I_C = 2 mA, V_{CE} = 2V)				
2N5810, 2N5811	h_{FE}	60	200	
2N5812, 2N5813	h_{FE}	150	500	
*(I_C = 500 mA, V_{CE} = 2V)				
2N5810, 2N5811	h_{FE}	45	—	
2N5812, 2N5813	h_{FE}	60	—	
Collector-Emitter Breakdown Voltage				
*(I_C = 10 mA)	$V_{(BR)CEO}$	25	—	Volts
(I_C = 10 μA)	$V_{(BR)CES}$	35	—	Volts
Emitter-Base Breakdown Voltage				
*(I_E = 10 μA)	$V_{(BR)EBO}$	5	—	Volts
Collector Saturation Voltage				
*(I_C = 500 mA, I_B = 50 mA)	$V_{CE(SAT)}$	—	0.75	Volts
Base-Saturation Voltage				
*(I_C = 500 mA, I_B = 50 mA)	$V_{BE(SAT)}$	—	1.2	Volts
Base-Emitter Voltage				
*(I_C = 500 mA, V_{CE} = 2V)	V_{BE}	.60	1.1	Volts
DYNAMIC CHARACTERISTICS				
Collector-Base Capacitance				
*(V_{CB} = 10V, f = 1 MHz)	C_{ob}	—	15	pF

*indicates JEDEC Registered values.

		Min.	Max.	
Input Capacitance, Common Base (V_{EB} = 0.5V, f = 1 MHz)	C_{eb}	—	55	pF
Gain Bandwidth Product (I_C = 50 mA, V_{CE} = 2V, f = 20 MHz)				
2N5810, 2N5811	f_T	100	—	MHz
2N5812, 2N5813	f_T	135	—	MH

Typical h_{FE} vs. I_C

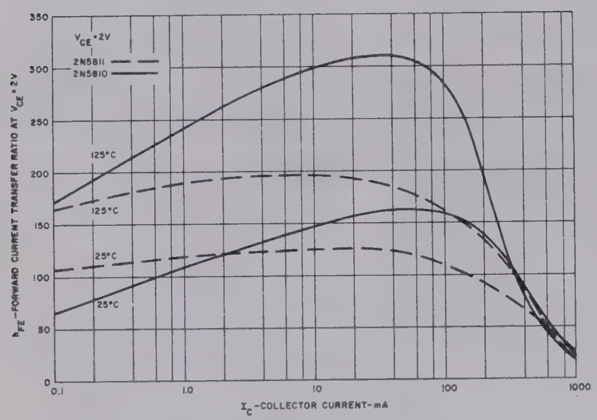


Figure 1

Typical h_{FE} vs. I_C

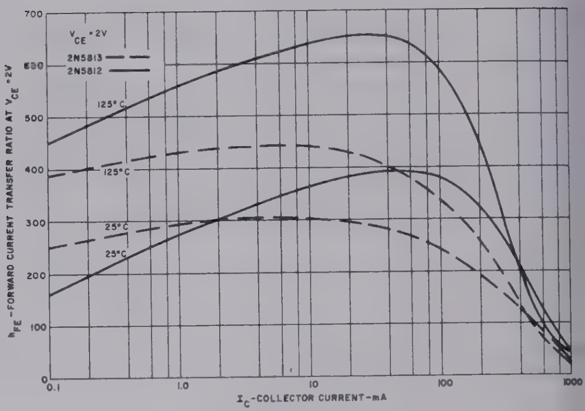


Figure 2

Typical I_{CBO} vs. Ambient Temperature

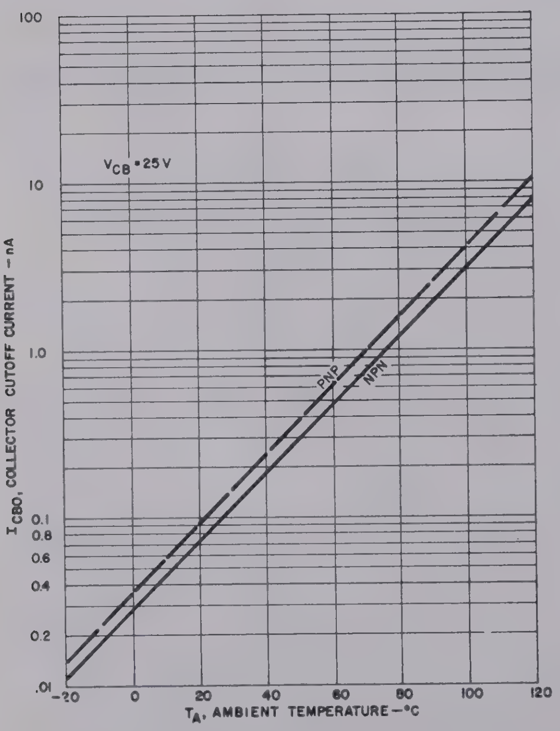


Figure 3

Power vs. Ambient Temperature Derating

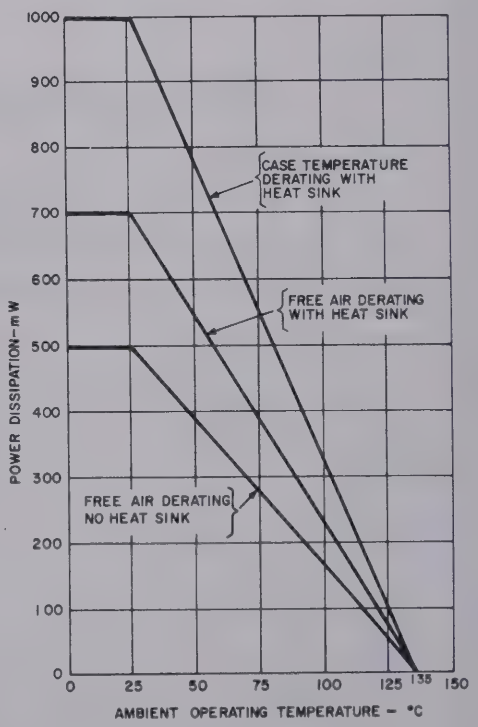


Figure 4

Silicon Transistors

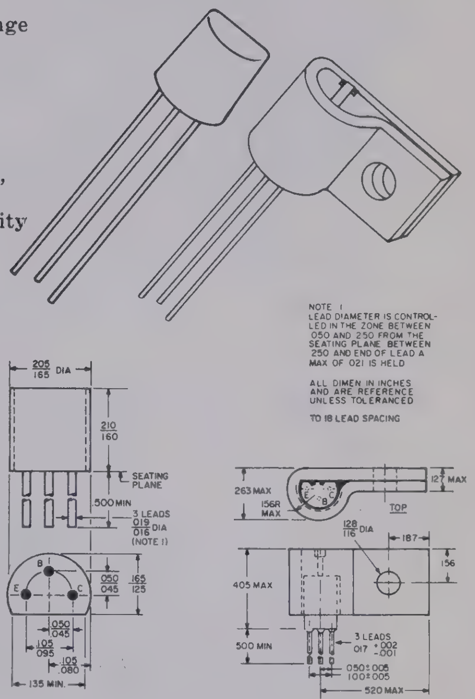
NPN	PNP
2N5814	2N5815
2N5816	2N5817
2N5818	2N5819

These silicon, planar, passivated, epitaxial transistors are intended to satisfy a wide range of general purpose applications at audio and intermediate frequencies.

Features:

- Excellent Gain Linearity over Wide Range of Collector Currents to 500mA and Beyond.
- High Collector Current Ratings: 1000 mA.
- Integral Heat Sinks Available.
- Epoxy Encapsulation with Proved Reliability—excellent characteristic stability under environmental stresses, 85°C—85% RH.

Voltage and current values for PNP devices are negative; observe proper bias polarity


NOTE 1
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN 050 AND 250 FROM THE SEATING PLANE BETWEEN 250 AND END OF LEAD A MAX OF 021 IS HELD
ALL DIMEN IN INCHES AND ARE REFERENCE UNLESS TOLERANCED
TO 18 LEAD SPACING
205/165 DIA
210/160
SEATING PLANE
.500 MIN
3 LEADS 019/016 DIA (NOTE 1)
B
E
C
050/045
165/125
050/045
105/095
105/080
135 MIN.
263 MAX
156R MAX
127 MAX
TOP
128/116 DIA
187
156
405 MAX
500 MIN
3 LEADS 017 +002 −001
050±005
100±005
520 MAX

ORDER HEATSINKED VERSIONS AS: HS5814, HS5815 HS5816, HS5817 HS5818, HS5819

absolute maximum ratings: (25°C) (unless otherwise specified)

Voltage			
*Collector to Emitter	V_{CEO}	40	Volts
*Emitter to Base	V_{EBO}	5	Volts
*Collector to Base	V_{CBO}	50	Volts
Collector to Emitter	V_{CES}	50	Volts
Current			
*Collector (Continuous)	I_C	750	mA
Collector (Pulsed, 300 μsec. pulse width, ≦ 2% duty cycle)	I_{CM}	1000	mA
Dissipation			
*Total Power (Free Air, $T_A \leqq 25°C$) (1)	P_T	500	mW
Total Power with Heatsink (Free Air, $T_A \leqq 25°C$) (2)	P_T	700	mW
Total Power with Heatsink (Case Temp., $T_C \leqq 25°C$) (3)	P_T	1000	mW
Temperature			
*Storage	T_{STG}	−65 to +150	°C
*Operating	T_J	−65 to +135	°C
*Leading soldering (1/16" ± 1/32" from case for 10 sec. max.)	T_L	+260	°C

*Indicates JEDEC Registered values.

*(1) Derate 4.55 mW/°C increase in ambient temperature above 25°C. (2) Derate 6.36 mW/°C increase in ambient temperature above 25°C. (3) Derate 0.09 mW/°C increase in case temperature above 25°C.

electrical characteristics: (25°C) (unless otherwise specified)

NOTE: Characteristics apply to both heatsinked and non-heatsinked devices.

STATIC CHARACTERISTICS		**Min.**	**Max.**	
Collector Cutoff Current				
*(V_{CB}=25V)	I_{CBO}	—	100	nA
(V_{CB}=25V, T_A=100°C)	I_{CBO}	—	15	μA
Emitter Cutoff Current				
*(V_{EB} = 5V)	I_{EBO}	—	10	μA
Forward Current Transfer Ratio				
*(I_C = 2 mA, V_{CE} = 2V)				
2N5814, 2N5815	h_{FE}	60	120	
2N5816, 2N5817	h_{FE}	100	200	
2N5818, 2N5819	h_{FE}	150	300	
*(I_C = 500 mA, V_{CE} = 2 V)				
2N5814, 2N5815	h_{FE}	20	—	
2N5816, 2N5817	h_{FE}	25	—	
2N5818, 2N5819	h_{FE}	25	—	
Collector Emitter Breakdown Voltage				
*(I_C = 10 mA)	$V_{(BR)CEO}$	40	—	Volts
(I_C = 10 μA)	$V_{(BR)CES}$	50	—	Volts
Emitter Base Breakdown Voltage				
*(I_E = 10 μA)	$V_{(BR)EBO}$	5	—	Volts
Collector Saturation Voltage				
*(I_C = 500 mA, I_B = 50 mA)	$V_{CE(SAT)}$	—	0.75	Volts
Base Saturation Voltage				
*(I_C = 500 mA, I_B = 50 mA)	$V_{BE(SAT)}$	—	1.2	Volts
Base Emitter Voltage				
*(I_C = 500 mA, V_{CE} = 2V)	V_{BE}	.60	1.1	Volts

electrical characteristics: (25°C) (unless otherwise specified)

DYNAMIC CHARACTERISTICS		Min.	Max.	
Collector-Base Capacitance *(V_{CB} = 10V, f = 1 MHz)	C_{cb}	—	15	pF
Input Capacitance, Common Base (V_{EB} = 0.5V, f = 1 MHz)	C_{ib}	—	55	pF
Gain Bandwidth Product (I_C = 50 mA, V_{CE} = 2V, f = 20 MHz)				
2N5814, 2N5815	f_T	100	—	MHz
2N5816, 2N5817	f_T	120	—	MHz
2N5818, 2N5819	f_T	135	—	MHz

*Indicates JEDEC Registered values.

Typical h_{FE} vs. I_C

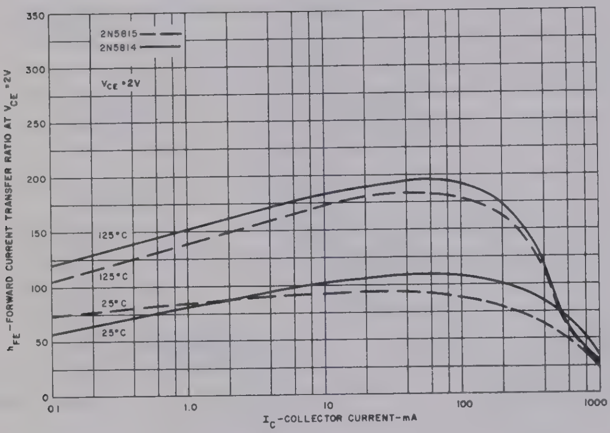


Figure 1

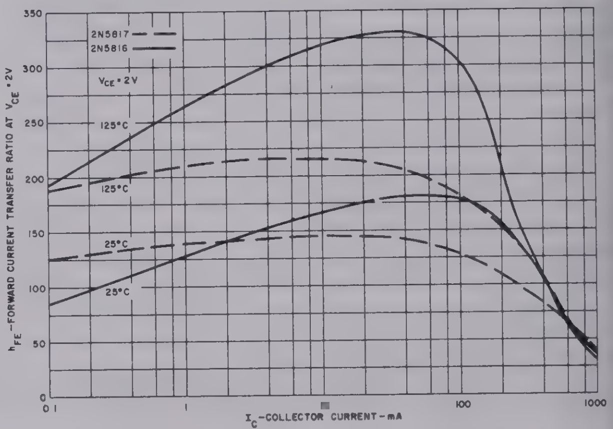


Figure 2

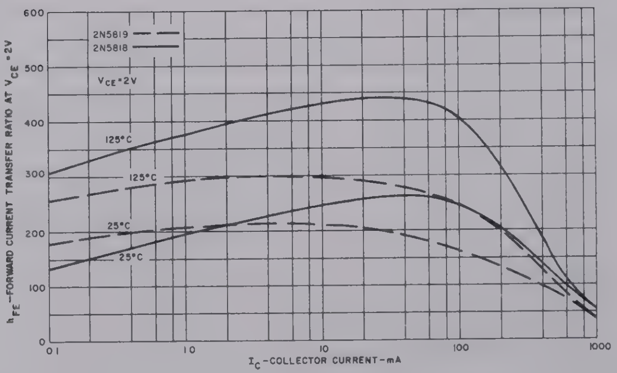


Figure 3

Typical $V_{CE(SAT)}$ vs. I_C, ($I_B = I_C/20$)

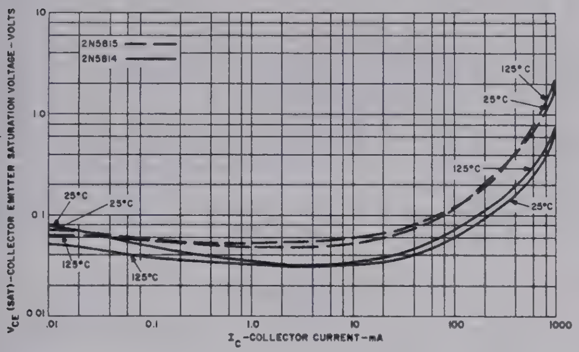


Figure 4

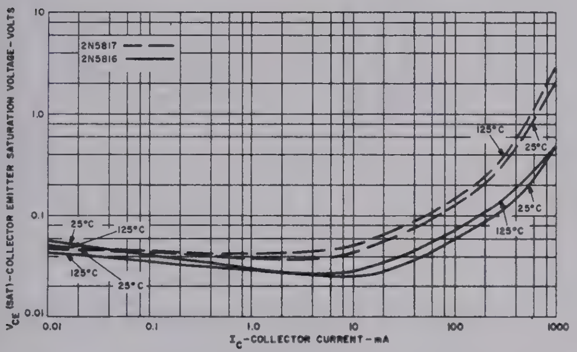


Figure 5

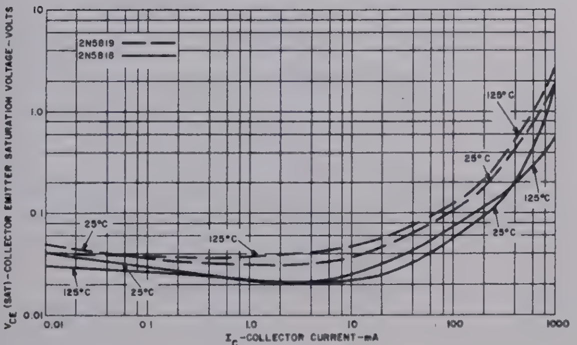


Figure 6

Typical $V_{CE(SAT)}$ vs. I_C, ($I_B = I_C/10$)

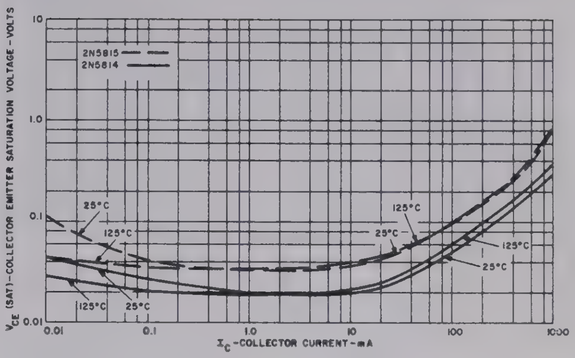


Figure 7

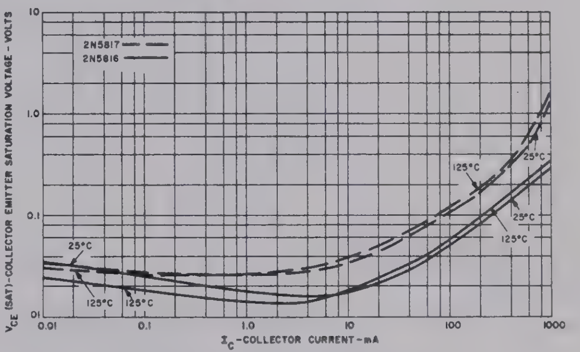


Figure 8

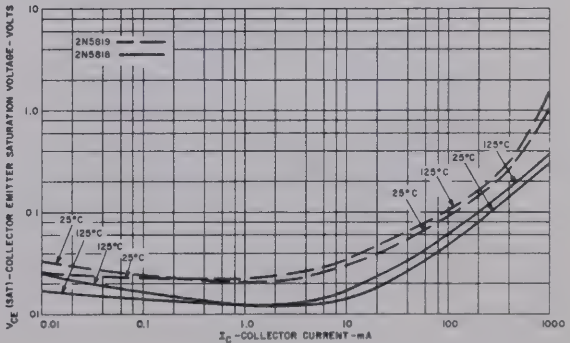


Figure 9

Typical $V_{BE\ on}$ vs. I_C

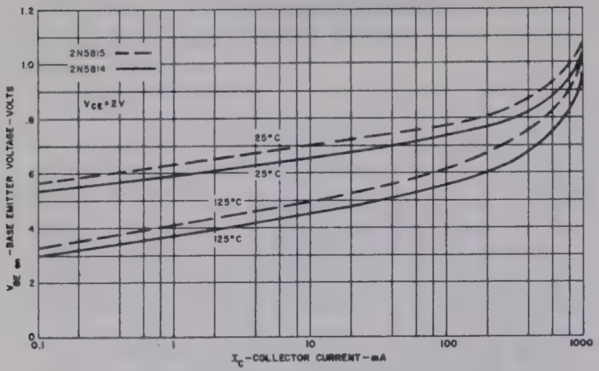


Figure 10

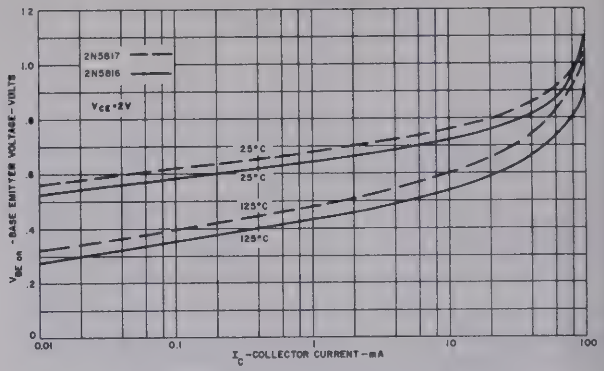


Figure 11

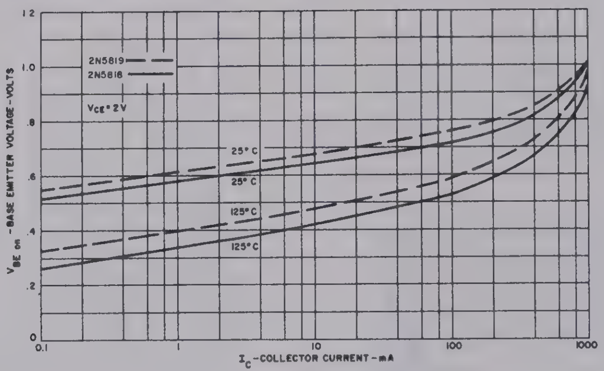


Figure 12

Typical I_{CBO} vs. Ambient Temperature

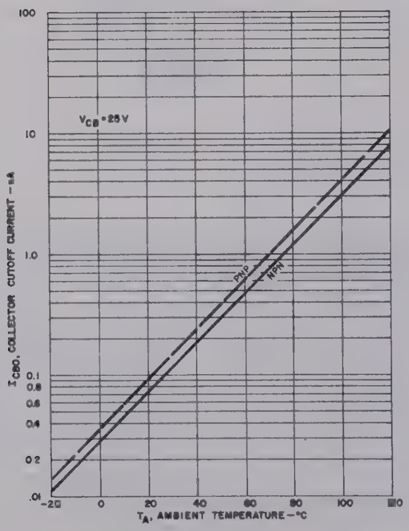


Figure 13

Power vs. Ambient Temperature Derating

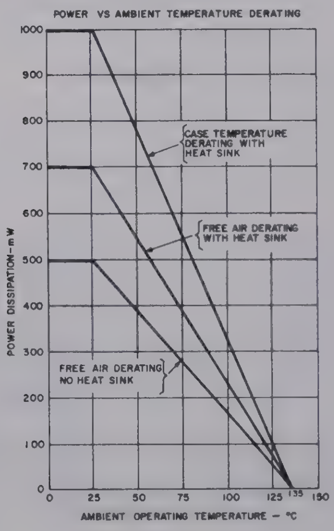


Figure 14

Silicon
Transistors

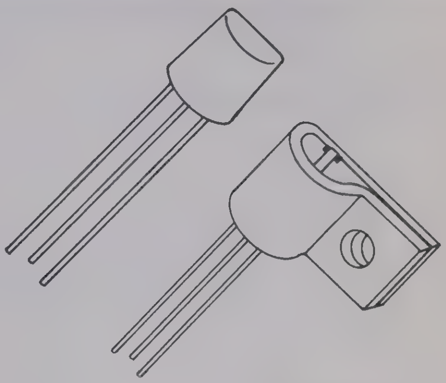
NPN	PNP
2N5820	2N5821
2N5822	2N5823

These silicon, planar, passivated, epitaxial transistors are intended to satisfy a wide range of general purpose applications at audio low and intermediate frequencies.

Features:

- Excellent Gain Linearity over Wide Range of Collector Currents to 500mA and Beyond
- High Collector Current Ratings: 1000 mA.
- Integral Heat Sinks Available.
- Epoxy Encapsulation with Proved Reliability—excellent characteristic stability under environmental stresses, 85°C—85% RH.

Voltage and current values for PNP devices are negative; observe proper bias polarity

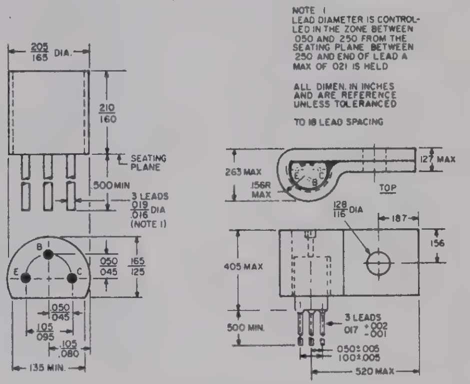


absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
*Collector to Emitter	V_{CEO}	60	Volts
*Emitter to Base	V_{EBO}	5	Volts
*Collector to Base	V_{CBO}	70	Volts
Collector to Emitter	V_{CES}	70	Volts
Current			
*Collector (Continuous)	I_C	750	mA
Collector (Pulsed, 300 μsec. pulse width, ≤ 2% duty cycle)	I_{CM}	1000	mA
Dissipation			
*Total Power (Free Air, $T_A \leq 25°C$)(1)	P_T	500	mW
Total Power with Heatsink (Free Air, $T_A \leq 25°C$)(2)	P_T	700	mW
Total Power with Heatsink (Case Temp., $T_C \leq 25°C$)(3)	P_T	1000	mW
Temperature			
*Storage	T_{STG}	−65 to +150	°C
*Operating	T_J	−65 to +135	°C
*Lead soldering (1/16" ± 1/32" from case for 10 sec. max.)	T_L	+260	°C

*indicates JEDEC Registered values.

*(1)Derate 4.55 mW/°C increase in ambient temperature above 25°C. (2)Derate 6.36 mW/°C increase in ambient temperature above 25°C. (3)Derate 9.09 mW/°C increase in case temperature above 25°C.


NOTE 1
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN 050 AND 250 FROM THE SEATING PLANE BETWEEN 250 AND END OF LEAD A MAX OF 021 IS HELD
ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED
TO 18 LEAD SPACING
205/165 DIA.
210/160
SEATING PLANE
.500 MIN
3 LEADS
.019/.016 DIA
(NOTE 1)
B
E
C
050/045
165/125
.050/.045
.105/.095
.105/.080
135 MIN.
263 MAX
156R MAX
127 MAX
TOP
128/116 DIA
187
156
405 MAX
500 MIN.
3 LEADS
017 +.002 -.001
050±.005
100±.005
520 MAX

ORDER HEATSINKED VERSIONS AS: HS5820, HS5821, HS5822, HS5823

electrical characteristics: (25°C) (unless otherwise specified)

NOTE: Characteristics apply to both heatsinked and non-heatsinked devices.

STATIC CHARACTERISTICS

		Min.	Max.	
Collector Cutoff Current ($V_{CB}=25V$)	I_{CBO}	—	100	nA
($V_{CB}=25V$, $T_A=100°C$)	I_{CBO}	—	15	μA
Emitter Cutoff Current				
*($V_{EB} = 5V$)	I_{EBO}	—	10	μA
Forward Current Transfer Ratio				
*($I_C = 2$ mA, $V_{CE} = 2V$)				
2N5820, 2N5821	h_{FE}	60	120	
2N5822, 2N5823	h_{FE}	100	200	
*($I_C = 500$ mA, $V_{CE} = 2V$)				
2N5820, 2N5821	h_{FE}	20	—	
2N5822, 2N5823	h_{FE}	25	—	
Collector-Emitter Breakdown Voltage				
*($I_C = 10$ mA)	$V_{(BR)CEO}$	60	—	Volts
($I_C = 10$ μA)	$V_{(BR)CES}$	70	—	Volts
Emitter-Base Breakdown Voltage				
*($I_E = 10$ μA)	$V_{(BR)EBO}$	5	—	Volts
Collector Saturation Voltage				
*($I_C = 500$ mA, $I_B = 50$ mA)	$V_{CE(SAT)}$	—	0.75	Volts
Base Saturation Voltage				
*($I_C = 500$ mA, $I_B = 50$ mA)	$V_{BE(SAT)}$	—	1.2	Volts
Base-Emitter Voltage				
*($I_C = 500$ mA, $V_{CE} = 2V$)	V_{BE}	.60	1.1	Volts

DYNAMIC CHARACTERISTICS		Min.	Max.	
Collector-Base Capacitance				
*($V_{CB} = 10V$, f = 1 MHz)	C_{cb}	—	15	pF
Input Capacitance, Common Base				
($V_{EB} = 0.5V$, f = 1 MHz)	C_{eb}	—	55	pF
Gain Bandwidth Product				
($I_C = 50$ mA, $V_{CE} = 2V$, f = 20 MHz)				
2N5820, 2N5821	f_T	100	—	MHz
2N5822, 2N5823	f_T	120	—	MHz

*indicates JEDEC registered values.

Typical h_{FE} vs. I_C

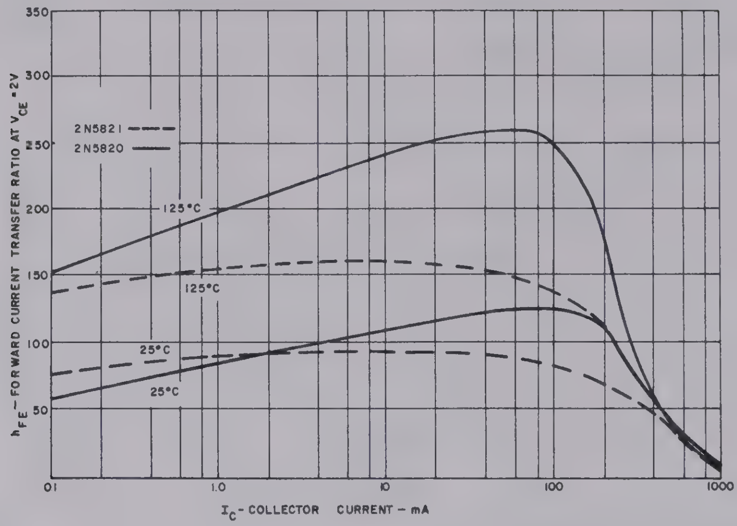


Figure 1

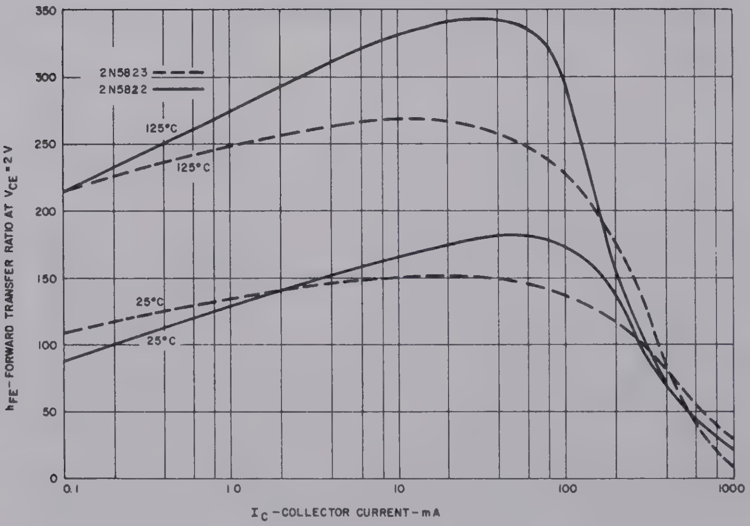


Figure 2

Typical $V_{CE(SAT)}$ vs. I_C
($I_B = I_C/20$)

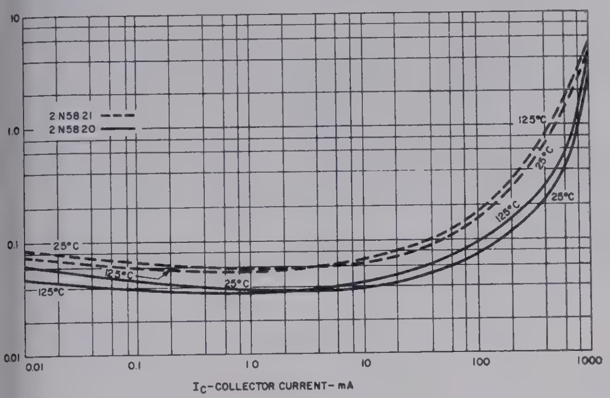


Figure 3

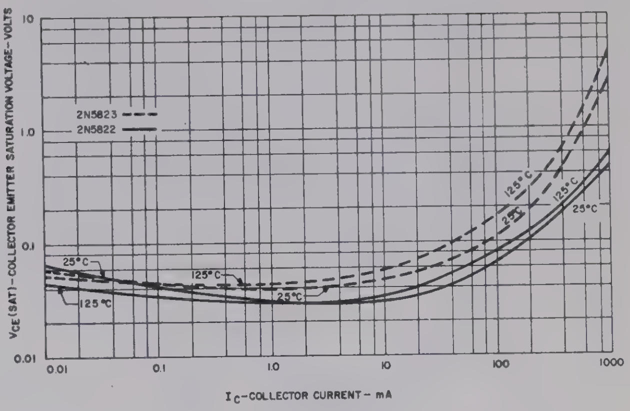


Figure 4

Typical $V_{CE(SAT)}$ vs. I_C
($I_B = I_C/10$)

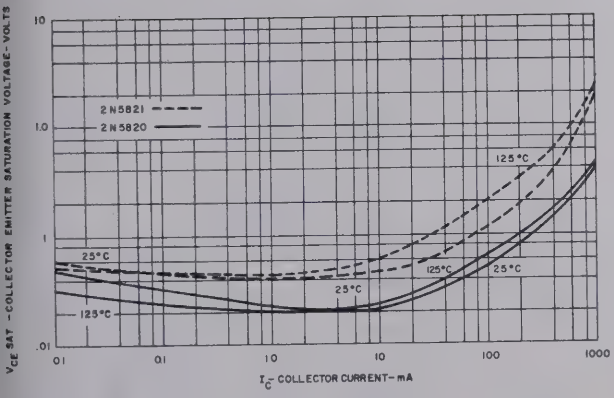


Figure 5

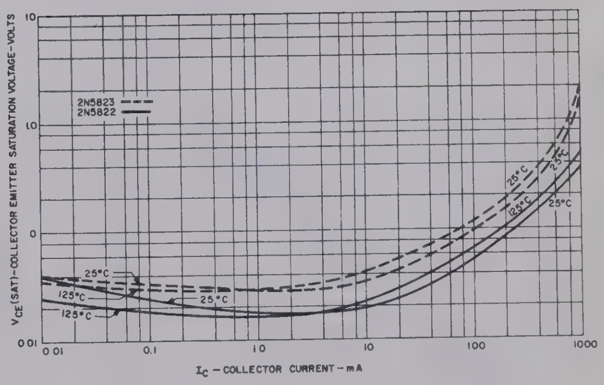


Figure 6

Typical $V_{BE\ on}$ vs. I_C

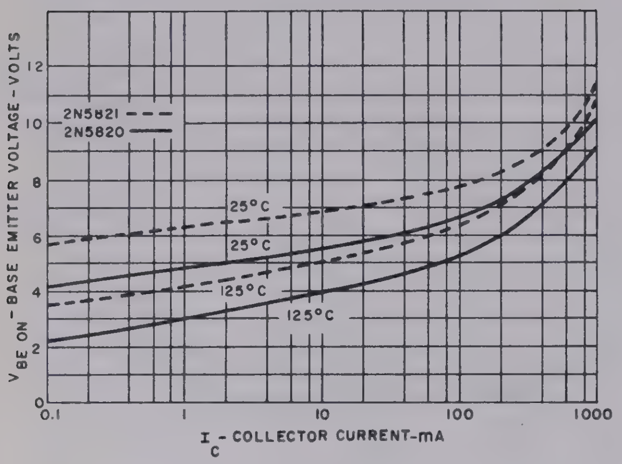


Figure 7

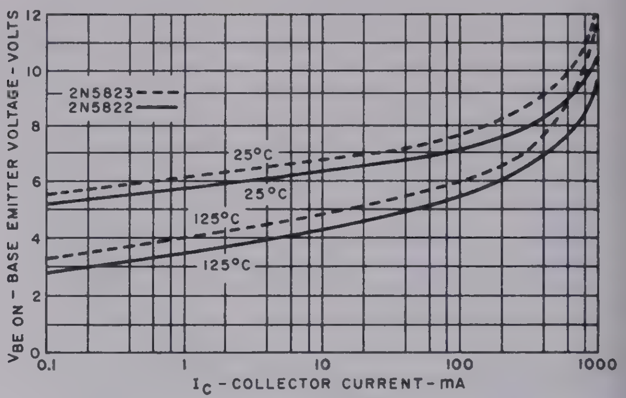


Figure 8

Typical I_{CBO} vs. Ambient Temperature

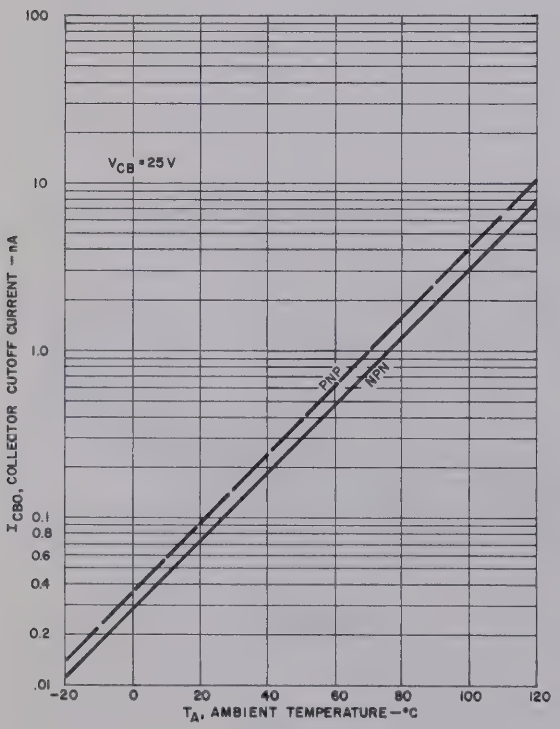


Figure 9

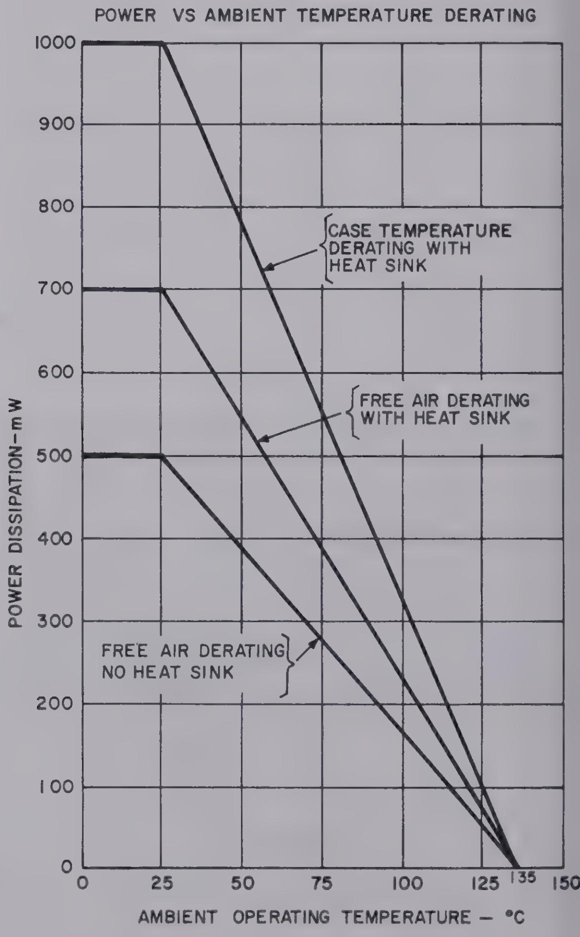


Figure 10

Silicon
Transistors

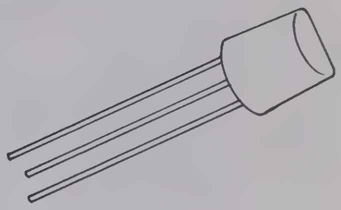
NPN

2N5824
2N5825
2N5826

These silicon, planar, passivated, epitaxial transistors are intended to satisfy a broad range of general purpose signal level applications at audio and intermediate frequencies.

Features:

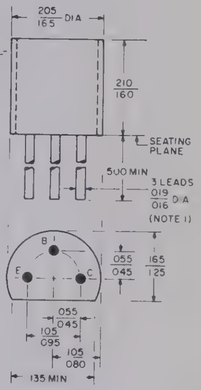
- Excellent Gain Linearity—particularly designed for operation in the 10 microampere to 20 milliampere range.
- 2:1 DC gain ratio per group.
- Low Collector Saturation Voltage
- Epoxy Encapsulation with Proved Reliability—excellent characteristic stability under environmental stresses, 85°C—85% RH.



absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
*Collector to Emitter	V_{CEO}	40	Volts
*Emitter to Base	V_{EBO}	5	Volts
*Collector to Base	V_{CBO}	50	Volts
Current			
*Collector (Continuous)	I_C	100	mA
Dissipation			
*Total Power (Free Air @ 25°C)[1]	P_T	360	mW
Total Power (Free Air @ 55°C)	P_T	260	mW
Temperature			
*Storage	T_{STG}	−65 to 150°C	
*Operating	T_J	−65 to 125°C	
*Lead Soldering, 1/16" ± 1/32" from case for 10 secs. max.	T_L	260°C	

*[1]Derate 3.60 mW/°C increase in ambient temperature above 25°C.



NOTE 1.
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN 050 AND 250 FROM THE SEATING PLANE BETWEEN 250 AND END OF LEAD A MAX OF 021 IS HELD

ALL DIMEN IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

TO-18 LEAD SPACING

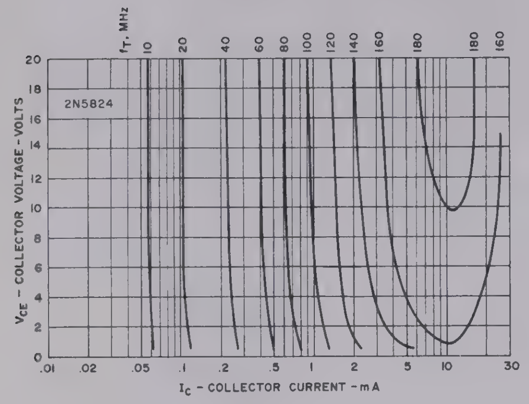
electrical characteristics: (25°C) (unless otherwise specified)

Static Characteristics		Min.	Typ.	Max.	Units
*Collector Current,					
V_{CB} = 40 Volts	I_{CBO}			50	nA
V_{CB} = 40 Volts, T_A = 100°C	I_{CBO}			10	μA
*Emitter Cutoff Current, V_{EB} = 5 Volts	I_{EBO}			50	nA
*Collector-Emitter Breakdown Voltage, I_C = 10 mA	$V_{(BR)CEO}$	40			Volts
*Collector Saturation Voltage (I_C = 10 mA, I_B = 1 mA)	$V_{CE(SAT)}$			.125	Volts
Base-Emitter Saturation Voltage (I_C = 10mA, I_B = 1 mA)	$V_{BE(SAT)}$			.78	Volts
*Base-Emitter Voltage (I_C = 2 mA, V_{CE} = 10V)	V_{BE}	.5		.9	Volts
*Forward Current Transfer Ratio (I_C = 2 mA, V_{CE} = 5V)					
2N5824	h_{FE}	60		120	
2N5825	h_{FE}	100		200	
2N5826	h_{FE}	150		300	
Dynamic Characteristics					
Gain Bandwidth Product (I_C = 2 mA, V_{CE} = 10V, f = 10 MHz)	f_T	90		250	MHz
*Forward Current Transfer Ratio (I_C = 2 mA, V_{CE} = 5V, f = 1 KHz)					
2N5824	h_{fe}	60		180	
2N5825	h_{fe}	100		300	
2N5826	h_{fe}	150		450	
*Collector-Base Capacitance (V_{CB} = 10V, f = 1 MHz)	C_{cb}		1.9	4.0	pF
Collector—Base Time Constant (V_{CE}=10V, I_C=2mA, f=31.9 MHz)	$r_b'C_c$		65		p sec.

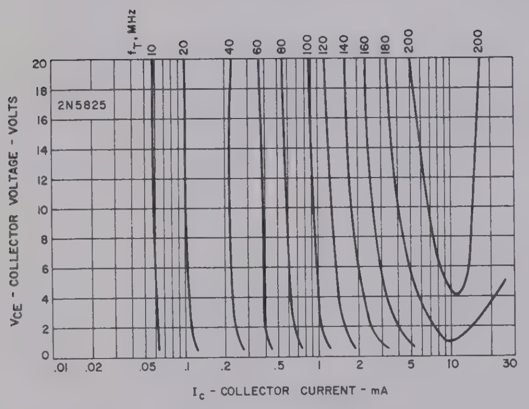
*Indicates JEDEC Registered values.

GAIN BAND-WIDTH PRODUCT vs. COLLECTOR CURRENT

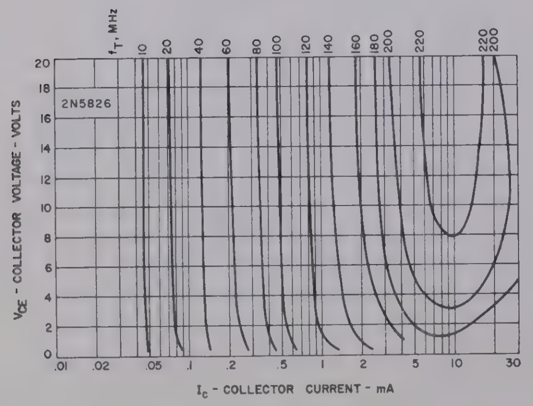
2N5824



2N5825

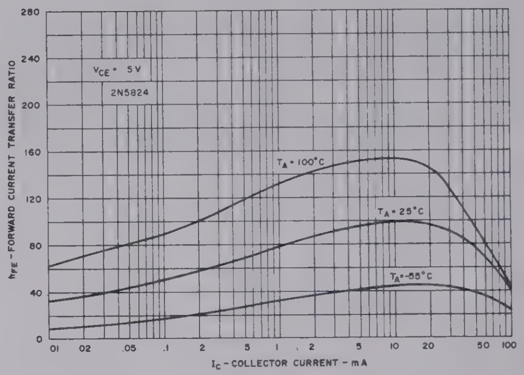


2N5826

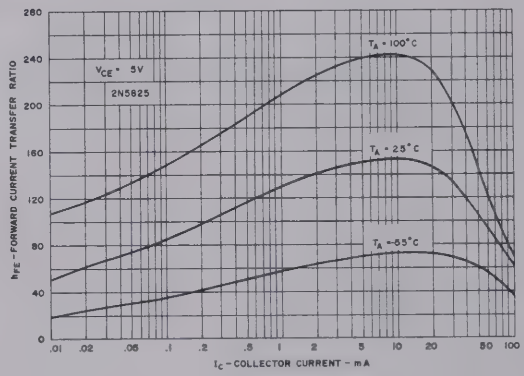


FORWARD CURRENT TRANSFER RATIO vs. COLLECTOR CURRENT

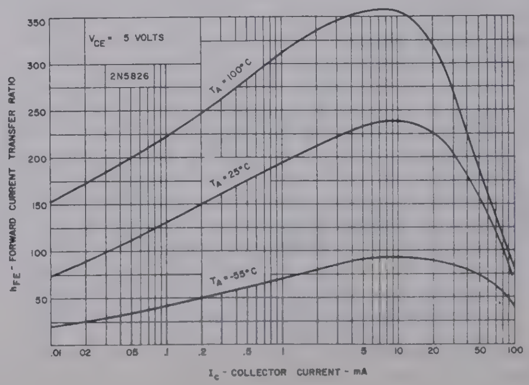
2N5824



2N5825

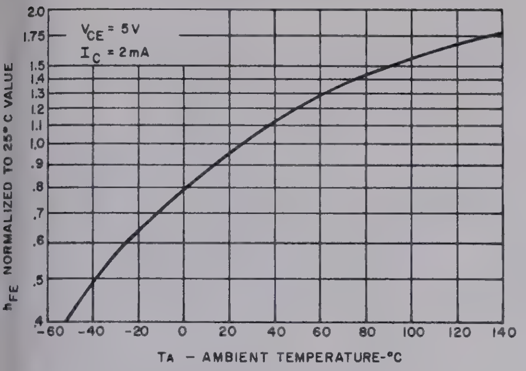


2N5826

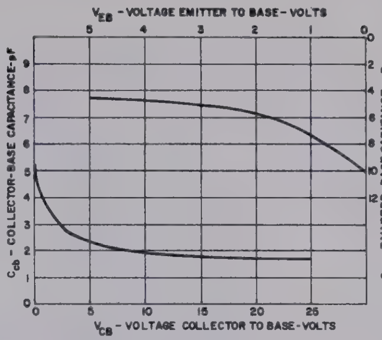


TYPICAL ELECTRICAL CHARACTERISTICS

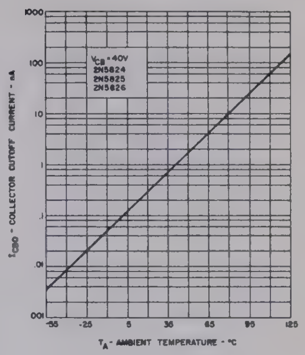
h_{FE} vs. TEMPERATURE



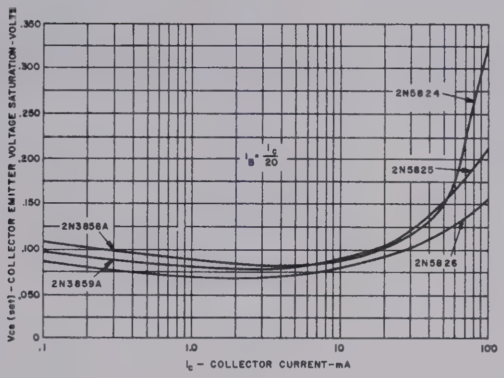
Capacitance vs. VOLTAGE



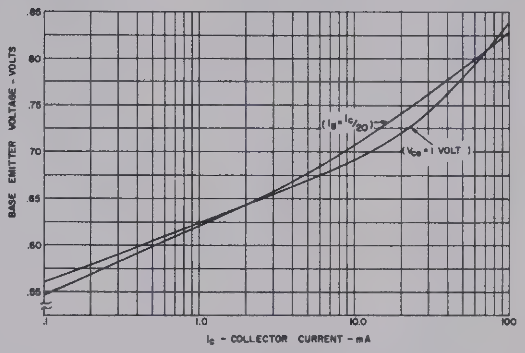
I_{CBO} vs. TEMPERATURE



$V_{CE(SAT)}$ vs. Collector Current



$V_{BE(SAT)}$, $V_{BE(DRIVE)}$ vs. Collector Current

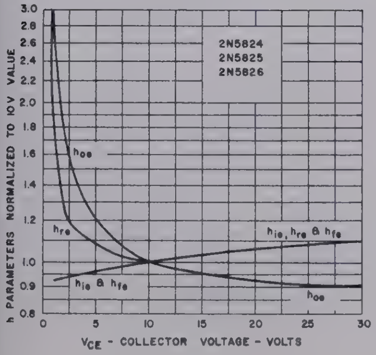


TYPICAL SMALL SIGNAL CHARACTERISTICS

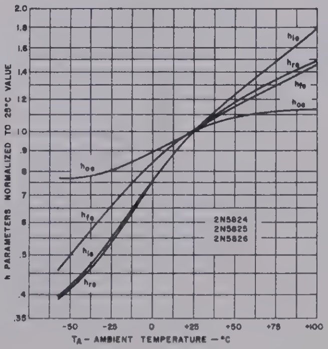
f = 1 KHz, V_{CE} = 10V, I_C = 2mA, T_A = 25°C

Symbol	Characteristics	2N5824	2N5825	2N5826	Units
h_{ie}	Input Resistance	1680	2480	3660	ohms
h_{oe}	Output Conductance	8.2	11	17	μmhos
h_{fe}	Forward Current Transfer Ratio	110	175	275	
h_{re}	Voltage Feedback Ratio	8.2	10.5	14.6	$X10^{-5}$

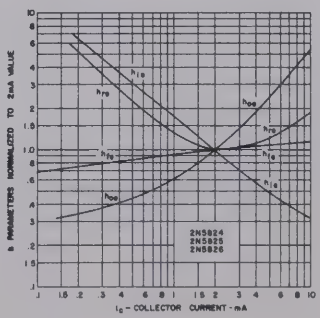
h PARAMETERS vs. V_{CE}



h PARAMETERS vs. TEMPERATURE



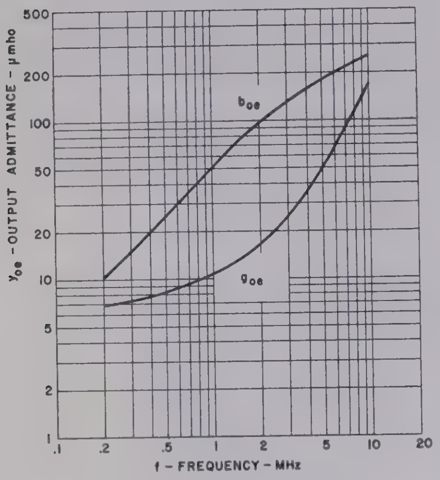
h PARAMETERS vs. I_C



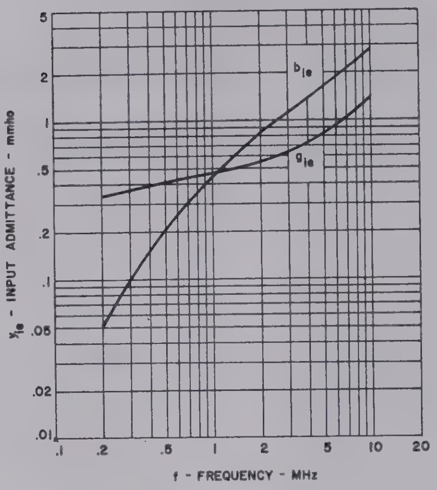
TYPICAL COMMON EMITTER "y" PARAMETERS

$V_{CE} = 10V$
$I_C = 2mA$

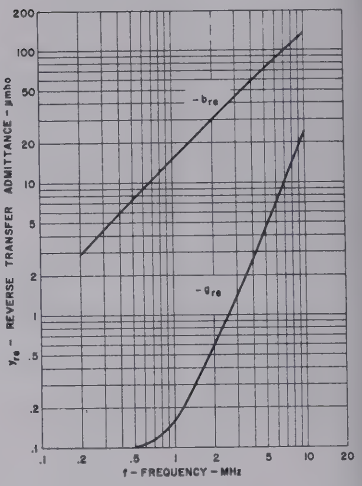
y_{oe}
Output Admittance
vs.
Frequency
(INPUT SHORT CIRCUIT)



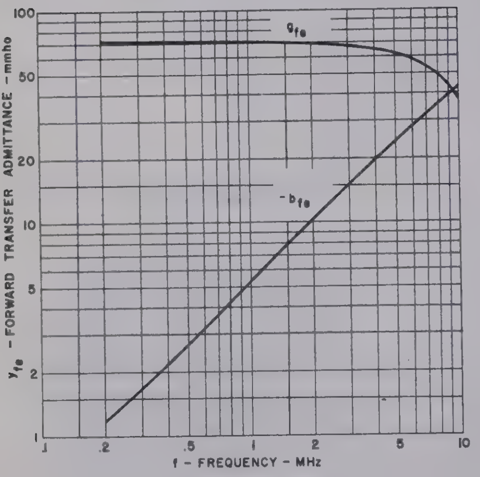
y_{ie}
Input Admittance
vs.
Frequency
(OUTPUT SHORT CIRCUIT)



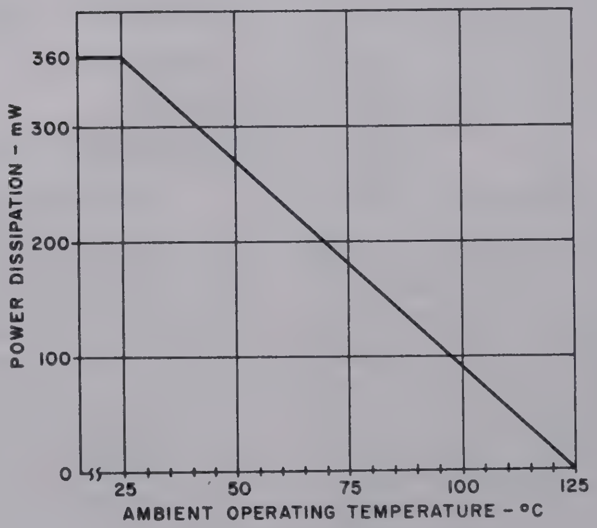
y_{re}
Reverse
Transfer Admittance
vs.
Frequency
(INPUT SHORT CIRCUIT)



y_{fe}
Forward Transfer
Admittance
vs.
Frequency
(OUTPUT SHORT CIRCUIT)



Power vs. Ambient Temp. Derating

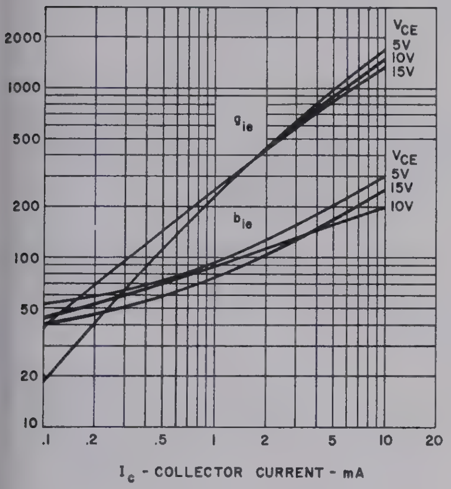


TYPICAL COMMON EMITTER "y" PARAMETERS

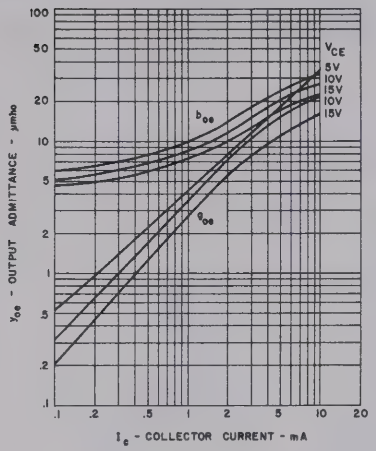
f = 250 KHz

COLLECTOR CHARACTERISTICS

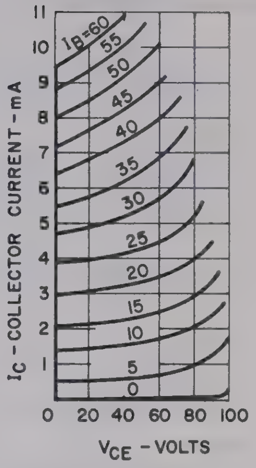
y_{ie}
Input Admittance
vs.
Collector Current
(OUTPUT SHORT CIRCUIT)



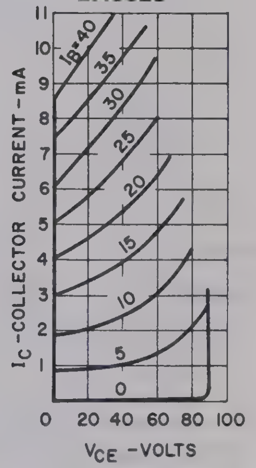
y_{oe}
Output Admittance
vs.
Collector Current
(INPUT SHORT CIRCUIT)



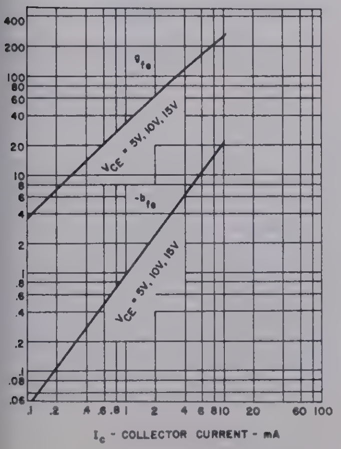
2N5824



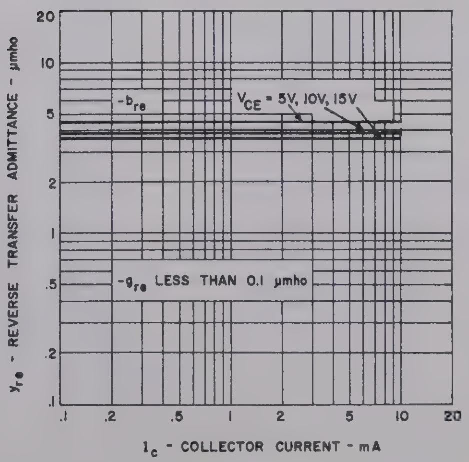
2N5825



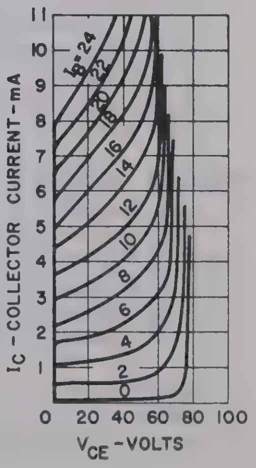
y_{fe}
Forward Transfer
Admittance
vs.
Collector Current
(OUTPUT SHORT CIRCUIT)



y_{re}
Reverse
Transfer Admittance
vs.
Collector Current
(INPUT SHORT CIRCUIT)



2N5826

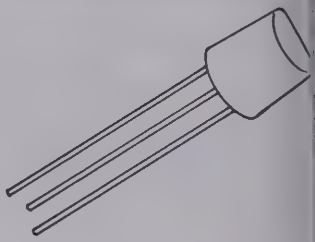


Silicon
Transistor

NPN

2N5827

These silicon, planar, passivated, epitaxial transistors are intended to satisfy a broad range of general purpose signal level applications at audio and intermediate frequencies.



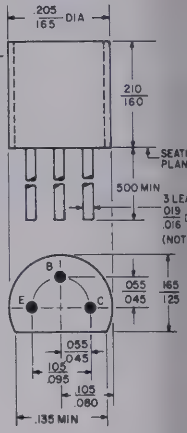
Features:

- Excellent Gain Linearity—particularly designed for operation in the 10 microampere to 20 milliampere range.
- 2:1 DC gain ratio per group.
- Low Collector Saturation Voltage
- Epoxy Encapsulation with Proved Reliability—excellent characteristic stability under environmental stresses, 85°C—85% RH.

absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
*Collector to Emitter	V_{CEO}	40	Volts
*Emitter to Base	V_{EBO}	5	Volts
*Collector to Base	V_{CBO}	50	Volts
Current			
*Collector (continuous)	I_C	100	mA
Dissipation			
*Total Power (Free Air @ 25°C) (1)	P_T	360	mW
Total Power (Free Air @ 55°C)	P_T	260	mW
Temperature			
*Storage	T_{STG}	−65 to +150	°C
*Operating	T_J	−65 to +125	°C
*Lead soldering, 1/16" ± 1/32" from case for 10 secs. max.	T_L	+260	°C

*(1) Derate 3.60 mW/°C increase in ambient temperature above 25°C.



NOTE 1:
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND 250 FROM THE SEATING PLANE. BETWEEN .250 AND END OF LEAD A MAX. OF .021 IS HELD.

ALL DIMEN IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.

TO-18 LEAD SPACING

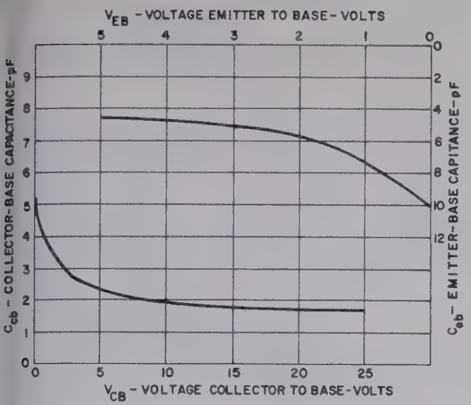
electrical characteristics: (25°C) (unless otherwise specified)

STATIC CHARACTERISTICS		Min.	Typ.	Max.	Units
*Collector Current ($V_{CB} = 40V$)	I_{CBO}			50	nA
($V_{CB} = 40V, T_A = 100°C$)	I_{CBO}			10	µA
*Emitter Cutoff Current ($V_{EB} = 5$ Volts)	I_{EBO}			50	nA
*Collector-Emitter Breakdown Voltage ($I_C = 10$ mA)	$V_{(BR)CEO}$	40			Volts
*Collector Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)	$V_{CE(SAT)}$			.125	Volts
Base-Emitter Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)	$V_{BE(SAT)}$			.78	Volts
*Base-Emitter Voltage ($I_C = 2$ mA, $V_{CE} = 10$ V)	V_{BE}	.5		.9	Volts
*Forward Current Transfer Ratio ($I_C = 2$ mA, $V_{CE} = 5V$)	h_{FE}	250		500	
DYNAMIC CHARACTERISTICS					
Gain Bandwidth Product ($I_C = 2$ mA, $V_{CE} = 10V$, f = 10 MHz)	f_T	90		350	MHz
*Forward Current Transfer Ratio ($I_C = 2$ mA, $V_{CE} = 5V$, f = 1 KHz)	h_{fe}	250		750	
*Collector-Base Capacitance ($V_{CB} = 10V$, f = 1 MHz)	C_{cb}		1.9	4.0	pF
Collector—Base Time Constant (V_{CE}=10V, I_C=2mA, f=31.9 MHz)	$r_b'C_c$		65		p sec.

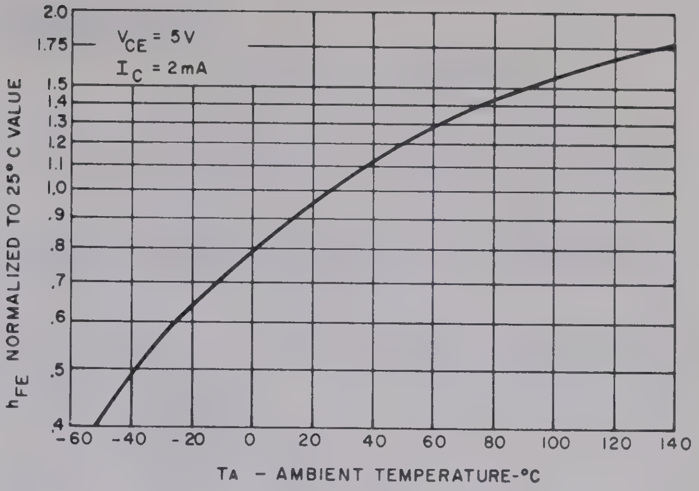
*indicates JEDEC registered values.

2N5827

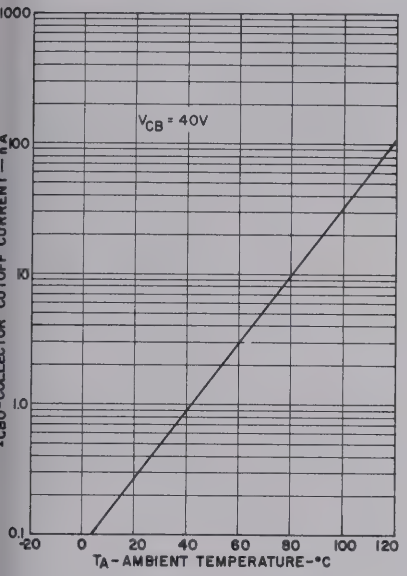
Capacitance vs. Voltage



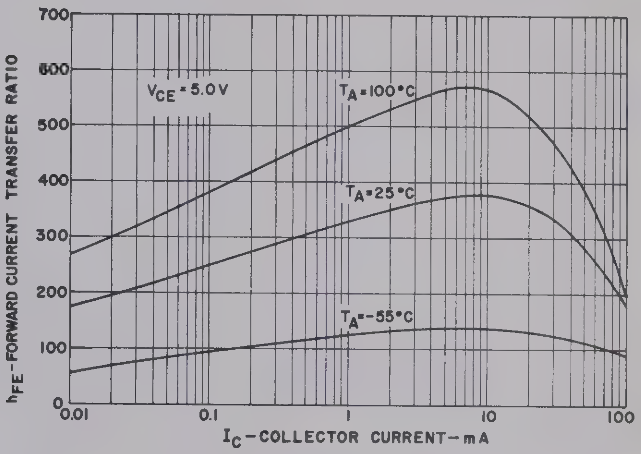
h_{FE} vs. Ambient Temperature



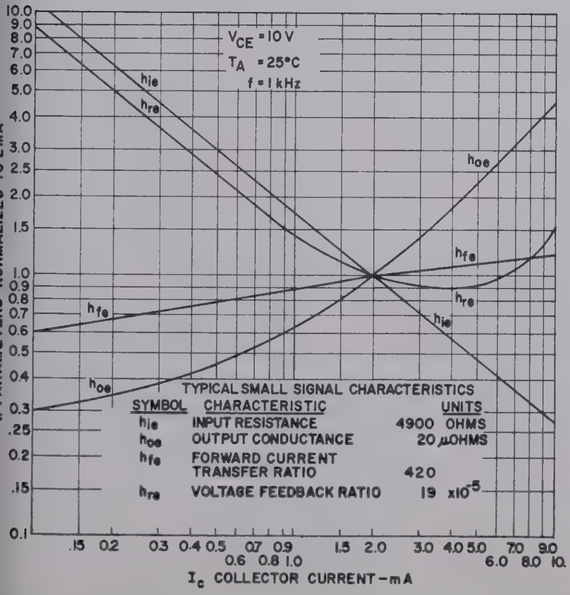
I_{CBO} vs. Ambient Temperature



Forward Current Transfer Ratio vs. Collector Current



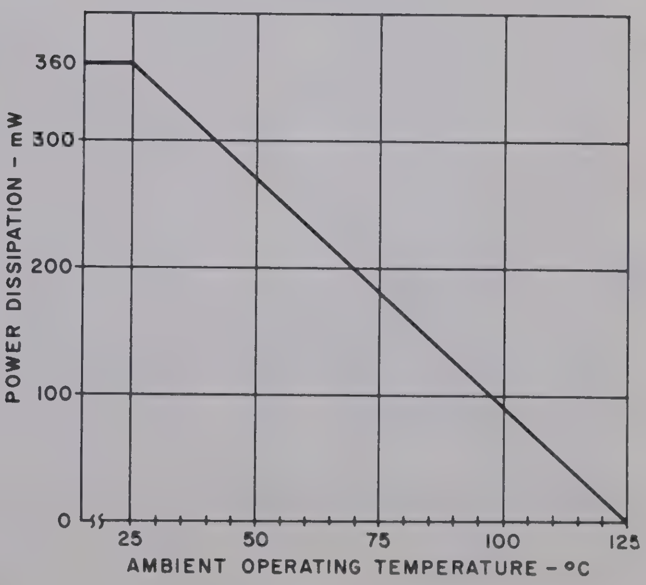
Normalized h Parameters vs. I_C



TYPICAL SMALL SIGNAL CHARACTERISTICS

SYMBOL	CHARACTERISTIC		UNITS
hie	INPUT RESISTANCE	4900	OHMS
hoe	OUTPUT CONDUCTANCE	20	μOHMS
hfe	FORWARD CURRENT TRANSFER RATIO	420	
hre	VOLTAGE FEEDBACK RATIO	19	$x10^{-5}$

Power vs. Ambient Temperature Derating

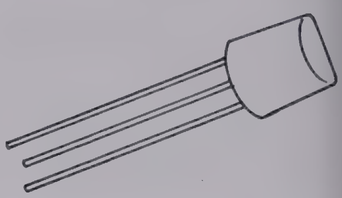


Silicon
Transistor

NPN

2N5828

These silicon, planar, passivated, epitaxial transistors are intended to satisfy a broad range of general purpose signal level applications at audio and intermediate frequencies.



Features:
- Excellent Gain Linearity—particularly designed for operation in the 10 microampere to 20 milliampere range.
- 2:1 DC gain ratio per group.
- Low Collector Saturation Voltage
- Epoxy Encapsulation with Proved Reliability—excellent characteristic stability under environmental stresses, 85°C—85% RH.

absolute maximum ratings: (25°C) (unless otherwise specified)

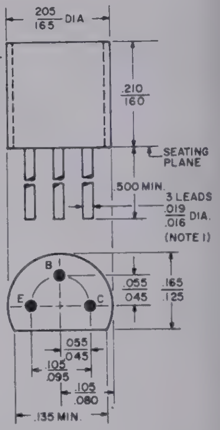
Voltages			
*Collector to Emitter	V_{CEO}	40	Volts
*Emitter to Base	V_{EBO}	5	Volts
*Collector to Base	V_{CBO}	50	Volts
Current			
*Collector (continuous)	I_C	100	mA
Dissipation			
*Total Power (Free Air @ 25°C)(1)	P_T	360	mW
Total Power (Free Air @ 55°C)	P_T	260	mW
Temperature			
*Storage	T_{STG}	−65 to +150	°C
*Operating	T_J	−65 to +125	°C
*Lead soldering, 1/16″ ± 1/32″ from case for 10 secs. max.	T_L	+260	°C

*(1)Derate 3.60 mW/°C increase in ambient temperature above 25°C.

NOTE 1:
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND .250 FROM THE SEATING PLANE. BETWEEN .250 AND END OF LEAD A MAX. OF .021 IS HELD.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.

TO-18 LEAD SPACING



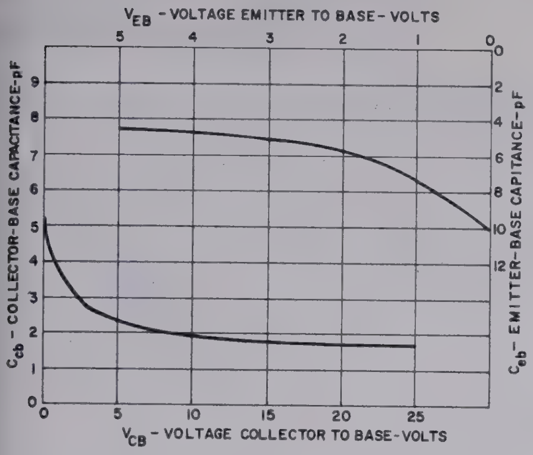
electrical characteristics: (25°C) (unless otherwise specified)

STATIC CHARACTERISTICS		**Min.**	**Typ.**	**Max.**	**Unit**
*Collector Current (V_{CB} = 40 Volts)	I_{CBO}			50	nA
(V_{CB} = 40 Volts, T_A = 100°C)	I_{CBO}			10	μA
*Emitter Cutoff Current (V_{EB} = 5 Volts)	I_{EBO}			50	nA
*Collector-Emitter Breakdown Voltage (I_C = 10 mA)	$V_{(BR)CEO}$	40			Vol
*Collector Saturation Voltage (I_C = 10 mA, I_B = 1 mA)	$V_{CE(SAT)}$			.125	Vol
Base-Emitter Saturation Voltage (I_C = 10 mA, I_B = 1 mA)	$V_{BE(SAT)}$			.78	Vol
*Base-Emitter Voltage (I_C = 2 mA, V_{CE} = 10V)	V_{BE}	.5		.9	Vo
*Forward Current Transfer Ratio (I_C = 2 mA, V_{CE} = 5V)	h_{FE}	400		800	

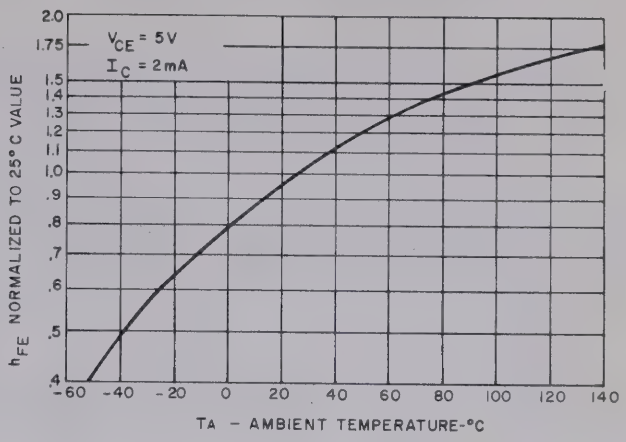
DYNAMIC CHARACTERISTICS		**Min.**		**Max.**	**Uni**
Gain Bandwidth Product (I_C = 2 mA, V_{CE} = 10V, f = 10 MHz)	f_T	90		350	M
*Forward Current Transfer Ratio (I_C = 2 mA, V_{CE} = 5V, f = 1 KHz)	h_{fe}	400		1200	
*Collector-Base Capacitance (V_{CB} = 10V, f = 1 MHz)	C_{cb}		1.9	4.0	pF
Collector—Base Time Constant (V_{CE}=10V, I_C=2mA, f=31.9 MHz)	$r_b'C_c$		65		p

*Indicates JEDEC
Registered values.

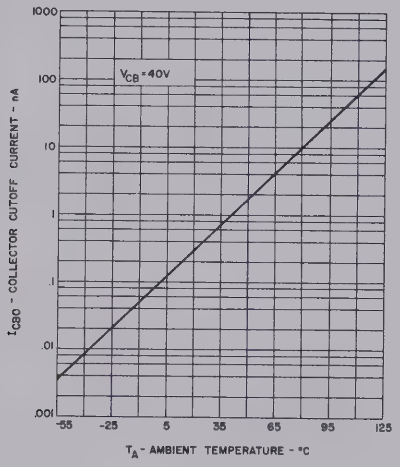
Capacitance vs. Voltage



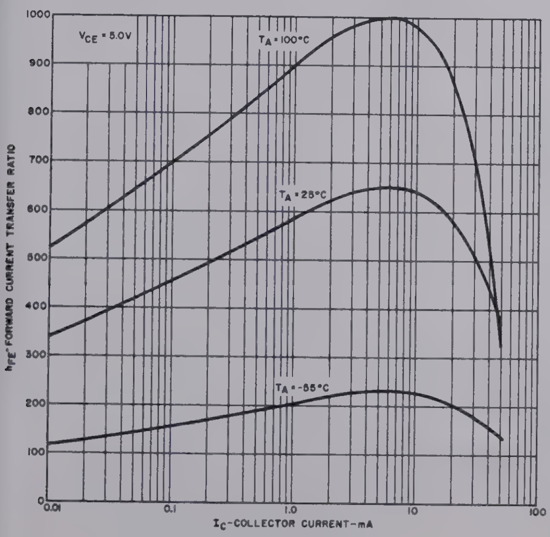
h_{FE} vs. Ambient Temperature



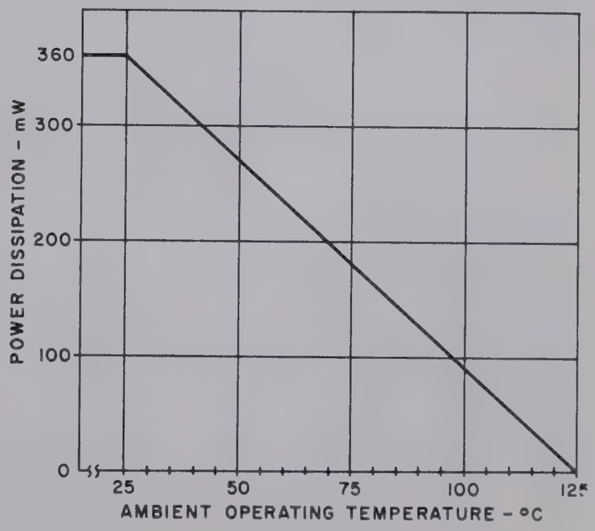
I_{CBO} vs. Ambient Temperature



orward Current Transfer Ratio vs. Collector Current



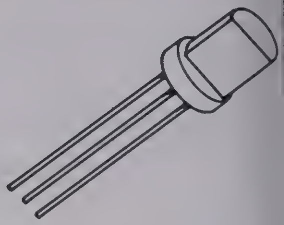
Power vs. Ambient Temperature Derating



Silicon
Transistors

NPN	PNP
2N5998	2N5999
2N6008	2N6009

N. F. = 1.5 dB Max.



This series of transistors are silicon, planar, epitaxial, passivated devices. They are designed primarily for *optimum low noise* performance, low-level audio amplifier applications. They feature excellent h_{FE} holdup at collector currents between 10 μA and 50 mA, and *minimum burst ("pop-corn") noise.*

Note: Polarities are absolute; observe PNP/NPN polarity.

absolute maximum ratings: (25°C) (unless otherwise specified)

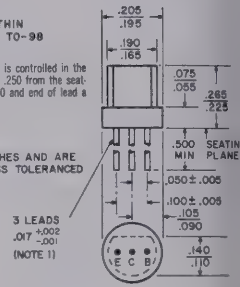
Voltages				
Collector-to-Emitter*	V_{CEO}	25		Volts
Emitter-to-Base*	V_{EBO}	5		Volts
Collector-to-Base*	V_{CBO}	35		Volts
Current				
Collector (Steady State)*	I_C		500	mA
Dissipation				
Total Power (Free Air)*††	P_T		400	mW
Temperature				
Storage*	T_{STG}		−65 to 150°C	
Operating	T_J		125°C	
Lead, 1/16 ± 1/32 from case for 10 seconds maximum	T_L		260°C	

††Derate 4.0mW/°C increase in ambient temperature above 25°C

DIMENSIONS WITHIN
JEDEC OUTLINE TO-98

NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED



electrical characteristics: (25°C) (unless otherwise specified)

STATIC CHARACTERISTICS

			MIN.	TYP.	MAX.	UNITS
Collector Cutoff Current ($V_{CB} = 25V$, $I_E = 0$)*		I_{CBO}			30	nA
Emitter Cutoff Current ($V_{EB} = 3V$, $I_C \doteq 0$)*		I_{EBO}			10	nA
Static Forward Current Transfer Ratio ($V_{CE} = 2V$, $I_C = 10\mu A$)	2N5998, 2N5999	h_{FE}	80			
	2N6008, 2N6009	h_{FE}	120			
($V_{CE} = 2V$, $I_C = 100\mu A$)	2N5998, 2N5999	h_{FE}	100			
	2N6008, 2N6009	h_{FE}	150			
($V_{CE} = 2V$, $I_C = 10mA$)*	2N5998, 2N5999	h_{FE}	150		300	
	2N6008, 2N6009	h_{FE}	250		500	
Collector-Emitter Saturation ($I_C = 50mA$, $I_B = 2.5mA$)*		$V_{CE(SAT)}$			0.25	V
Base-Emitter Saturation Voltage ($I_C = 50mA$, $I_B = 2.5mA$)		$V_{BE(SAT)}$			0.85	V
Collector-Emitter Breakdown Voltage ($I_C = 10mA$, $I_B = 0$)*		$V_{(BR)CEO}$	25			V
Emitter-Base Breakdown Voltage ($I_E = 10\mu A$, $I_C = 0$)		$V_{(BR)EBO}$	5			V
Collector-Base Breakdown Voltage ($I_C = 10\mu A$, $I_E = 0$)		$V_{(BR)CBO}$	35			V
Base-Emitter Voltage ($V_{CE} = 10V$, $I_C = 2mA$)*		$V_{BE(ON)}$	0.5		0.8	V

2N5998,9 2N6008,9

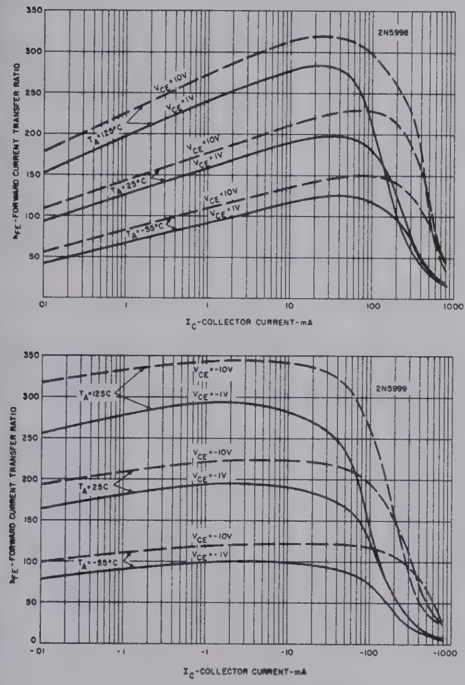
DYNAMIC CHARACTERISTICS

		MIN.	TYP.	MAX.	UNITS
FORWARD CURRENT TRANSFER RATIO ($V_{CE} = 2V$, $I_C = 10mA$, $f = 1kH_z$)*					
2N5998, 2N5999	h_{fe}	150		450	
2N6008, 2N6009	h_{fe}	250		750	
Collector-Base Capacitance ($V_{CB} = 10V$, $I_E = 0$, $f = 1MH_z$)*	C_{cb}				
2N5998, 2N6008			4	6	pF
2N5999, 2N6009			6	8	pF
Emitter-Base Capacitance ($V_{EB} = 0.5V$, $I_C = 0$, $f = 1MH_z$)	C_{eb}		20	35	pF
Gain Bandwidth Product ($V_{CE} = 2V$, $I_C = 100\mu A$)	f_T		10		MH_z
($V_{CE} = 2V$, $I_C = 10mA$)	f_T	140	300	630	MH_z
Wide Band Noise Figure ($V_{CE} = 5V$, $I_C = 100\mu A$, $f = 10H_z$ to $10kH_z$, $BW = 15.7kH_z$, $R_g = 5k\Omega$)*	N.F.		0.5	1.5	dB

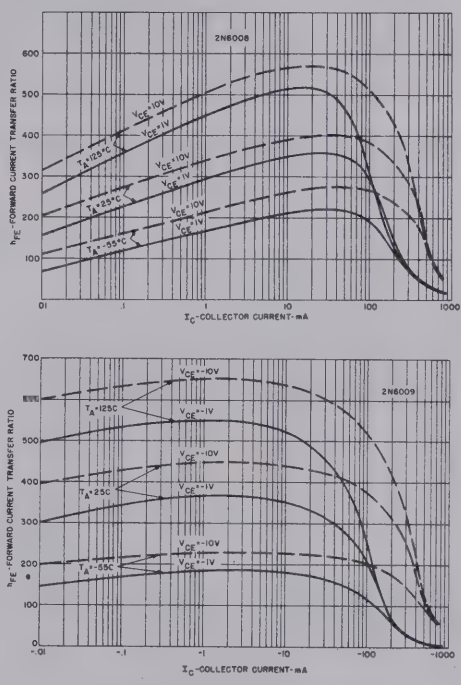
Typical "h" Parameters

($V_{CE} = 10V$, $I_C = 1mA$, $f = 1kH_z$)		2N5998	2N6008	2N5999	2N6009	UNITS
	h_{ie}	4	9	7	10	kΩ
	h_{re}	9	20	12	24	$x10^{-4}$
	h_{oe}	35	70	45	75	μmhos

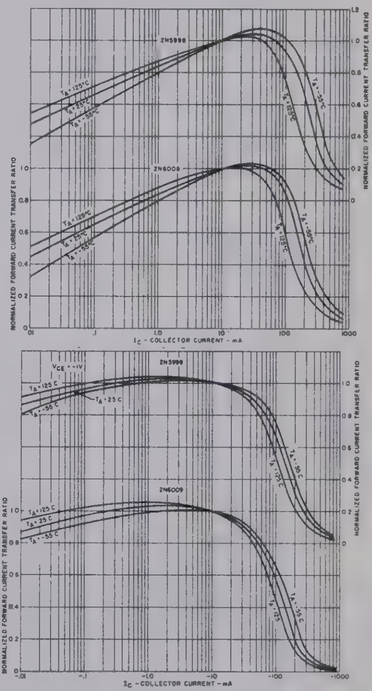
*Registered Data



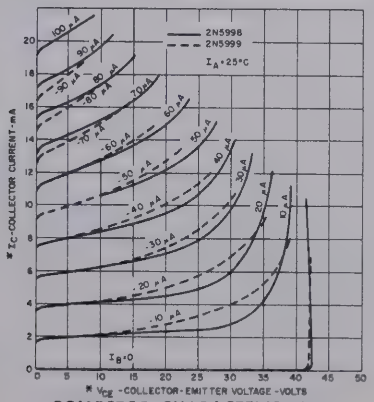
BETA VS. COLLECTOR CURRENT



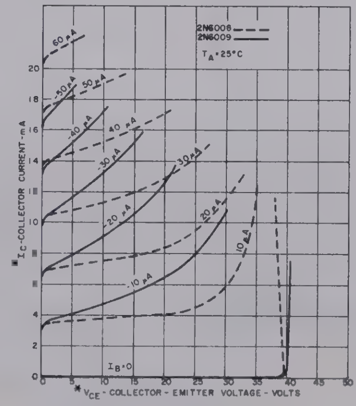
BETA VS. COLLECTOR CURRENT



NORMALIZED FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT

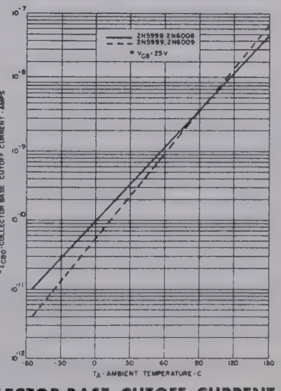


COLLECTOR CHARACTERISTICS



COLLECTOR CHARACTERISTICS

*Polarities are absolute

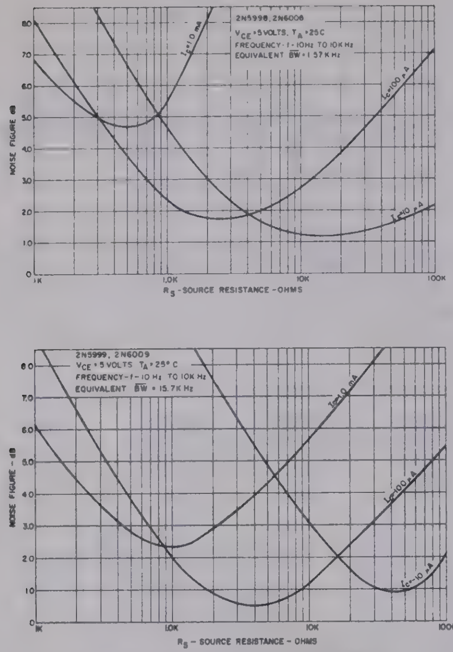


COLLECTOR-BASE CUTOFF CURRENT VS. AMBIENT TEMPERATURE

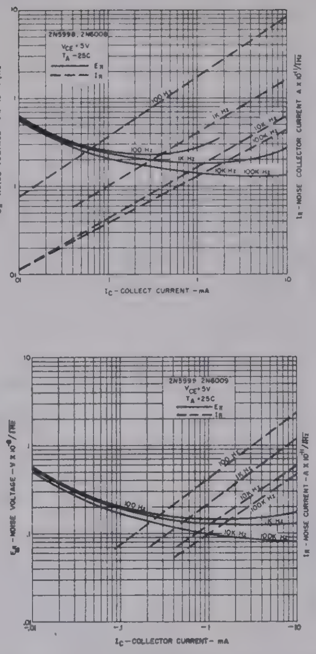
2N5998,9 2N6008,9

2N5998
2N6008
NPN

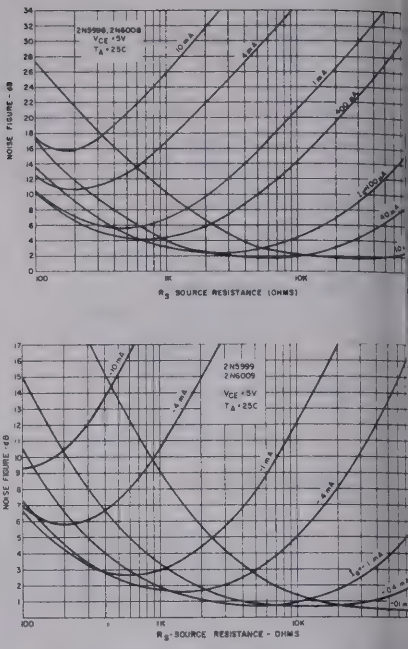
2N5999
2N6009
PNP



NOISE FIGURE-WIDEBAND VS. SOURCE RESISTANCE



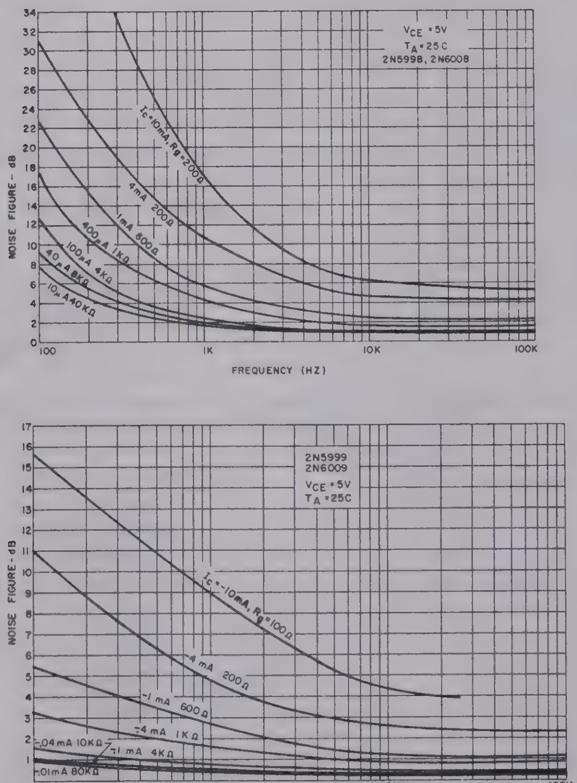
Eπ & Iπ VS. COLLECTOR CURRENT



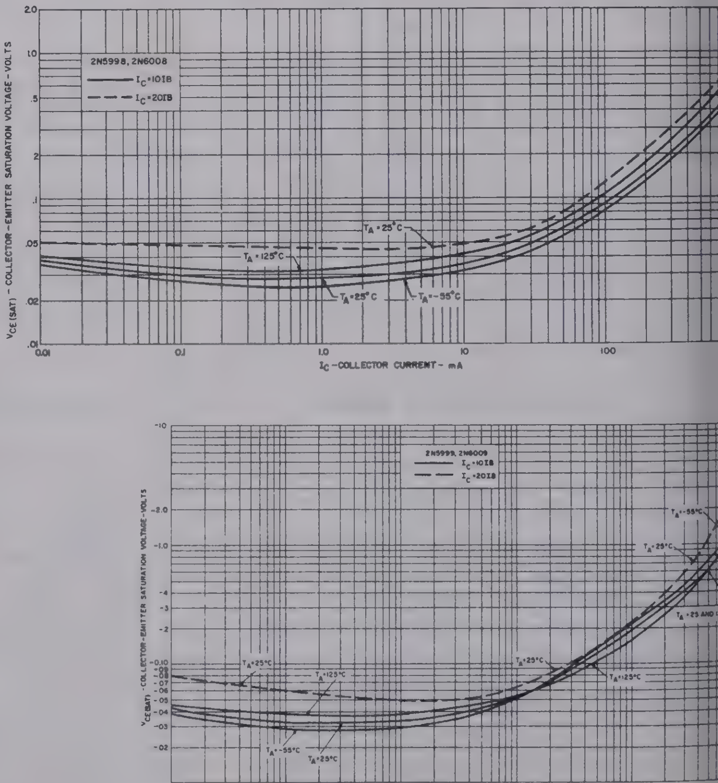
NOISE FIGURE VS. SOURCE RESISTANCE

2N5998
2N6008
NPN

2N5999
2N6009
PNP



NOISE FIGURE VS. FREQUENCY

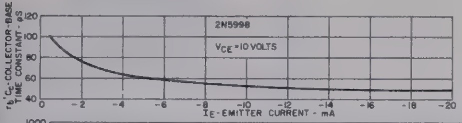


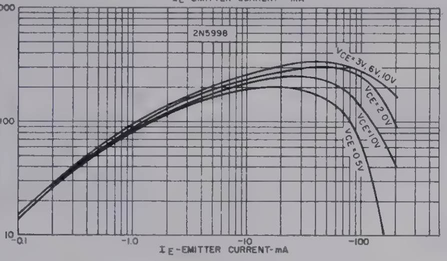
COLLECTOR-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT

2N5998,9 2N6008,9

998
008
PN

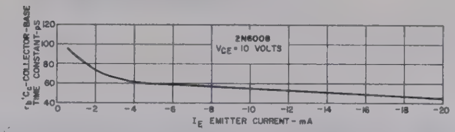
COLLECTOR BASE TIME CONSTANT VS. EMITTER CURRENT

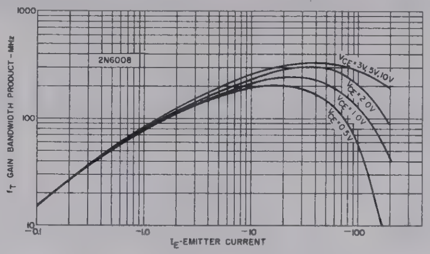




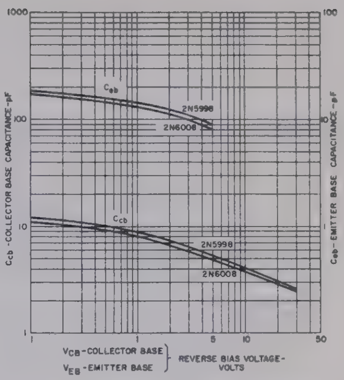
GAIN BANDWIDTH PRODUCT VS. EMITTER CURRENT

COLLECTOR-BASE TIME CONSTANT VS. EMITTER CURRENT





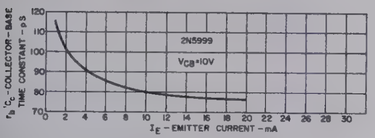
GAIN BANDWIDTH PRODUCT VS. EMITTER CURRENT

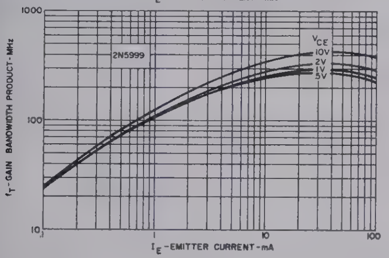


COLLECTOR-BASE & EMITTER-BASE CAPACITANCE VS. REVERSE BIAS VOLTAGE

999
009
NP

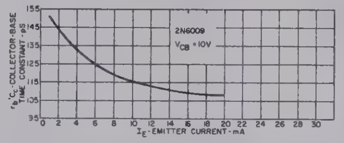
COLLECTOR BASE TIME CONSTANT VS. EMITTER CURRENT

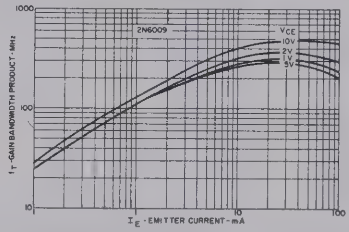




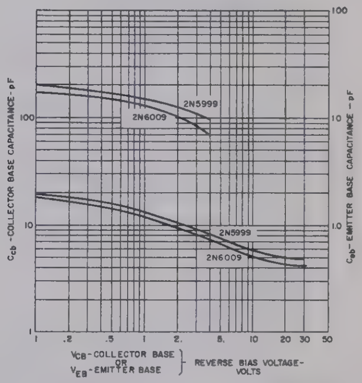
GAIN BANDWIDTH PRODUCT VS. EMITTER CURRENT

COLLECTOR-BASE TIME CONSTANT VS. EMITTER CURRENT



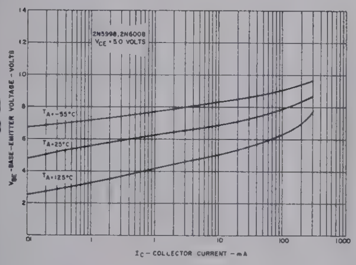


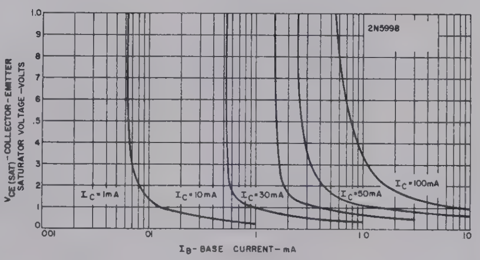
GAIN BANDWIDTH PRODUCT VS. EMITTER CURRENT

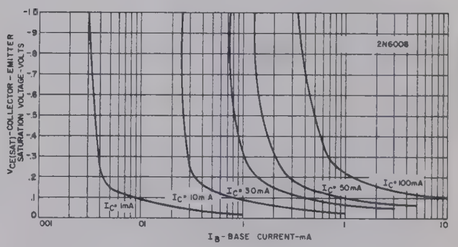


COLLECTOR-BASE & EMITTER-BASE CAPACITANCE VS. REVERSE BIAS VOLTAGE

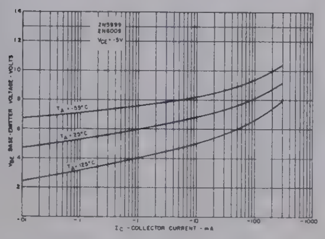
998
008
N



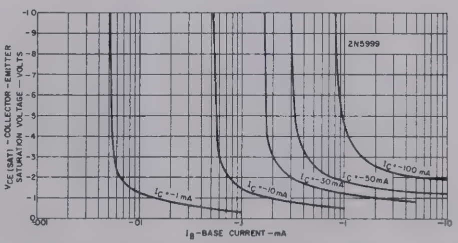




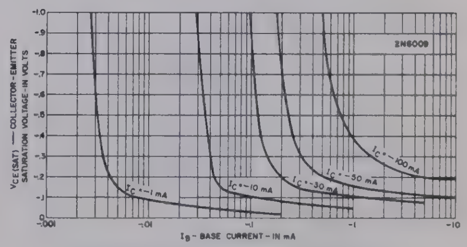
99
09
P



TRANSCONDUCTANCE VS. COLLECTOR CURRENT



COLLECTOR-EMITTER SATURATION VOLTAGF VS. BASE CURRENT



COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT

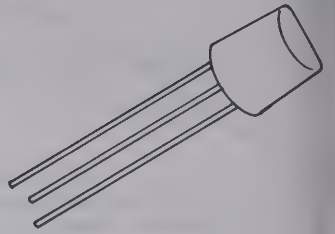
Silicon
Transistors

NPN

2N6000

2N6002

The General Electric 2N6000 and 2N6002 units are silicon NPN planar passivated, epitaxial devices designed primarily for high speed switching, low noise amplifier and core driver applications. Complementary PNP versions of these units are available and are designated as 2N6001 and 2N6003 respectively.



Features

- Epoxy encapsulation with proved reliability.
- Performance comparable to hermetic units—excellent characteristic stability under environmental stresses—85°C—85% Relative Humidity.
- Low $V_{CE(SAT)}$
- Characterized for Industrial Service.*
- Low Noise Figure.

* Parameters are JEDEC Registered values.

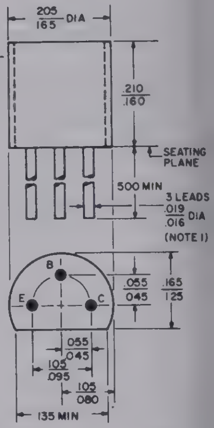
absolute maximum ratings: ($T_A = 25°C$, unless otherwise specified)

		2N6000	2N6002	
Voltages				
Collector to Emitter	V_{CEO}*	25	25	Volts
Collector to Emitter	V_{CES}*	35	35	Volts
Emitter to Base	V_{EBO}*	5	5	Volts
Collector to Base	V_{CBO}*	35	35	Volts
Current				
Collector	I_C*	500	500	mA
Collector (peak, pulsed 10 µsec, ≦ 2% duty cycle)	I_C	800	800	mA
Dissipation				
Total Power ($T_C \leqq 25°C$)	P_T*	.800	.800	Watts
Total Power ($T_A \leqq 25°C$)	P_T*	.400	.400	Watts
Derate Factor ($T_C \geqq 25°C$)		8.0	8.0	mW/°C
Derate Factor ($T_A \geqq 25°C$)		4.0	4.0	mW/°C
Temperature				
Storage	T_{STG}*	← −65 to +150 →		°C
Operating	T_J*	← −65 to +125 →		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L*	← +260 →		°C

NOTE 1:
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND 250 FROM THE SEATING PLANE. BETWEEN 250 AND END OF LEAD A MAX OF 021 IS HELD.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.

TO-18 LEAD SPACING



electrical characteristics: ($T_A = 25°C$, unless otherwise specified)

STATIC CHARACTERISTICS	Symbol	2N6000 Min.	2N6000 Typ.	2N6000 Max.	2N6002 Min.	2N6002 Typ.	2N6002 Max.	
Collector-Emitter Breakdown Voltage ($I_C = 10mA, I_B = 0$)†	$V_{(BR)CEO}$*	25			25			Volts
Emitter-Base Breakdown Voltage ($I_E = 100\mu A, I_C = 0$)	$V_{(BR)EBO}$*	5			5			Volts
Collector-Base Breakdown Voltage ($I_C = 100\mu A, I_E = 0$)	$V_{(BR)CBO}$*	35			35			Volts
Collector-Emitter Breakdown Voltage ($I_C = 100\mu A, V_{BE} = 0$)	$V_{(BR)CES}$*	35			35			Volts
Collector-Emitter Saturation Voltage								
($I_C = 10mA, I_B = 1mA$)†	$V_{CE(SAT)}$*			.80			.80	Volts
($I_C = 100mA, I_B = 10mA$)†	$V_{CE(SAT)}$*			.175			.175	Volts
($I_C = 300mA, I_B = 30mA$)†	$V_{CE(SAT)}$*			.400			.400	Volts
Base-Emitter Saturation Voltage								
($I_C = 10mA, I_B = 1mA$)†	$V_{BE(SAT)}$*	.60		.80	.60		.80	Volts
($I_C = 100mA, I_B = 10mA$)†	$V_{BE(SAT)}$*	.70		.95	.70		.95	Volts
($I_C = 300mA, I_B = 30mA$)†	$V_{BE(SAT)}$*	.80		1.1	.80		1.1	Volts
Base-Emitter Voltage ($V_{CE} = 5V, I_C = 10mA$)†	V_{BE}*	.55		.78	.55		.78	Volts
Forward Current Transfer Ratio								
($V_{CE} = 1V, I_C = 100\mu A$)	h_{FE}*	50			130			
($V_{CE} = 1V, I_C = 1mA$)	h_{FE}*	70	160		175	295		
($V_{CE} = 1V, I_C = 10mA$)†	h_{FE}*	100	190	300	250	350	500	
($V_{CE} = 1V, I_C = 50mA$)†	h_{FE}*	105			260			
($V_{CE} = 1V, I_C = 100mA$)†	h_{FE}*	100			245			
($V_{CE} = 2V, I_C = 300mA$)†	h_{FE}*	40			80			
Collector Cutoff Current								
($V_{CB} = 25V, I_E = 0$)	I_{CBO}*		.2	10		.2	10	nA
($V_{CB} = 25V, I_E = 0, T_A = 100°C$)	I_{CBO}*			10			10	µA
Emitter-Base Reverse Current ($V_{EB} = 3.0V, I_C = 0$)	I_{EBO}*		.1	20		.1	20	nA

† Pulsed, 300µsec, ≦ 2% duty cycle

YNAMIC CHARACTERISTICS

		2N6000			2N6002			
		Min.	Typ.	Max.	Min.	Typ.	Max.	
orward Current Transfer Ratio ($I_E = -1mA$, $V_{CE} = 10V$, f = 1KHz)	h_{fe}*	70		450	175		750	
nput Impedance ($I_E = -1mA$, $V_{CE} = 10V$, f = 1KHz)	h_{fe}*	1.5	4	10	2.5	9	15	Kohms
utput Conductance ($I_E = -1mA$, $V_{CE} = 10V$, f = 1KHz)	h_{oe}*	20	35	80	30	70	100	umhos
oltage Feedback Ratio ($I_E = -1mA$, $V_{CE} = 10V$, f = 1KHz)	h_{re}		9			20		$x10^{-4}$
ollector-Base Capacitance ($V_{CB} = 10V$, $I_E = 0$, f = 1 MHz)	C_{cb}*	2.5	3.9	6.0	2.5	3.9	6.0	pF
mitter-Base Capacitance ($V_{EB} = 0.5V$, $I_C = 0$, f = 1 MHz)	C_{eb}*		15	20		13	18	pF
agnitude of Forward Current Transfer Ratio ($V_{CE} = 10V$, $I_E = -10mA$, f = 100 MHz)	$\|h_{fe}\|$*	3.5		14	4.5		15	dB
ain-Bandwidth Product ($V_{CE} = 10V$, $I_E = -10mA$, f = 100 MHz)	f_T	150	250	500	165	260	560	MHz
ollector-Base Time Constant ($V_{CB} = 10V$, $I_E = -10mA$, f = 31.9 MHz)	$r_b'C_c$*	20	53	100	30	55	120	psec
oise Figure ($V_{CE} = 5V$, $I_E = -100\mu A$, BW = 15.7KHz, $R_S = 5K\,\Omega$, f = 10 Hz to 10KHz)	NF*			3			2	dB
elay Time—See Figure 1 ($V_{CC} = 30V$, $I_C(on) = 150mA$, $I_{B1} = 15mA$, $V_{BE}(off) = 0V$)	t_d*		7	10		7	10	nsec
ise Time—See Figure 1 ($V_{CC} = 30V$, $I_C(on) = 150mA$, $I_{B1} = 15mA$, $V_{BE}(off) = 0V$)	t_r*		12	15		12	15	nsec
torage Time—See Figure 2 ($V_{CC} = 30V$, $I_C(on) = 150mA$, $I_{B1} = 15mA$, $I_{B2} = -15mA$)	t_s*		170	250		200	300	nsec
all Time—See Figure 2 ($V_{CC} = 30V$, $I_C(on) = 150mA$, $I_{B1} = 15mA$, $I_{B2} = -15mA$)	t_f*		35	70		50	110	nsec

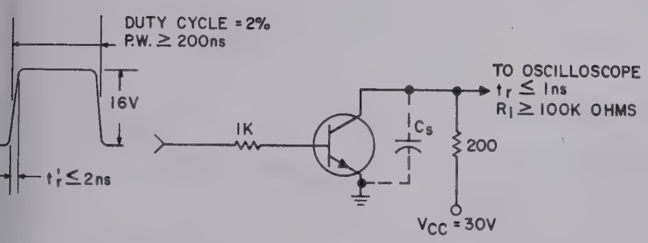
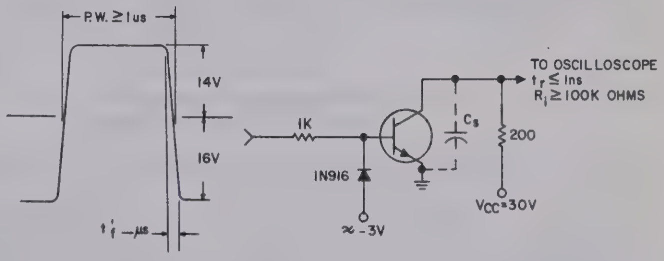
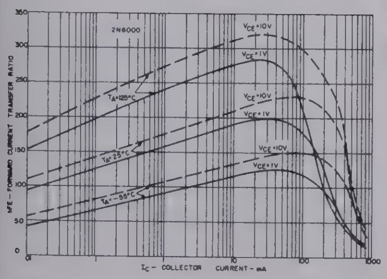

DUTY CYCLE = 2%
P.W. ≥ 200ns
16V
t'r ≤ 2ns
1K
Cs
200
TO OSCILLOSCOPE
tr ≤ 1ns
Ri ≥ 100K OHMS
VCC = 30V

FIGURE 1. DELAY AND RISE TIME EQUIVALENT CIRCUIT

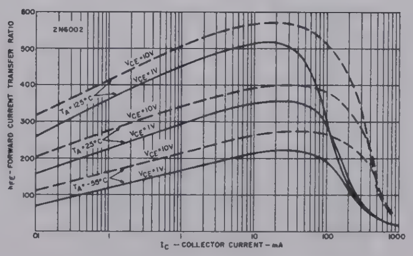

P.W. ≥ 1us
14V
16V
t'f —μs
1K
1N916
≈ -3V
Cs
200
TO OSCILLOSCOPE
tr ≤ 1ns
Ri ≥ 100K OHMS
VCC = 30V

C_S = TOTAL SHUNT CAPACITANCE FIXTURE, CONNECTORS AND PROBE = 10pF

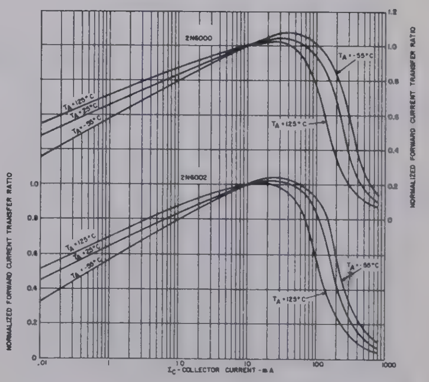
FIGURE 2. STORAGE AND FALL TIME EQUIVALENT CIRCUIT



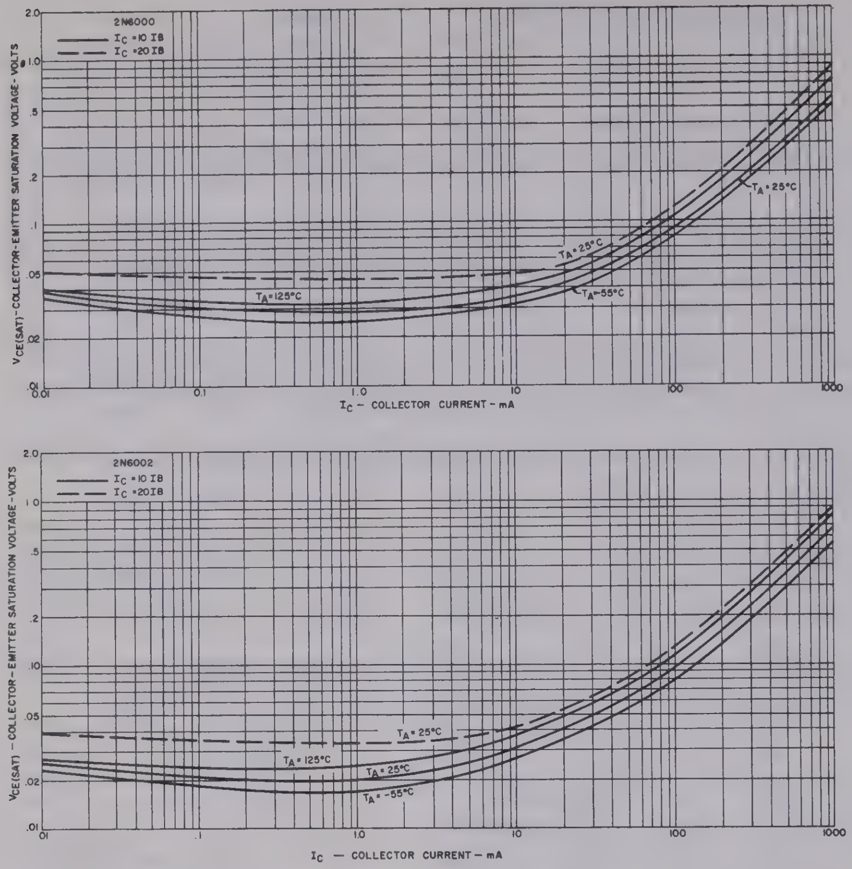
BETA VS. COLLECTOR CURRENT



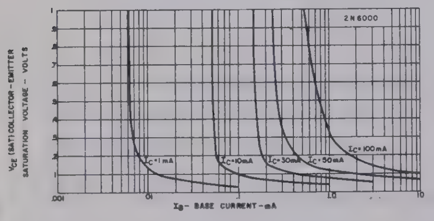
BETA VS. COLLECTOR CURRENT



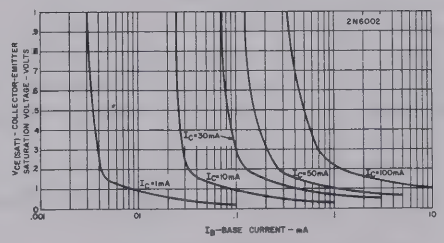
NORMALIZED FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT



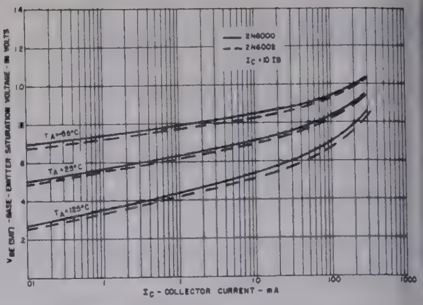
COLLECTOR-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



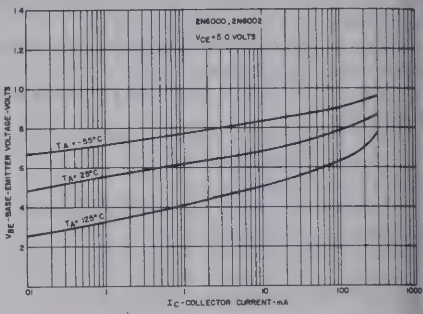
COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT



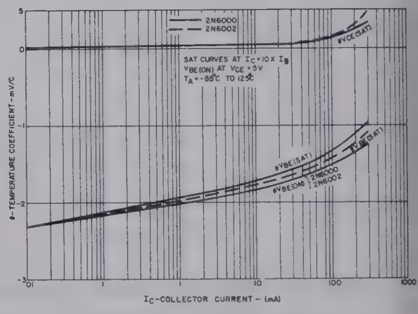
COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT



BASE-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT

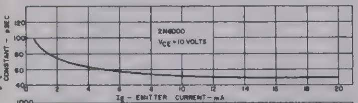


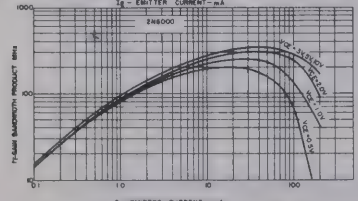
TRANSCONDUCTANCE VS. COLLECTOR CURRENT



TEMPERATURE COEFFICIENTS VS. COLLECTOR CURRENT

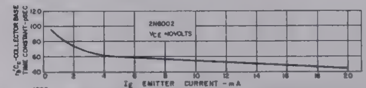
COLLECTOR-BASE TIME CONSTANT VS. EMITTER CURRENT

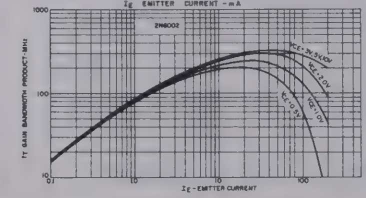




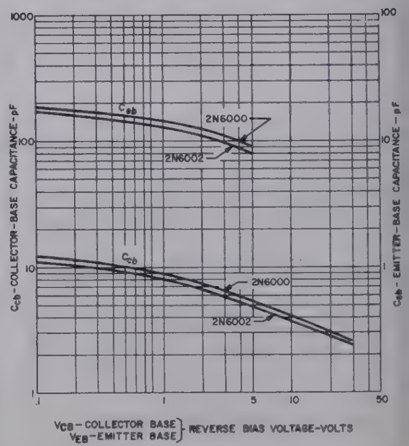
GAINBANDWIDTH PRODUCT VS. EMITTER CURRENT

COLLECTOR BASE TIME CONSTANT VS. EMITTER CURRENT

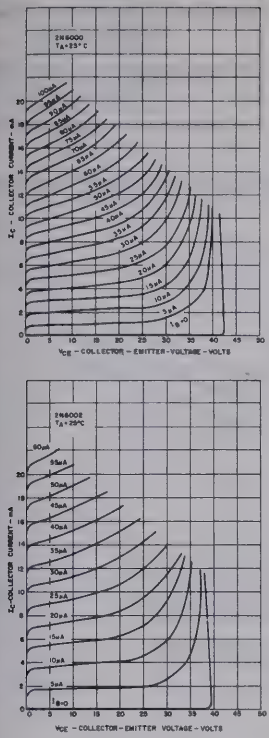




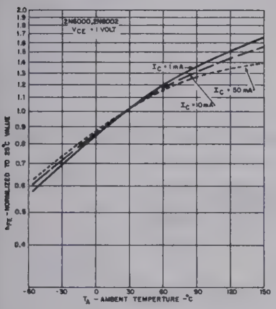
GAINBANDWIDTH PRODUCT VS. EMITTER CURRENT



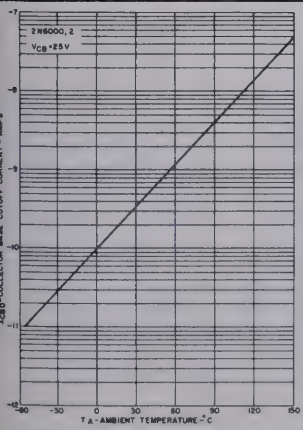
COLLECTOR-BASE & EMITTER-BASE CAPACITANCE VS. REVERSE BIAS VOLTAGE



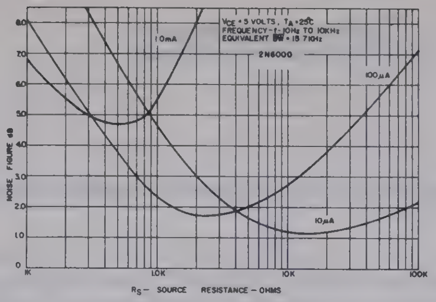
COLLECTOR CHARACTERISTICS



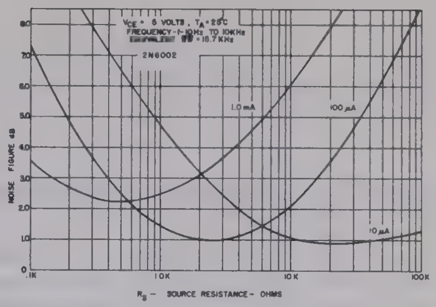
NORMALIZED FORWARD CURRENT TRANSFER RATIO VS. AMBIENT TEMPERATURE



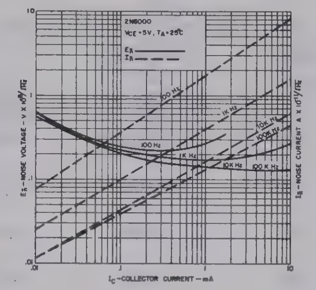
COLLECTOR-BASE CUTOFF CURRENT VS. AMBIENT TEMPERATURE



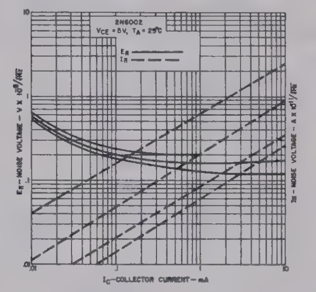
NOISE FIGURE-WIDEBAND VS. SOURCE RESISTANCE



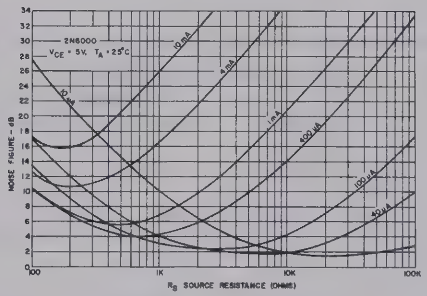
NOISE FIGURE-WIDEBAND VS. SOURCE RESISTANCE



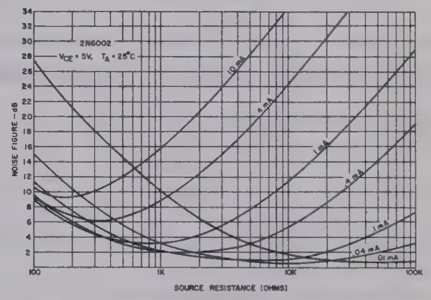
E_n & I_n VS. COLLECTOR CURRENT



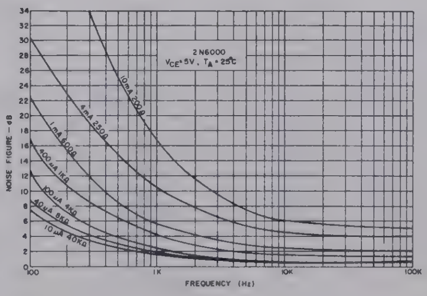
E_n & I_n VS. COLLECTOR CURRENT



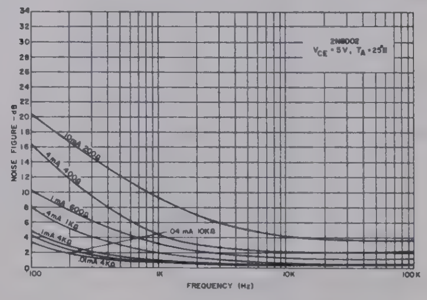
NOISE FIGURE VS. SOURCE RESISTANCE



NOISE FIGURE VS. SOURCE RESISTANCE



NOISE FIGURE VS. FREQUENCY



NOISE FIGURE VS. FREQUENCY

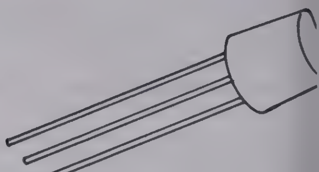
Silicon Transistors

PNP

2N6001

2N6003

The General Electric 2N6001 and 2N6003 units are silicon PNP planar passivated epitaxial devices developed primarily for high speed switching and general purpose amplifier applications where ultra low noise characteristics are desirable. Complementary NPN versions of these types are available and are designated as 2N6000 and 2N6002 respectively.



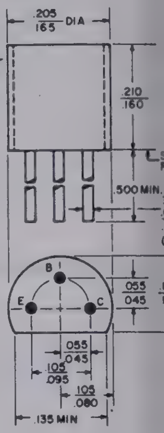
Features

- Epoxy encapsulation with proved reliability
- Performance comparable to hermetic units — excellent characteristic stability under environmental stresses—85°C—85% Relative Humidity.
- Low $V_{CE\ (SAT)}$
- Characterized for Industrial Service*
- Low Noise Figure.

*Parameters are JEDEC registered values.

absolute maximum ratings: ($T_A = 25°$, unless otherwise specified)

	Symbol	2N6001	2N6003	
Voltages				
Collector to Emitter	V_{CEO}*	–25	–25	Volts
Collector to Emitter	V_{CES}*	–35	–35	Volts
Emitter to Base	V_{EBO}*	–5	–5	Volts
Collector to Base	V_{CBO}*	–35	–35	Volts
Current				
Collector	I_C*	–500	–500	mA
Collector (peak, pulsed 10 µsec, ≦ 2% duty cycle)	I_C	–800	–800	mA
Dissipation				
Total Power ($T_C \leqq 25°C$)	P_T*	.800	.800	Watts
Total Power ($T_A \leqq 25°C$)	P_T*	.400	.400	Watts
Derate Factor ($T_C \geqq 25°C$)		8.0	8.0	mW/°C
Derate Factor ($T_A \geqq 25°C$)		4.0	4.0	mW/°C
Temperature				
Storage	T_{STG}*	← –65 to +150 →		°C
Operating	T_J*	← –65 to +125 →		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L*	← +260 →		°C



NOTE 1:
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND .250 FROM THE SEATING PLANE. BETWEEN .250 AND END OF LEAD A MAX. OF 021 IS HELD.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.

TO-18 LEAD SPACING

electrical characteristics: ($T_A = 25°$, unless otherwise specified)

STATIC CHARACTERISTICS	Symbol	2N6001 Min.	2N6001 Typ.	2N6001 Max.	2N6003 Min.	2N6003 Typ.	2N6003 Max.	
Collector-Emitter Breakdown Voltage ($I_C = -10mA, I_B = 0$)†	$V_{(BR)CEO}$*	–25			–25			Volts
Emitter-Base Breakdown Voltage ($I_E = -100\mu A, I_C = 0$)	$V_{(BR)EBO}$*	–5			–5			Volts
Collector-Base Breakdown Voltage ($I_C = -100\mu A, I_E = 0$)	$V_{(BR)CBO}$*	–35			–35			Volts
Collector-Emitter Breakdown Voltage ($I_C = -100\mu A, V_{BE} = 0$)	$V_{(BR)CES}$*	–35			–35			Volts
Collector-Emitter Saturation Voltage								
($I_C = -10mA, I_B = -1mA$)†	$V_{CE(SAT)}$*			–.100			–.100	Volts
($I_C = -100mA, I_B = -10mA$)†	$V_{CE(SAT)}$*			–.350			–.350	Volts
($I_C = -300mA, I_B = -30mA$)†	$V_{CE(SAT)}$*			–.750			–.750	Volts
Base-Emitter Saturation Voltage								
($I_C = -10mA, I_B = -1mA$)†	$V_{BE(SAT)}$*	–.60		–.85	–.60		–.85	Volts
($I_C = -100mA, I_B = -10mA$)†	$V_{BE(SAT)}$*	–.75		–1.0	–.75		–1.0	Volts
($I_C = -300mA, I_B = -30mA$)†	$V_{BE(SAT)}$*	–.85		–1.2	–.85		–1.2	Volts
Base-Emitter Voltage ($V_{CE} = -5V, I_C = -10mA$)†	V_{BE}*	–.55		–.80	–.55		–.80	Volts
Forward Current Transfer Ratio								
($V_{CE} = -1V, I_C = -100\mu A$)	h_{FE}*	90			210			
($V_{CE} = -1V, I_C = -1mA$)	h_{FE}*	95	195		235	355		
($V_{CE} = -1V, I_C = -10mA$)†	h_{FE}*	100	190	300	250	350	500	
($V_{CE} = -1V, I_C = -50mA$)†	h_{FE}*	90			210			
($V_{CE} = -1V, I_C = -100mA$)†	h_{FE}*	75			165			
($V_{CE} = -2V, I_C = -300mA$)†	h_{FE}*	35			50			
Collector Cutoff Current								
($V_{CB} = -25V, I_E = 0$)	I_{CBO}*		–.2	–10		–.2	–10	nA
($V_{CB} = -25V, I_E = 0, T_A = 100°C$)	I_{CBO}			–10			–10	µA
Emitter-Base Reverse Current ($V_{EB} = -3.0V, I_C = 0$)	I_{EBO}*		–1	–20		–1	–20	nA

†—Pulsed, 300µsec. ≦ 2% duty cycle

DYNAMIC CHARACTERISTICS

		2N6001			2N6003			
		Min.	Typ.	Max.	Max.	Typ.	Max.	
Forward Current Transfer Ratio ($I_E = 1mA, V_{CE} = -10V, f = 1KHz$)	h_{fe}*	85		450	235		750	
Input Impedance ($I_E = 1mA, V_{CE} = -10V, f = 1KHz$)	h_{fe}*	1.5	7	12	3	10	17	Kohms
Output Conductance ($I_E = 1mA, V_{CE} = -10V, f = 1KHz$)	h_{oe}*	15	45	100	30	75	150	μmhos
Voltage Feedback Ratio ($I_E = 1mA, V_{CE} = -10V, f = 1KHz$)	h_{re}		10			20		$x10^{-4}$
Collector-Base Capacitance ($V_{CB} = -10V, I_E = 0, f = 1$ MHz)	C_{cb}*	3.0	5.4	8.0	3.0	4.5	8.0	pF
Emitter-Base Capacitance ($V_{EB} = -0.5V, I_C = 0, f = 1$ MHz)	C_{eb}*		17	25		15	20	pF
Magnitude of Forward Current Transfer Ratio ($V_{CE} = -10V, I_E = 10mA, f = 100$ MHz)	$\|h_{fe}\|$*	7		14	8		15	dB
Gain-Bandwidth Product ($V_{CE} = -10V, I_E = 10mA, f = 100$ MHz)	f_T	225	340	500	250	400	560	MHz
Collector-Base Time Constant ($V_{CB} = -10V, I_E = 10mA, f = 31.9$ MHz)	$r_b'C_c$*	20	80	130	40	115	160	psec
Noise Figure ($V_{CE} = -5V, I_E = 100\mu A$, BW = 15.7KHz, $R_S = 5K\Omega$, f = 10 Hz to 10KHz)	NF*			3			1.5	dB
Delay Time — see figure 1 ($V_{CC} = -30V, I_C(on) = -150mA, I_{B1} = -15mA, V_{BE}(off) = 0V$)	t_d*		3	6		3	6	nsec
Rise Time — see figure 1 ($V_{CC} = -30V, I_C(on) = -150mA, I_{B1} = -15mA, V_{BE}(off) = 0V$)	t_r*		13	17		13	17	nsec
Storage Time — see figure 2 ($V_{CC} = -30V, I_C(on) = -150mA, I_{B1} = -15mA, I_{B2} = 15mA$)	t_s*		130	170		150	200	nsec
Fall Time — see figure 2 ($V_{CC} = -30V, I_C(on) = -150mA, I_{B1} = -15mA, I_{B2} = 15mA$)	t_f*		25	60		50	100	nsec

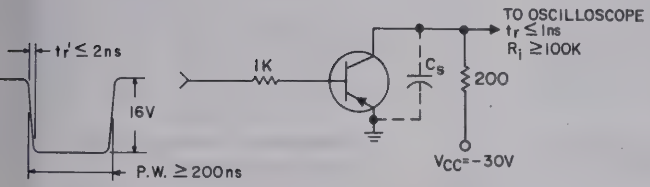
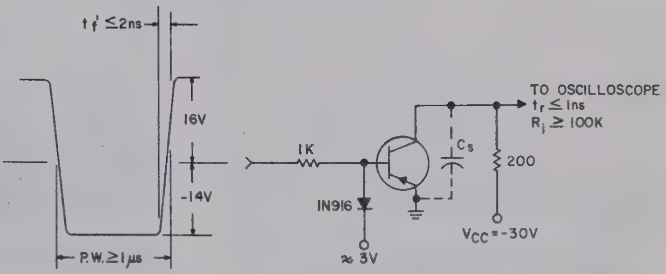
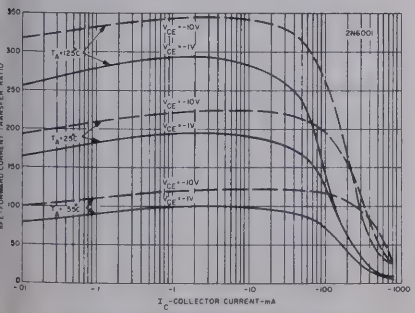


FIGURE 1. DELAY AND RISE TIME EQUIVALENT CIRCUIT

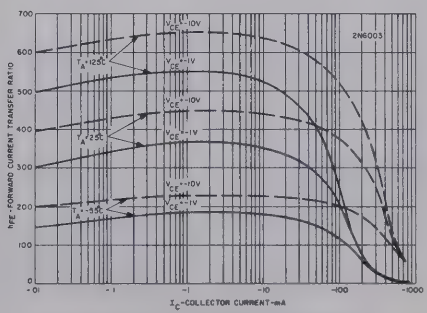


C_s = TOTAL SHUNT CAPACITANCE FIXTURE, CONNECTORS, AND PROBE = 10pF

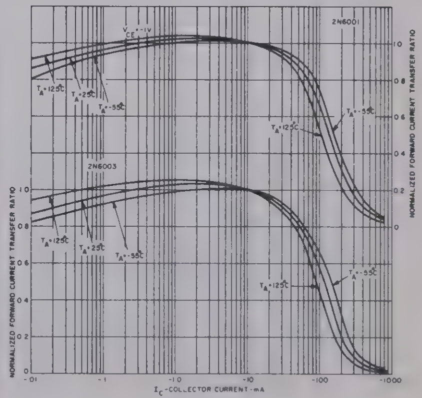
FIGURE 2. STORAGE AND FALL TIME EQUIVALENT CIRCUIT



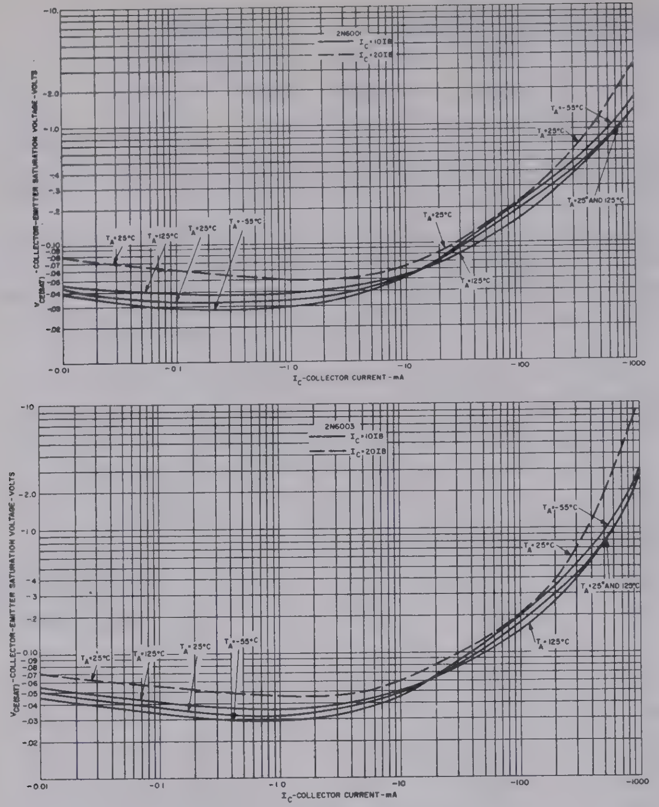
BETA VS. COLLECTOR CURRENT



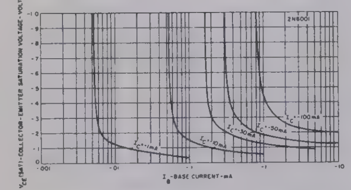
BETA VS. COLLECTOR CURRENT



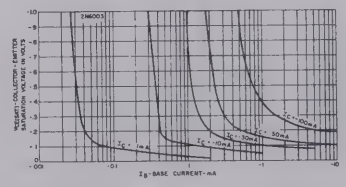
NORMALIZED FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT



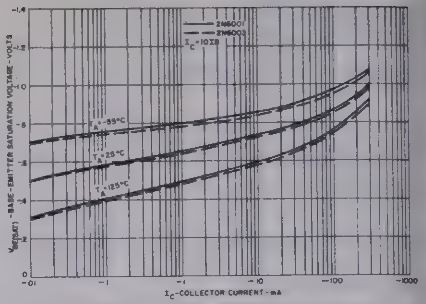
COLLECTOR-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



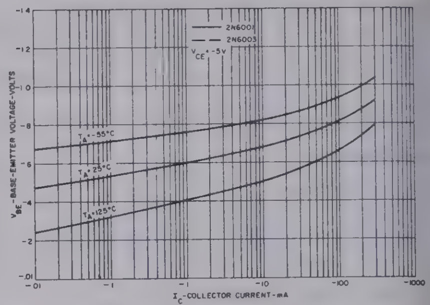
COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT



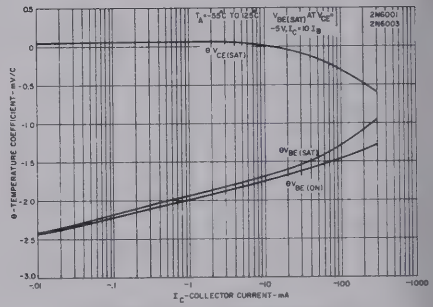
COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT



BASE-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT

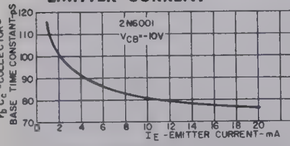


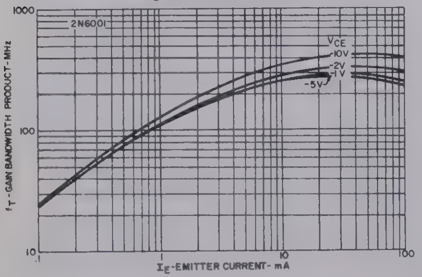
TRANSCONDUCTANCE VS. COLLECTOR CURRENT



TEMPERATURE COEFFICIENTS VS. COLLECTOR CURRENT

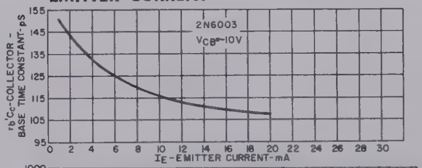
EMITTER -BASE TIME CONSTANT VS. EMITTER CURRENT

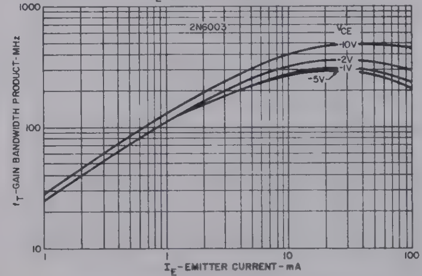




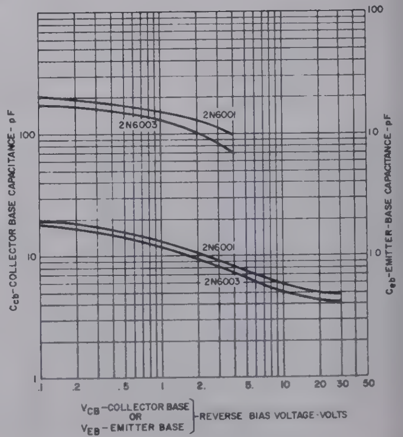
GAINBANDWIDTH PRODUCT VS. EMITTER CURRENT

COLLECTOR BASE TIME CURRENT VS. EMITTER CURRENT



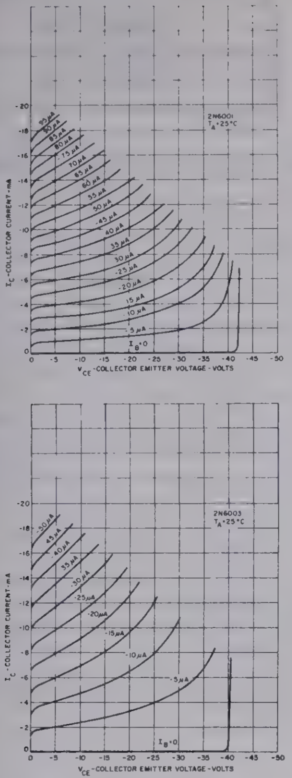


GAINBANDWIDTH PRODUCT VS. EMITTER CURRENT

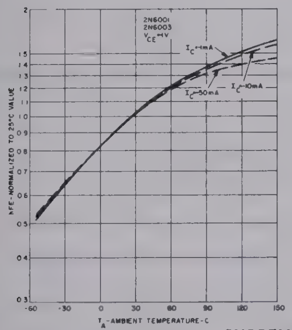


COLLECTOR-BASE & EMITTER-BASE CAPACITANCE VS. REVERSE BIAS VOLTAGE

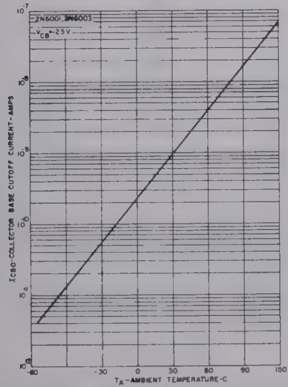
2N6001,3



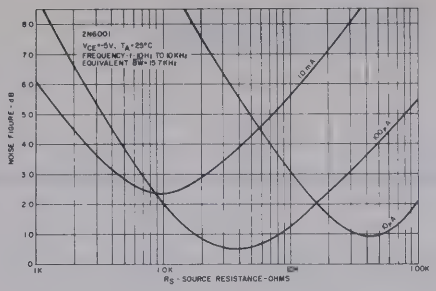
COLLECTOR CHARACTERISTICS



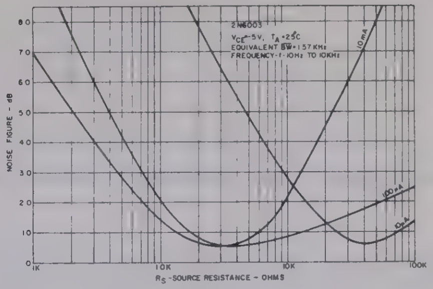
NORMALIZED FORWARD CURRENT TRANSFER RATIO VS. AMBIENT TEMPERATURE



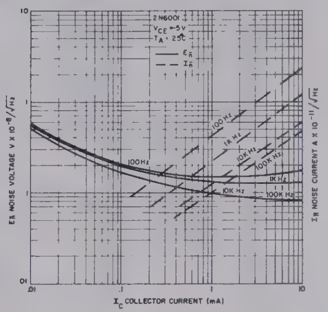
COLLECTOR-BASE CUTOFF CURRENT VS. AMBIENT TEMPERATURE



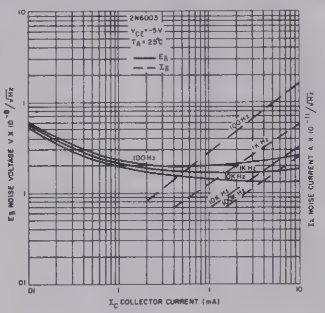
NOISE FIGURE-WIDEBAND VS. SOURCE RESISTANCE



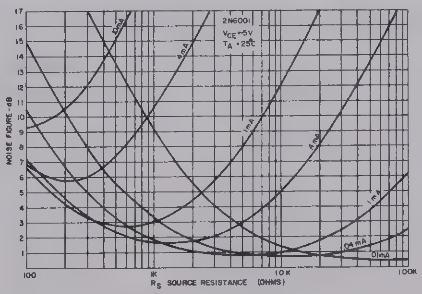
NOISE FIGURE-WIDEBAND VS. SOURCE RESISTANCE



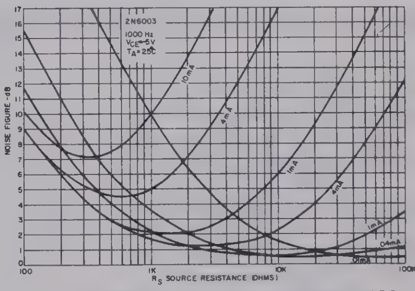
E_n & I_n VS. COLLECTOR CURRENT



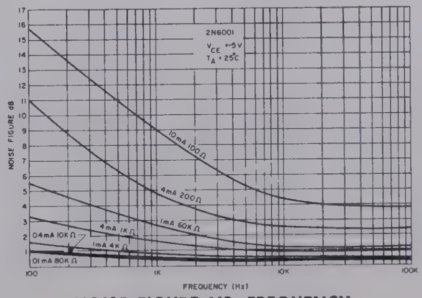
E_n & I_n VS. COLLECTOR CURRENT



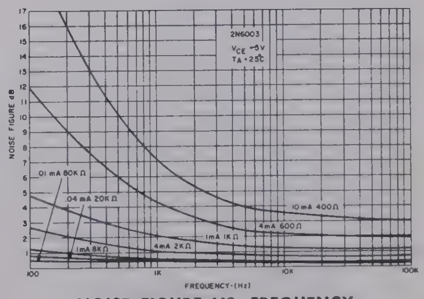
NOISE FIGURE VS. SOURCE RESISTANCE



NOISE FIGURE VS. SOURCE RESISTANCE



NOISE FIGURE VS. FREQUENCY



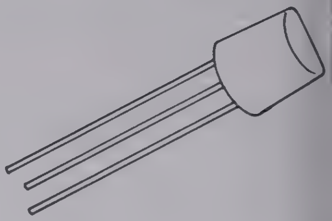
NOISE FIGURE VS. FREQUENCY

Silicon Transistors

NPN

2N6004
2N6006

The General Electric 2N6004 and 2N6006 units are NPN silicon, planar passivated, epitaxial devices specifically developed for higher voltage general purpose amplifier and switch applications in industrial applications. PNP versions of these units are available and are designated 2N6005 and 2N6007 respectively.

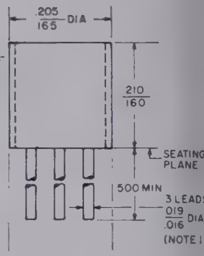


Features
- Epoxy encapsulation with proved reliability.
- Performance comparable to hermetic units—excellent characteristic stability under environmental stresses—85°C—85% Relative Humidity.
- Low $V_{CE(SAT)}$
- Characterized for Industrial Service.*
- Low Noise Figure.
- 40V $_{(BR)CEO}$—Maximum voltage rating.

* Parameters are JEDEC Registered values.

absolute maximum ratings: ($T_A = 25°C$, unless otherwise specified)

		2N6004	2N6006	
Voltages				
Collector to Emitter	V_{CEO}*	40	40	Volts
Collector to Emitter	V_{CES}*	50	50	Volts
Emitter to Base	V_{EBO}*	5	5	Volts
Collector to Base	V_{CBO}*	50	50	Volts
Current				
Collector	I_C*	500	500	mA
Collector (peak, pulsed 10 μsec, ≦ 2% duty cycle)	I_C	800	800	mA
Dissipation				
Total Power ($T_C \leqq 25°C$)	P_T*	.800	.800	Watts
Total Power ($T_A \leqq 25°C$)	P_T*	.400	.400	Watts
Derate Factor ($T_C \geqq 25°C$)		8.0	8.0	mW/°C
Derate Factor ($T_A \geqq 25°C$)		4.0	4.0	mW/°C
Temperature				
Storage	T_{STG}*	←— −65 to +150 —→		°C
Operating	T_J*	←— −65 to +125 —→		°C
Lead (1/16″ ± 1/32″ from case for 10 sec.)	T_L*	←— +260 —→		°C



NOTE 1
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND .250 FROM THE SEATING PLANE BETWEEN .250 AND END OF LEAD A MAX OF .021 IS HELD.

ALL DIMEN IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

TO-18 LEAD SPACING

electrical characteristics: ($T_A = 25°C$, unless otherwise specified)

STATIC CHARACTERISTICS	Symbol	2N6004 Min.	2N6004 Typ.	2N6004 Max.	2N6006 Min.	2N6006 Typ.	2N6006 Max.	
Collector-Emitter Breakdown Voltage ($I_C = 10mA, I_B = 0$)†	$V_{(BR)CEO}$*	40			40			Volts
Emitter-Base Breakdown Voltage ($I_E = 100\mu A, I_C = 0$)	$V_{(BR)EBO}$*	5			5			Volts
Collector-Base Breakdown Voltage ($I_C = 100\mu A, I_E = 0$)	$V_{(BR)CBO}$*	50			50			Volts
Collector-Emitter Breakdown Voltage ($I_C = 100\mu A, V_{BE} = 0$)	$V_{(BR)CES}$*	50			50			Volts
Collector-Emitter Saturation Voltage								
($I_C = 10mA, I_B = 1mA$)†	$V_{CE(SAT)}$*			.080			.080	Volts
($I_C = 100mA, I_B = 10mA$)†	$V_{CE(SAT)}$*			.175			.175	Volts
($I_C = 300mA, I_B = 30mA$)†	$V_{CE(SAT)}$*			.400			.400	Volts
Base-Emitter Saturation Voltage								
($I_C = 10mA, I_B = 1mA$)†	$V_{BE(SAT)}$*	.60		.80	.60		.80	Volts
($I_C = 100mA, I_B = 10mA$)†	$V_{BE(SAT)}$*	.70		.95	.70		.95	Volts
($I_C = 300mA, I_B = 30mA$)†	$V_{BE(SAT)}$*	.80		1.1	.80		1.1	Volts
Base-Emitter Voltage ($V_{CE} = 5V, I_C = 10mA$)†	V_{BE}*	.55		.78	.55		.78	Volts
Forward Current Transfer Ratio								
($V_{CE} = 1V, I_C = 100\mu A$)	h_{FE}*	50			130			
($V_{CE} = 1V, I_C = 1mA$)	h_{FE}*	70	160		175	295		
($V_{CE} = 1V, I_C = 10mA$)†	h_{FE}*	100	190	300	250	350	500	
($V_{CE} = 1V, I_C = 50mA$)†	h_{FE}*	105			260			
($V_{CE} = 1V, I_C = 100mA$)†	h_{FE}*	100			245			
($V_{CE} = 2V, I_C = 300mA$)†	h_{FE}*	40			80			
Collector Cutoff Current								
($V_{CB} = 25V, I_E = 0$)	I_{CBO}*		.2	10		.2	10	nA
($V_{CB} = 25V, I_E = 0, T_A = 100°C$)	I_{CBO}*			10			10	μA
Emitter-Base Reverse Current ($V_{EB} = 3.0V, I_C = 0$)	I_{EBO}*		.1	20		.1	20	nA

† Pulsed, 300μsec, ≦ 2% duty cycle

DYNAMIC CHARACTERISTICS

		2N6004			2N6006			
		Min.	Typ.	Max.	Min.	Typ.	Max.	
Forward Current Transfer Ratio $(I_E = -1mA, V_{CE} = 10V, f = 1KHz)$	h_{fe}*	70		450	175		750	
Input Impedance $(I_E = -1mA, V_{CE} = 10V, f = 1KHz)$	h_{fe}*	1.5	4	10	2.5	9	15	Kohms
Output Conductance $(I_E = -1mA, V_{CE} = 10V, f = 1KHz)$	h_{oe}*	20	35	80	30	70	100	umhos
Voltage Feedback Ratio $(I_E = -1mA, V_{CE} = 10V, f = 1KHz)$	h_{re}		9			20		$x10^{-4}$
Collector-Base Capacitance $(V_{CB} = 10V, I_E = 0, f = 1 MHz)$	C_{cb}*	2.5	4.2	6.0	2.5	4.2	6.0	pF
Emitter-Base Capacitance $(V_{EB} = 0.5V, I_C = 0, f = 1 MHz)$	C_{eb}*		15	20		14	18	pF
Magnitude of Forward Current Transfer Ratio $(V_{CE} = 10V, I_E = -10mA, f = 100 MHz)$	$\|h_{fe}\|$*		3.5	14	4.5		15	dB
Gain-Bandwidth Product $(V_{CE} = 10V, I_E = -10mA, f = 100 MHz)$	f_T	150	300	500	165	310	560	MHz
Collector-Base Time Constant $(V_{CB} = 10V, I_E = -10mA, f = 31.9 MHz)$	$r_b'C_c$*	20	62	100	30	62	120	psec
Noise Figure $(V_{CE} = 5V, I_E = -100\mu A, BW = 15.7KHz, R_S = 5K\Omega,$ $f = 10 Hz$ to $10KHz)$	NF*			3			2	dB
Delay Time—See Figure 1 $(V_{CC} = 30V, I_C(on) = 150mA, I_{B1} = 15mA, V_{BE}(off) = 0V)$	t_d*		7	10		7	10	nsec
Rise Time—See Figure 1 $(V_{CC} = 30V, I_C(on) = 150mA, I_{B1} = 15mA, V_{BE}(off) = 0V)$	t_r*		12	15		12	15	nsec
Storage Time—See Figure 2 $(V_{CC} = 30V, I_C(on) = 150mA, I_{B1} = 15mA, I_{B2} = -15mA)$	t_s*		150	250		190	300	nsec
Fall Time—See Figure 2 $(V_{CC} = 30V, I_C(on) = 150mA, I_{B1} = 15mA, I_{B2} = -15mA)$	t_f*		30	70		50	110	nsec

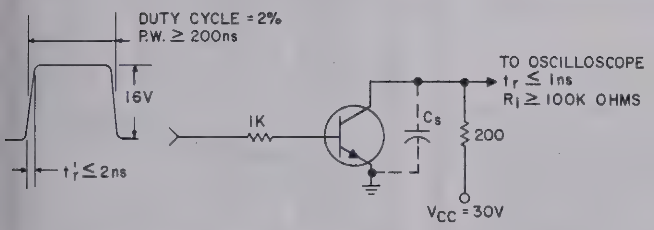
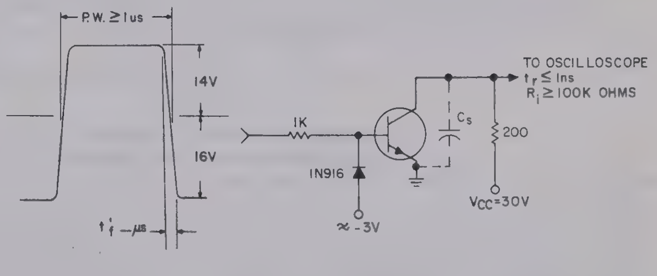
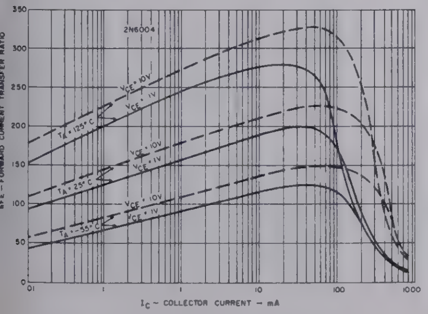

DUTY CYCLE = 2%
P.W. ≥ 200ns
16V
t_r ≤ 2ns
1K
C_S
200
TO OSCILLOSCOPE
t_r ≤ 1ns
R_i ≥ 100K OHMS
V_CC = 30V

FIGURE 1. DELAY AND RISE TIME EQUIVALENT CIRCUIT

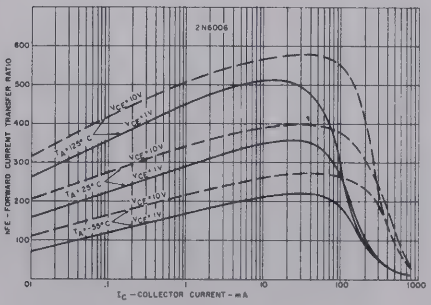

P.W. ≥ 1us
14V
16V
t_f — μs
1K
1N916
≈ -3V
C_s
200
TO OSCILLOSCOPE
t_r ≤ 1ns
R_i ≥ 100K OHMS
V_CC=30V

C_s = TOTAL SHUNT CAPACITANCE FIXTURE, CONNECTORS AND PROBE = 10pF

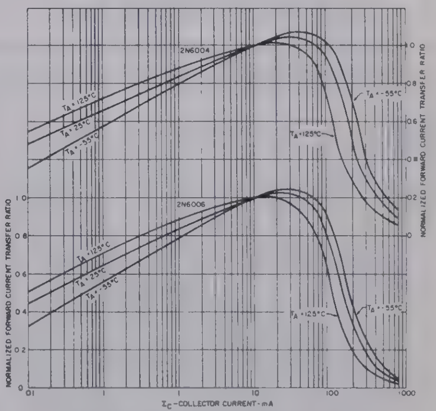
FIGURE 2. STORAGE AND FALL TIME EQUIVALENT CIRCUIT



BETA VS. COLLECTOR CURRENT

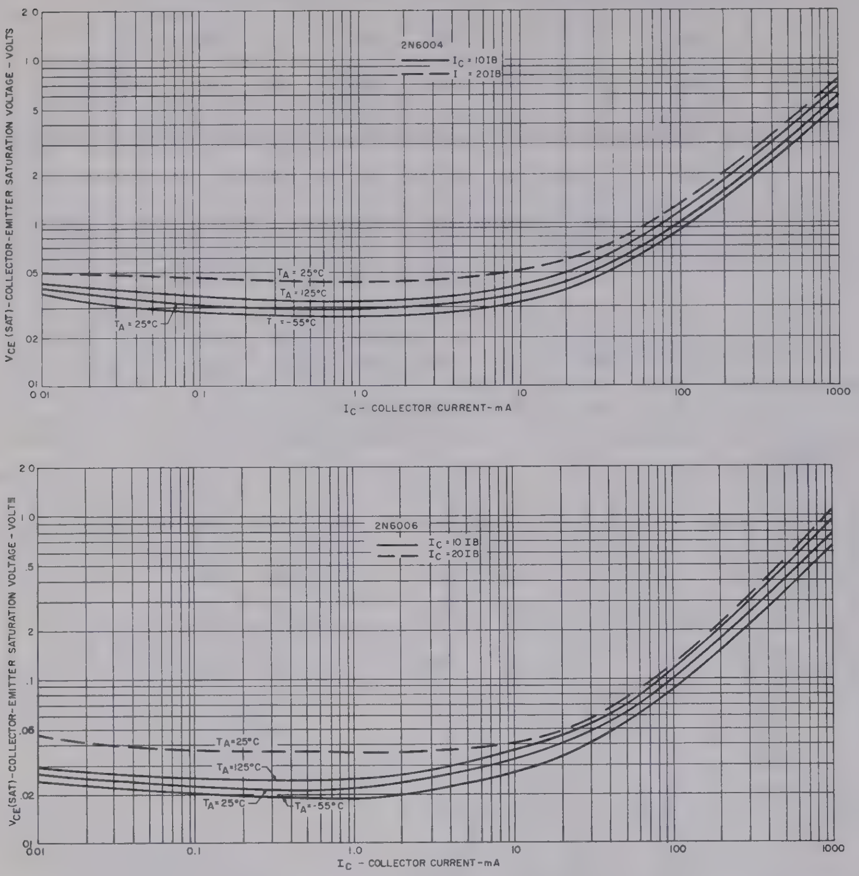


BETA VS. COLLECTOR CURRENT

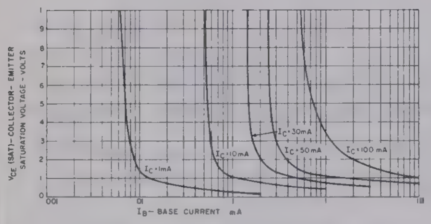


NORMALIZED FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT

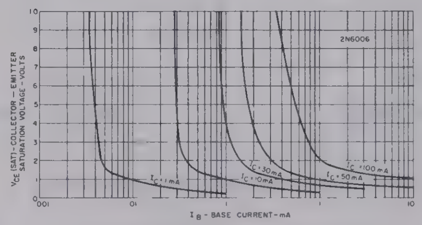
2N6004,6



COLLECTOR-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT

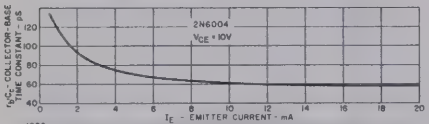


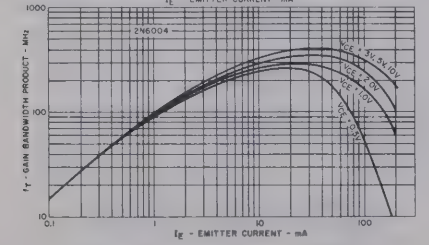
COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT



COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT

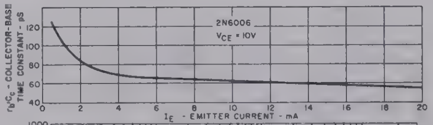
COLLECTOR-BASE TIME CONSTANT VS. EMITTER CURRENT

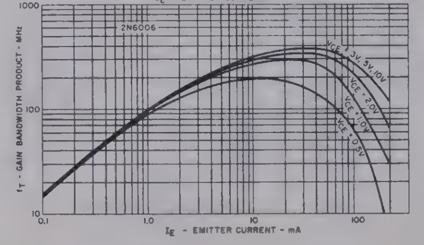




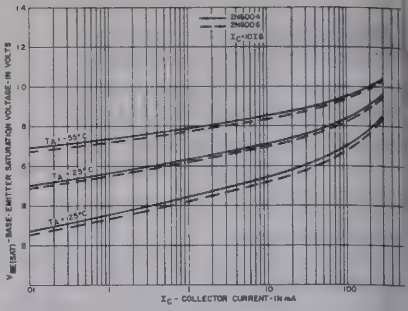
GAINBANDWIDTH PRODUCT VS. EMITTER CURRENT

COLLECTOR BASE TIME CONSTANT VS. EMITTER CURRENT

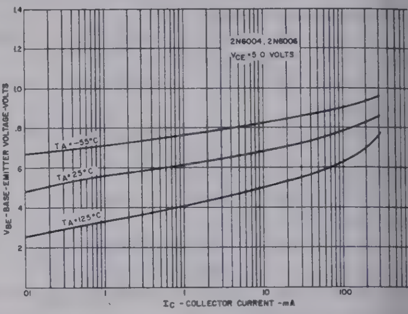




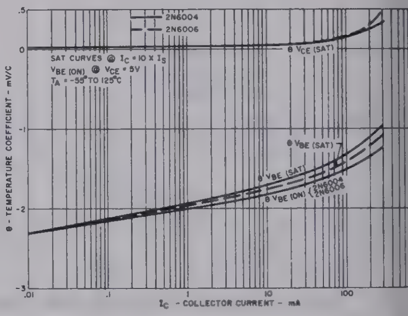
GAINBANDWIDTH PRODUCT VS. EMITTER CURRENT



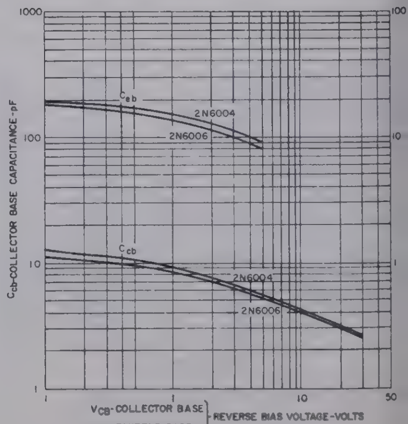
BASE-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



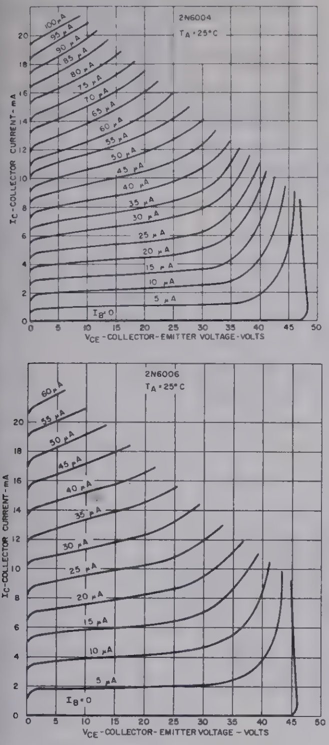
TRANSCONDUCTANCE VS. COLLECTOR CURRENT



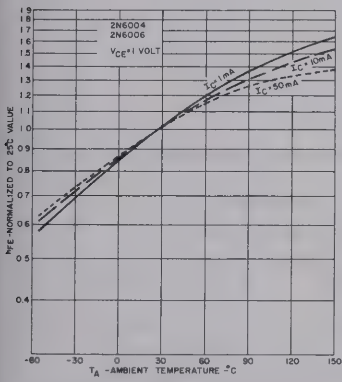
TEMPERATURE COEFFICIENTS VS. COLLECTOR CURRENT



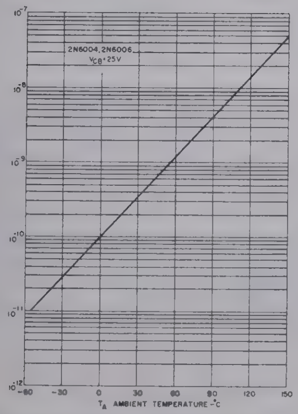
COLLECTOR-BASE & EMITTER-BASE CAPACITANCE VS. REVERSE BIAS VOLTAGE



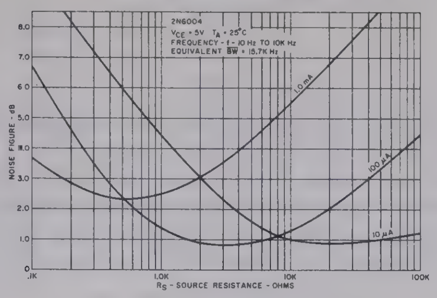
COLLECTOR CHARACTERISTICS



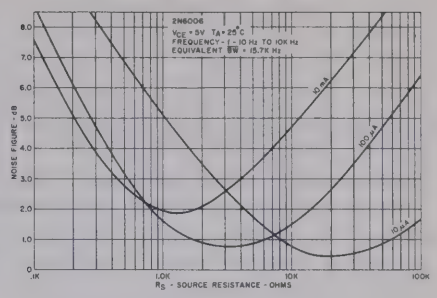
NORMALIZED FORWARD CURRENT TRANSFER RATIO VS. AMBIENT TEMPERATURE



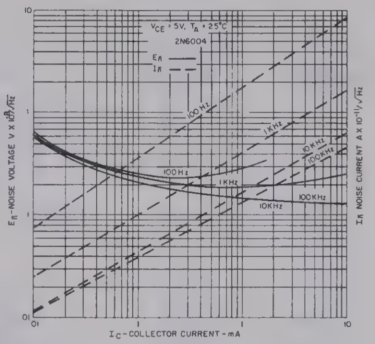
COLLECTOR-BASE CUTOFF CURRENT VS. AMBIENT TEMPERATURE



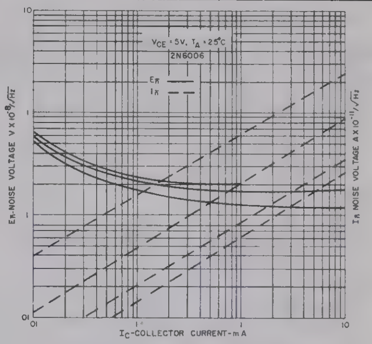
NOISE FIGURE-WIDEBAND VS. SOURCE RESISTANCE



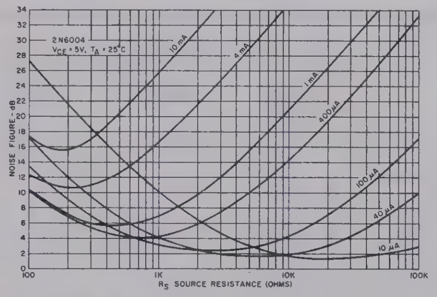
NOISE FIGURE-WIDEBAND VS. SOURCE RESISTANCE



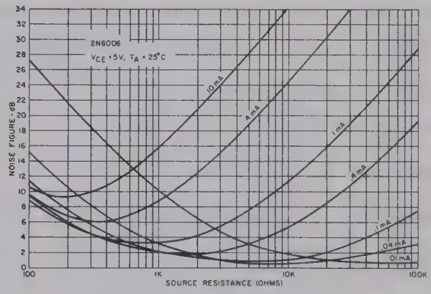
E_n & I_n VS. COLLECTOR CURRENT



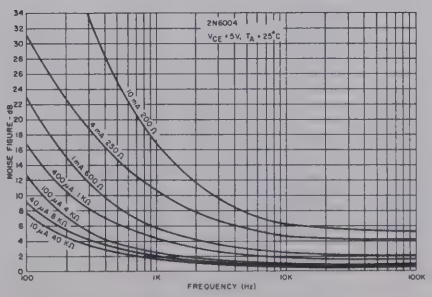
E_n & I_n VS. COLLECTOR CURRENT



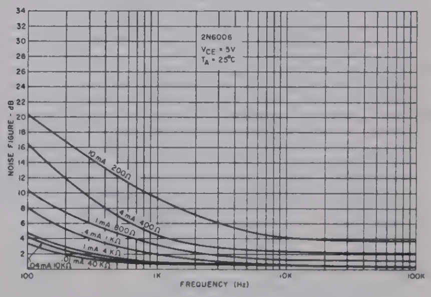
NOISE FIGURE VS. SOURCE RESISTANCE



NOISE FIGURE VS. SOURCE RESISTANCE



NOISE FIGURE VS. FREQUENCY



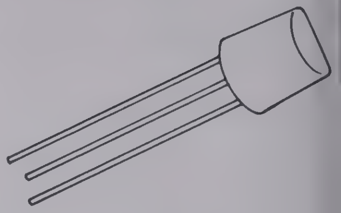
NOISE FIGURE VS. FREQUENCY

Silicon
Transistors

PNP

2N6005
2N6007

The General Electric 2N6005 and 2N6007 units are silicon PNP planar passivated epitaxial devices developed specifically for high speed switching and general purpose amplifier applications where ultra low noise characteristics are desirable. Complementary NPN versions of these units are available and are designated as 2N6004 and 2N6006 respectively.



Features

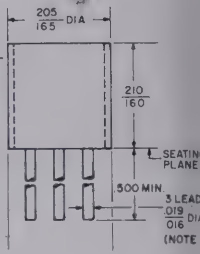
- Epoxy encapsulation with proved reliability
- Performance comparable to hermetic units — excellent characteristic stability under environmental stresses — 85°C — 85% Relative Humidity.
- Low $V_{CE(SAT)}$
- Characterized for Industrial Service*
- Low Noise Figure.
- 40$V_{(BR)CEO}$ — Maximum voltage rating.

*Parameters are JEDEC registered values.

NOTE 1:
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND .250 FROM THE SEATING PLANE BETWEEN .250 AND END OF LEAD A MAX OF .021 IS HELD.

ALL DIMEN IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.

TO-18 LEAD SPACING



absolute maximum ratings: (T$_A$ = 25°, unless otherwise specified)

		2N6005	2N6007	
Voltages				
Collector to Emitter	V_{CEO}*	−40	−40	Volts
Collector to Emitter	V_{CES}*	−50	−50	Volts
Emitter to Base	V_{EBO}*	−5	−5	Volts
Collector to Base	V_{CBO}*	−50	−50	Volts
Current				
Collector	I_C*	−500	−500	mA
Collector (peak, pulsed 10 μsec, ≦ 2% duty cycle)	I_C	−800	−800	mA
Dissipation				
Total Power ($T_C \leqq 25°C$)	P_T*	.800	.800	Watts
Total Power ($T_A \leqq 25°C$)	P_T*	.400	.400	Watts
Derate Factor ($T_C \geqq 25°C$)		8.0	8.0	mW/°C
Derate Factor ($T_A \geqq 25°C$)		4.0	4.0	mW/°C
Temperature				
Storage	T_{STG}*	← −65 to +150 →		°C
Operating	T_J*	← −65 to +125 →		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	← +260 →		°C

electrical characteristics: (T$_A$ = 25°, unless otherwise specified)

STATIC CHARACTERISTICS	Symbol	2N6005 Min.	2N6005 Typ.	2N6005 Max.	2N6007 Min.	2N6007 Typ.	2N6007 Max.	
Collector-Emitter Breakdown Voltage ($I_C = -10mA, I_B = 0$) †	$V_{(BR)CEO}$*	−40			−40			Volts
Emitter-Base Breakdown Voltage ($I_E = -100\mu A, I_C = 0$)	$V_{(BR)EBO}$*	−5			−5			Volts
Collector-Base Breakdown Voltage ($I_C = -100\mu A, I_E = 0$)	$V_{(BR)CBO}$*	−50			−50			Volts
Collector-Emitter Breakdown Voltage ($I_C = -100\mu A, V_{BE} = 0$)	$V_{(BR)CES}$*	−50			−50			Volts
Collector-Emitter Saturation Voltage ($I_C = -10mA, I_B = -1mA$) †	$V_{CE(SAT)}$*			— .100			— .100	Volts
($I_C = -100mA, I_B = -10mA$) †	$V_{CE(SAT)}$*			— .350			— .350	Volts
($I_C = -300mA, I_B = -30mA$) †	$V_{CE(SAT)}$*			— .750			— .750	Volts
Base-Emitter Saturation Voltage ($I_C = -10mA, I_B = -1mA$) †	$V_{BE(SAT)}$*	— .60		— .85	— .60		−0.85	Volts
($I_C = -100mA, I_B = -10mA$) †	$V_{BE(SAT)}$*	— .75		−1.0	— .75		−1.0	Volts
($I_C = -300mA, I_B = -30mA$) †	$V_{BE(SAT)}$*	— .85		−1.2	— .85		−1.2	Volts
Base-Emitter Voltage ($V_{CE} = -5V, I_C = -10mA$) †	V_{BE}*	— .55		— .80	— .55		— .80	Volts
Forward Current Transfer Ratio ($V_{CE} = -1V, I_C = -100\mu A$)	h_{FE}*	90			210			
($V_{CE} = -1V, I_C = -1mA$)	h_{FE}*	95	195		235	355		
($V_{CE} = -1V, I_C = -10mA$) †	h_{FE}*	100	190	300	250	350	500	
($V_{CE} = -1V, I_C = -50mA$) †	h_{FE}*	90			210			
($V_{CE} = -1V, I_C = -100mA$) †	h_{FE}*	75			165			
($V_{CE} = -2V, I_C = -300mA$) †	h_{FE}*	35			50			
Collector Cutoff Current ($V_{CB} = -25V, I_E = 0$)	I_{CBO}*		−.2	−10		−.2	−10	nA
($V_{CB} = -25V, I_E = 0, T_A = 100°C$)	I_{CBO}			−10			−10	μA
Emitter-Base Reverse Current ($V_{EB} = -3.0V, I_C = 0$)	I_{EBO}*		−1	−20		−1	−20	nA

†—Pulsed, 300μsec. ≦ 2% duty cycle

2N6005,7

DYNAMIC CHARACTERISTICS

	Symbol	2N6005 Min.	2N6005 Typ.	2N6005 Max.	2N6007 Min.	2N6007 Typ.	2N6007 Max.	
Forward Current Transfer Ratio ($I_E = 1mA, V_{CE} = -10V, f = 1KHz$)	h_{fe}*	85		450	235		750	
Input Impedance ($I_E = 1mA, V_{CE} = -10V, f = 1KHz$)	h_{ie}*	1.5	7	12	3	10	17	Kohms
Output Conductance ($I_E = 1mA, V_{CE} = -10V, f = 1KHz$)	h_{oe}*	15	45	100	30	75	150	μmhos
Voltage Feedback Ratio ($I_E = 1mA, V_{CE} = -10V, f = 1KHz$)	h_{re}		12			24		$x10^{-4}$
Collector-Base Capacitance ($V_{CB} = -10V, I_E = 0, f = 1$ MHz)	C_{cb}*	3	4.5	8	3	4.5	8	pF
Emitter-Base Capacitance ($V_{EB} = -0.5V, I_C = 0, f = 1$ MHz)	C_{eb}*		17	25		15	20	pF
Magnitude of Forward Current Transfer Ratio ($V_{CE} = -10V, I_E = 10mA, f = 100$ MHz)	$\lvert h_{fe}\rvert$*	7		14	8		15	dB
Gain-Bandwidth Product ($V_{CE} = -10V, I_E = 10mA, f = 100$ MHz)	f_T	225	340	500	250	400	560	MHz
Collector-Base Time Constant ($V_{CB} = -10V, I_E = 10mA, f = 31.9$ MHz)	$r_b'C_c$*	20	70	130	40	100	160	psec
Noise Figure ($V_{CE} = -5V, I_E = +100\mu A$, BW = 15.7 KHz, $R_S = 5K\Omega$, f = 10 Hz to 10 KHz)	NF*			3			1.5	dB
Delay Time — see figure 1 ($V_{CC} = -30V, I_C(on) = -150mA, I_{B1} = -15mA, V_{BE}(off) = 0V$)	t_d*		3	6		3	6	nsec
Rise Time — see figure 1 ($V_{CC} = -30V, I_C(on) = -150mA, I_{B1} = -15mA, V_{BE}(off) = 0V$)	t_r*		13	17		13	17	nsec
Storage Time — see figure 2 ($V_{CC} = -30V, I_C(on) = -150mA, I_{B1} = -15mA, I_{B2} = +15mA$)	t_s*		130	170		150	200	nsec
Fall Time — see figure 2 ($V_{CC} = -30V, I_C(on) = -150mA, I_{B1} = -15mA, I_{B2} = +15mA$)	t_f*		25	60		50	100	nsec

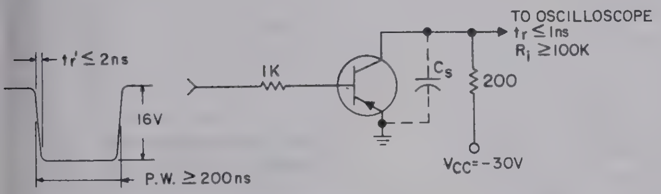
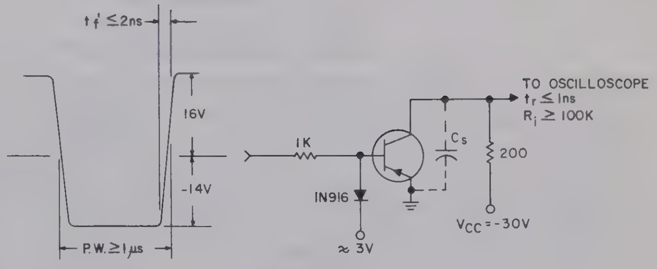
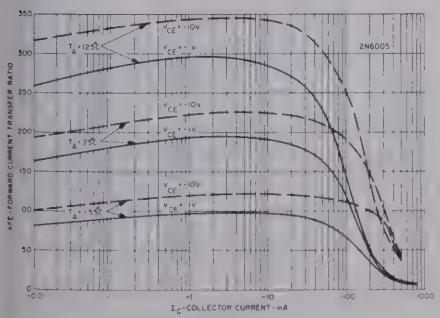


FIGURE 1. DELAY AND RISE TIME EQUIVALENT CIRCUIT

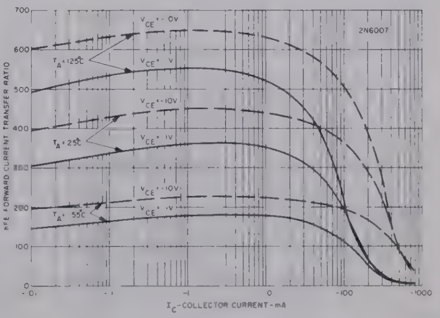


C_s = TOTAL SHUNT CAPACITANCE FIXTURE, CONNECTORS, AND PROBE = 10pF

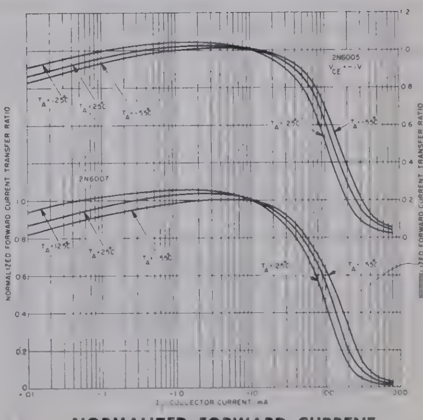
FIGURE 2. STORAGE AND FALL TIME EQUIVALENT CIRCUIT



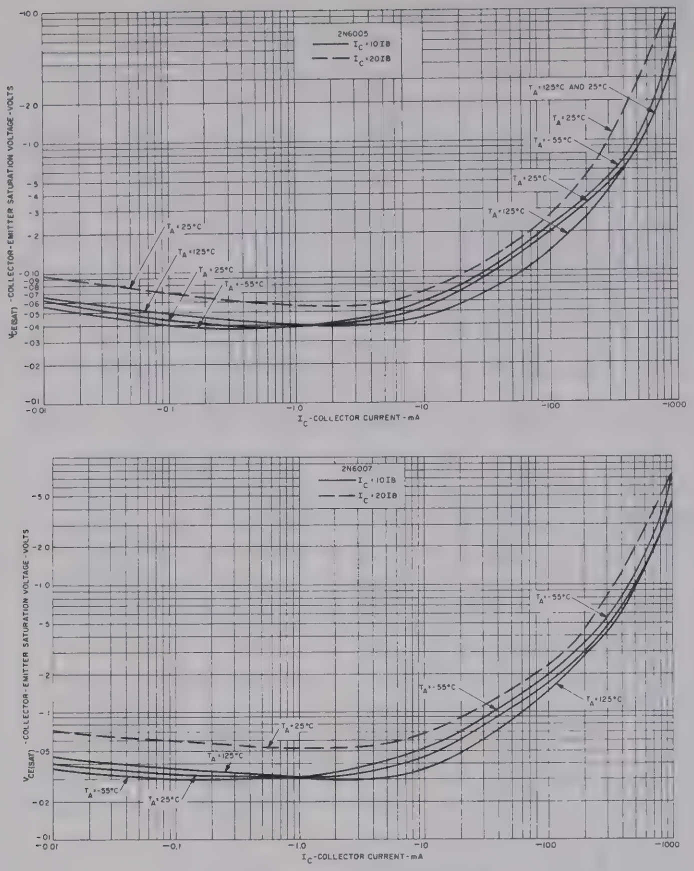
BETA VS. COLLECTOR CURRENT



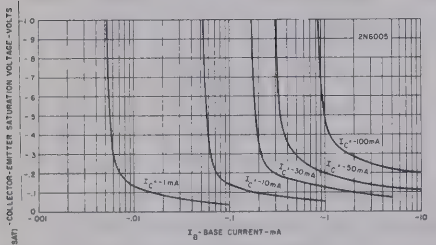
BETA VS. COLLECTOR CURRENT



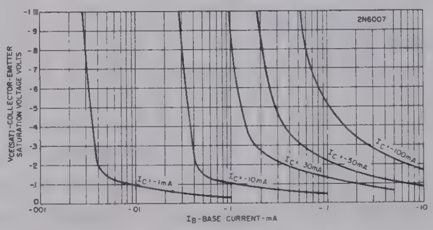
NORMALIZED FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT



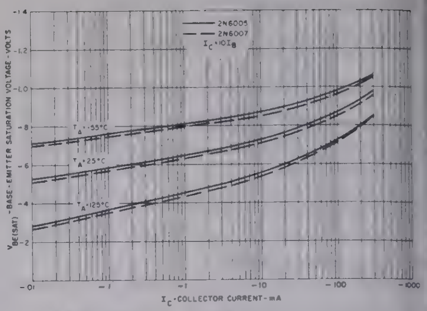
COLLECTOR-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



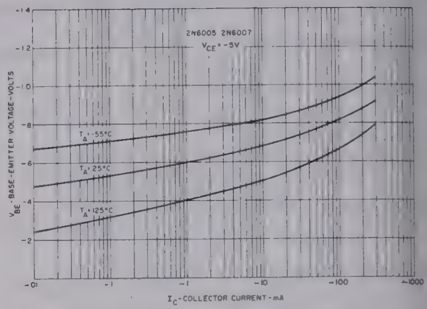
COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT



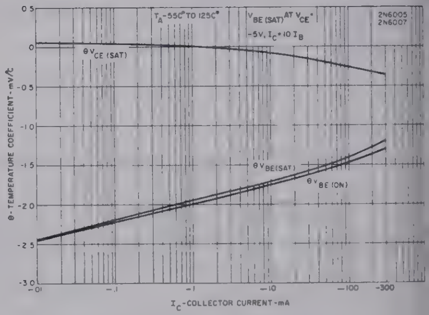
COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT



BASE-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT

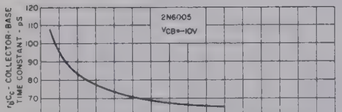


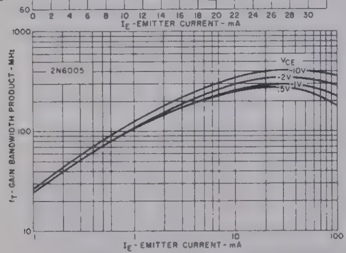
TRANSCONDUCTANCE VS. COLLECTOR CURRENT



TEMPERATURE COEFFICIENTS VS. COLLECTOR CURRENT

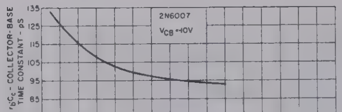
COLLECTOR-BASE TIME CONSTANT VS. EMITTER CURRENT

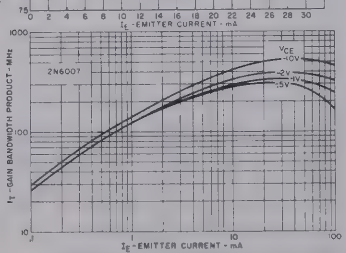




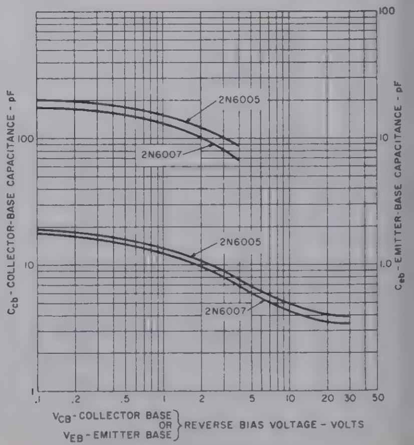
GAINBANDWIDTH PRODUCT VS. EMITTER CURRENT

COLLECTOR BASE TIME CONSTANT VS. EMITTER CURRENT



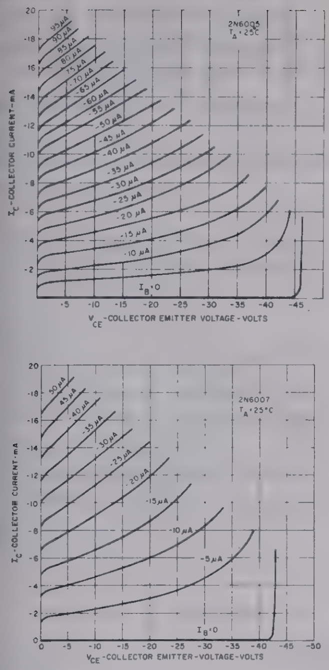


GAINBANDWIDTH PRODUCT VS. EMITTER CURRENT

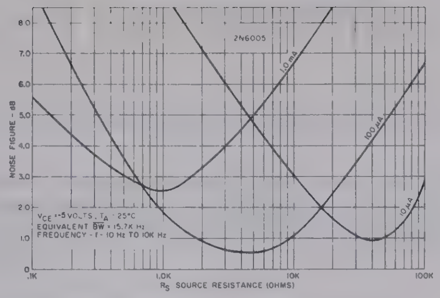


COLLECTOR-BASE & EMITTER-BASE CAPACITANCE VS. REVERSE BIAS VOLTAGE

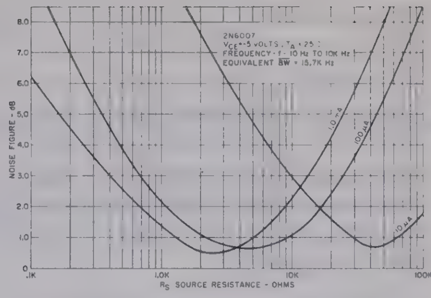
2N6005,7



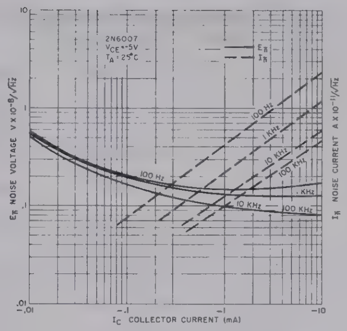
COLLECTOR CHARACTERISTICS



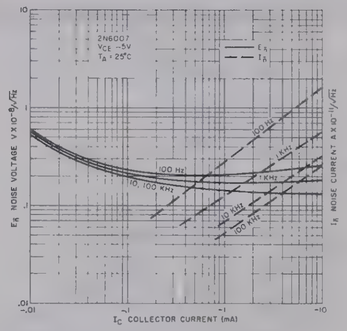
NOISE FIGURE-WIDEBAND VS. SOURCE RESISTANCE



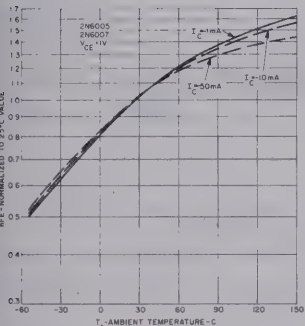
NOISE FIGURE-WIDEBAND VS. SOURCE RESISTANCE



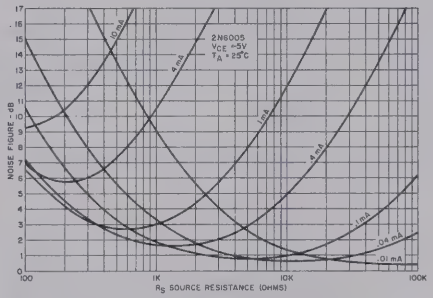
E_n & I_n VS. COLLECTOR CURRENT



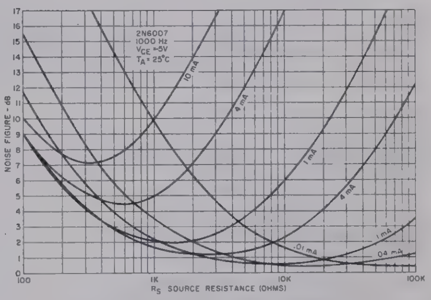
E_n & I_n VS. COLLECTOR CURRENT



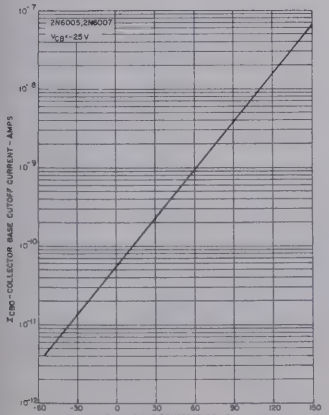
NORMALIZED FORWARD CURRENT TRANSFER RATIO VS. AMBIENT TEMPERATURE



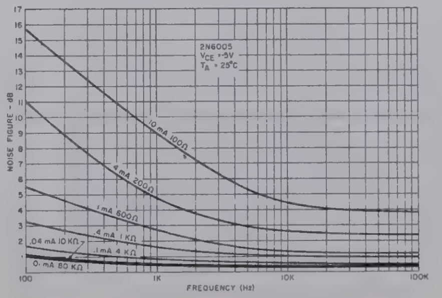
NOISE FIGURE VS. SOURCE RESISTANCE



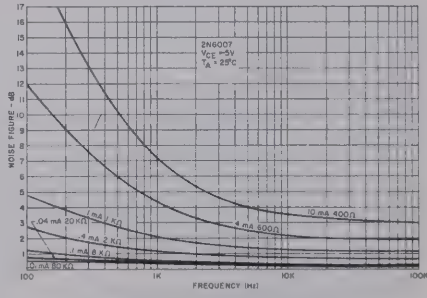
NOISE FIGURE VS. SOURCE RESISTANCE



COLLECTOR-BASE CUTOFF CURRENT VS. AMBIENT TEMPERATURE



NOISE FIGURE VS. FREQUENCY



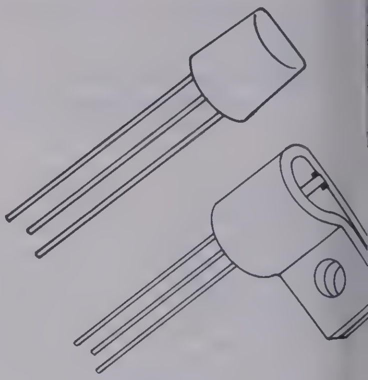
NOISE FIGURE VS. FREQUENCY

Silicon
Transistors

NPN

2N6010
2N6012

The General Electric 2N6010 and 2N6012 devices are silicon, NPN, planar epitaxial passivated transistors designed primarily for high level linear amplifiers or medium speed switching circuits and are especially suited for industrial control applications. Complementary PNP versions of these types are available and are designated as 2N6011 and 2N6013 respectively.

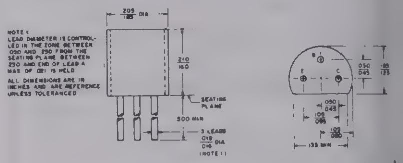


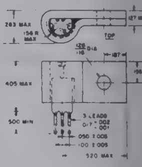
Features

- Epoxy encapsulation with proved reliability.
- Performance comparable to hermetic units—excellent characteristic stability under environmental stresses—85°C—85% Relative Humidity.
- 500 mw Power Dissipation.
- * Parameters are JEDEC Registered values.
- Excellent Beta Linearity over extremely wide current ranges.
- Beta hold-up out to 800 mA.
- 40 Volt BV_{CEO} ratings.
- Integral Heat Sinks available—Up to 1 W Power Dissipation.

absolute maximum ratings: ($T_A = 25°C$, unless otherwise specified)

		2N6010	2N6012	
Voltages				
Collector to Emitter	V_{CEO}*	40	40	Volts
Collector to Emitter	V_{CES}*	50	50	Volts
Emitter to Base	V_{EBO}*	5	5	Volts
Collector to Base	V_{CBO}*	50	50	Volts
Current				
Collector	I_C*	800	800	mA
Collector (peak, pulsed 10 μsec, ≦ 2% duty cycle)	I_C	1500	1500	mA
Dissipation				
Total Power $T_A \leq 25°C$	P_T*	.500	.500	Watts
Derating Factor $T_A \geq 25°C$		4	4	mW/°C
Total Power $T_A \leq 25°C$ Heatsink	P_T*	.625	.625	Watts
Total Power $T_C \leq 25°C$ Heatsink	P_T*	1.0	1.0	Watts
Derating Factor $T_A \geq 25°C$ Heatsink		5	5	mW/°C
Derating Factor $T_C \geq 25°C$ Heatsink		8	8	mW/°C
Temperature				
Storage	T_{STG}*	← −65 to +150 →		°C
Operating	T_J*	← −65 to +150 →		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L*	← +260 →		°C





ORDER HEATSINKED VERSIONS AS: HS6010
HS6012

electrical characteristics: ($T_A = 25°C$, unless otherwise specified)

STATIC CHARACTERISTICS	Symbol	2N6010 Min.	2N6010 Max.	2N6012 Min.	2N6012 Max.	
Collector-Emitter Breakdown Voltage ($I_C = 10mA, I_B = 0$)†	$V_{(BR)CEO}$*	40		40		Volts
Emitter-Base Breakdown Voltage ($I_E = 100\mu A, I_C = 0$)	$V_{(BR)EBO}$*	5		5		Volts
Collector-Base Breakdown Voltage ($I_C = 100\mu A, I_E = 0$)	$V_{(BR)CBO}$*	50		50		Volts
Collector-Emitter Breakdown Voltage ($I_C = 100\mu A, V_{BE} = 0$)	$V_{(BR)CES}$*	50		50		Volts
Collector-Emitter Saturation Voltage ($I_C = 10mA, I_B = 1mA$)†	$V_{CE(SAT)}$*		.050		.050	Volts
($I_C = 100mA, I_B = 10mA$)†	$V_{CE(SAT)}$*		.130		.130	Volts
($I_C = 300mA, I_B = 30mA$)†	$V_{CE(SAT)}$*		.250		.250	Volts
Base-Emitter Saturation Voltage ($I_C = 10mA, I_B = 1mA$)†	$V_{BE(SAT)}$*	.60	.80	.60	.80	Volts
($I_C = 100mA, I_B = 10mA$)†	$V_{BE(SAT)}$*	.70	.88	.70	.88	Volts
($I_C = 300mA, I_B = 30mA$)†	$V_{BE(SAT)}$*	.80	1.0	.80	1.0	Volts
Base-Emitter Voltage ($V_{CE} = 5V, I_C = 10mA$)†	V_{BE}*	.55	.75	.55	.75	Volts
Forward Current Transfer Ratio ($V_{CE} = 1V, I_C = 100\mu A$)	h_{FE}*	45		90		
($V_{CE} = 1V, I_C = 1mA$)	h_{FE}*	65		155		
($V_{CE} = 1V, I_C = 10mA$)†	h_{FE}*	100	300	250	500	
($V_{CE} = 1V, I_C = 100mA$)†	h_{FE}*	105		250		
($V_{CE} = 2V, I_C = 300mA$)†	h_{FE}*	85		160		
($V_{CE} = 2V, I_C = 500mA$)†	h_{FE}*	60		70		
($V_{CE} = 5V, I_C = 800mA$)†	h_{FE}*	45		50		
Collector Cutoff Current ($V_{CB} = 25V, I_E = 0$)	I_{CBO}*		10		10	nA
Emitter-Base Reverse Current ($V_{EB} = 3.0V, I_C = 0$)	I_{EBO}*		20		20	nA

† Pulsed, 300μsec, ≦ 2% duty cycle

DYNAMIC CHARACTERISTICS

		2N6010		2N6012		
		Min.	Max.	Min.	Max.	
Forward Current Transfer Ratio ($I_E = -1mA$, $V_{CE} = 10V$, $f = 1KHz$)	h_{fe}*	65	450	155	750	
Input Impedance ($I_E = -1mA$, $V_{CE} = 10V$, $f = 1KHz$)	h_{fe}*	1.5	12	3	20	Kohms
Output Conductance ($I_E = -1mA$, $V_{CE} = 10V$, $f = 1KHz$)	h_{oe}*	10	90	20	150	umhos
Collector-Base Capacitance ($V_{CB} = 10V$, $I_E = 0$, $f = 1$ MHz)	C_{cb}*		10		10	pF
Emitter-Base Capacitance ($V_{EB} = 0.5V$, $I_C = 0$, $f = 1$ MHz)	C_{eb}*		50		45	pF
Magnitude of Forward Current Transfer Ratio ($V_{CE} = 10V$, $I_E = -10mA$, $f = 100$ MHz)	h_{fe} *	11	21	14	23	dB
Noise Figure ($V_{CE} = 5V$, $I_E = -100\mu A$, BW = 15.7KHz, $R_S = 5K\Omega$, f = 10 Hz to 10KHz)	NF*		5		3	dB
Delay Time—See Figure 1 ($V_{CC} = 30V$, $I_C(on) = 150mA$, $I_{B1} = 15mA$, $V_{BE}(off) = 0V$)	t_d*		12		12	nsec
Rise Time—See Figure 1 ($V_{CC} = 30V$, $I_C(on) = 150mA$, $I_{B1} = 15mA$, $V_{BE}(off) = 0V$)	t_r*		25		25	nsec
Storage Time—See Figure 2 ($V_{CC} = 30V$, $I_C(on) = 150mA$, $I_{B1} = 15mA$, $I_{B2} = -15mA$)	t_s*		300		350	nsec
Fall Time—See Figure 2 ($V_{CC} = 30V$, $I_C(on) = 150mA$, $I_{B1} = 15mA$, $I_{B2} = -15mA$)	t_f*		100		150	nsec

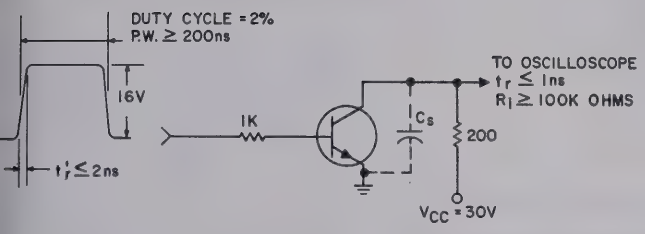
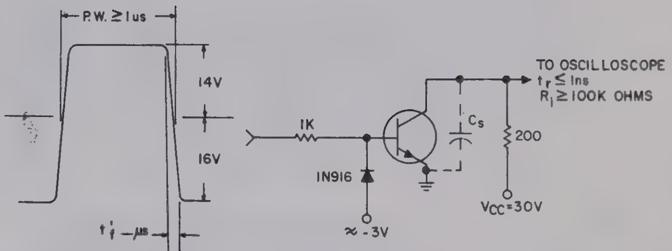
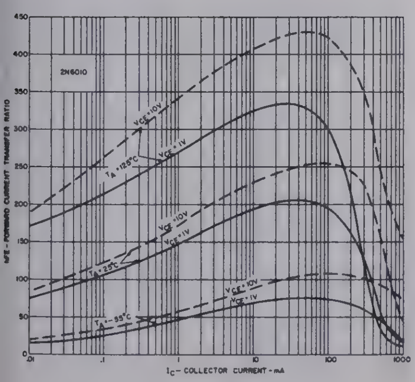

DUTY CYCLE = 2%
P.W. ≥ 200ns
16V
$t_r' \leq 2ns$
1K
C_S
200
TO OSCILLOSCOPE
$t_r \leq$ 1ns
$R_I \geq$ 100K OHMS
V_{CC} = 30V

FIGURE 1. DELAY AND RISE TIME EQUIVALENT CIRCUIT

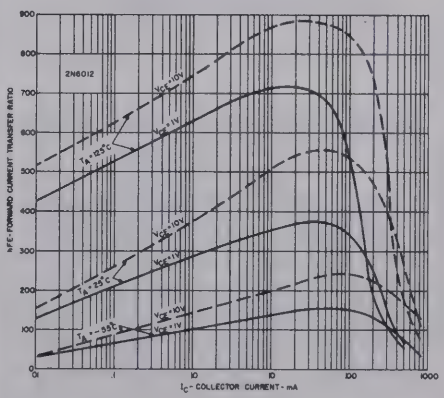

P.W. ≥ 1us
14V
16V
t_f' —μs
1K
1N916
≈ -3V
C_S
200
TO OSCILLOSCOPE
$t_r \leq$ 1ns
$R_I \geq$ 100K OHMS
V_{CC}=30V

C_s = TOTAL SHUNT CAPACITANCE FIXTURE, CONNECTORS AND PROBE = 10pF

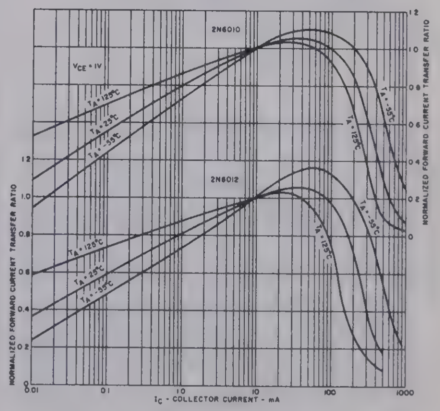
FIGURE 2. STORAGE AND FALL TIME EQUIVALENT CIRCUIT



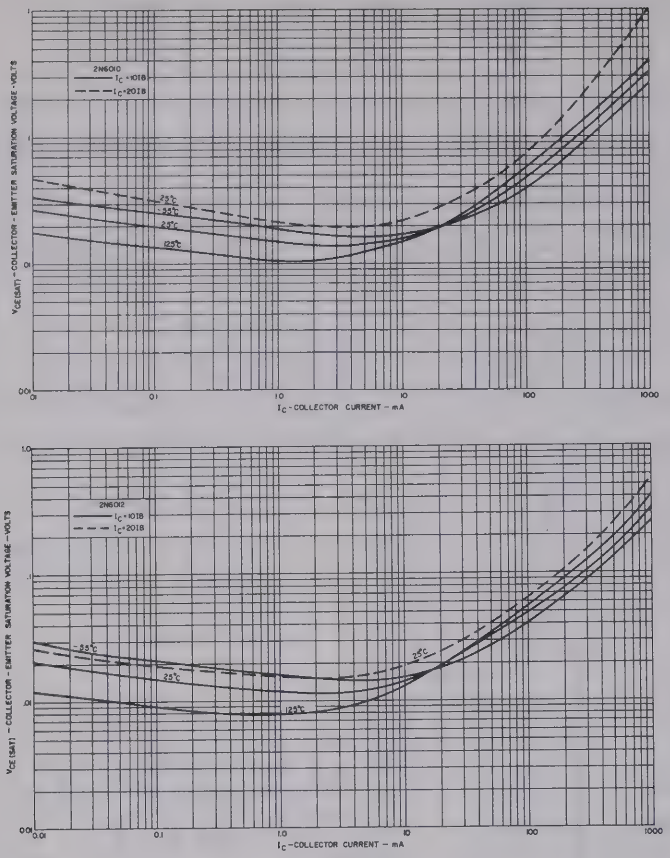
BETA VS. COLLECTOR CURRENT



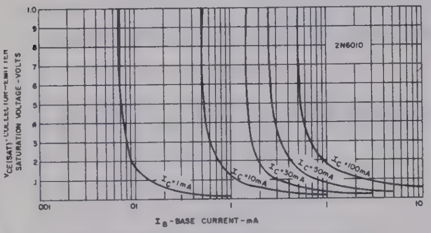
BETA VS. COLLECTOR CURRENT



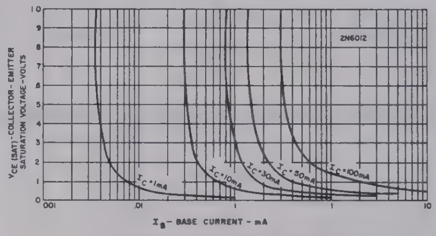
NORMALIZED FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT



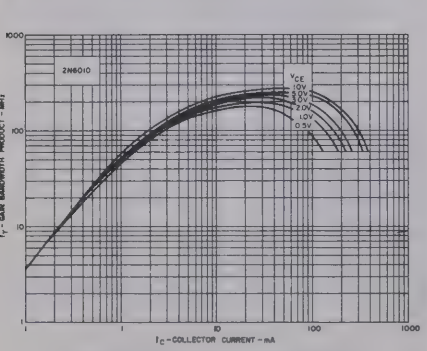
COLLECTOR-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



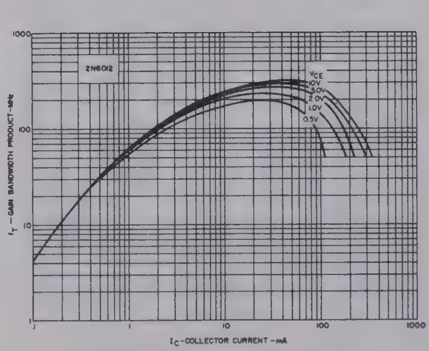
COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT



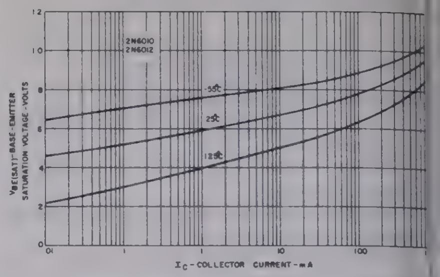
COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT



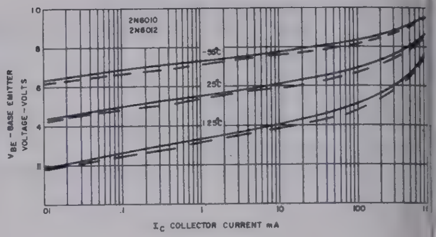
GAINBANDWIDTH PRODUCT VS. COLLECTOR CURRENT



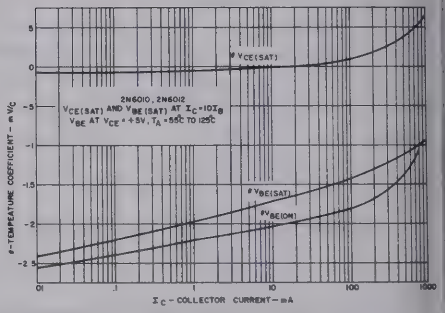
GAINBANDWIDTH PRODUCT VS. COLLECTOR CURRENT



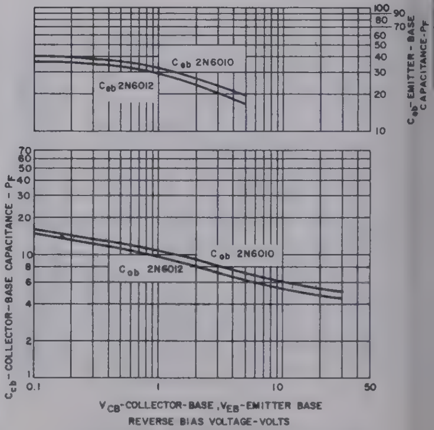
BASE-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



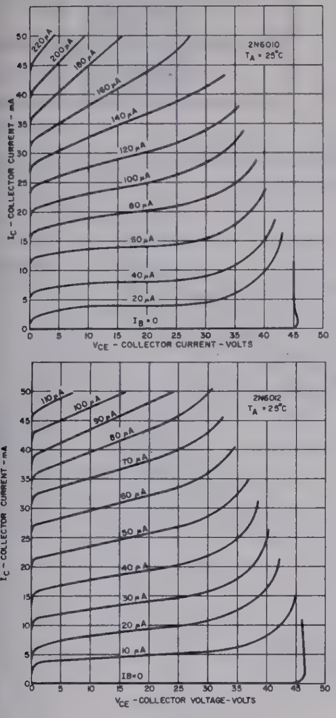
TRANSCONDUCTANCE VS. COLLECTOR CURRENT



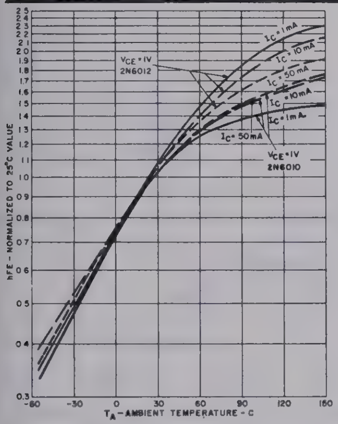
TEMPERATURE COEFFICIENTS VS. COLLECTOR CURRENT



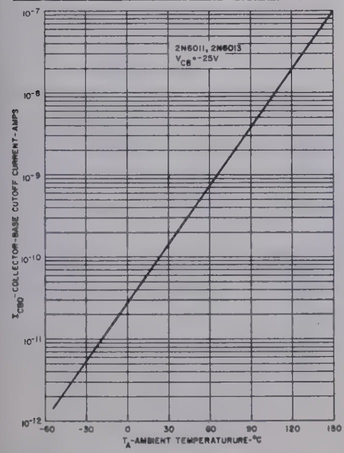
COLLECTOR-BASE & EMITTER-BASE CAPACITANCE VS. REVERSE BIAS VOLTAGE



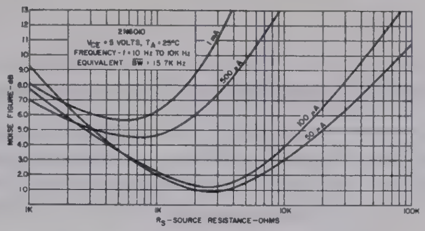
COLLECTOR CHARACTERISTICS



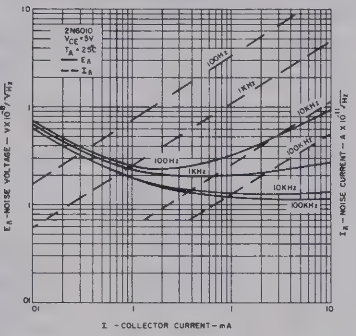
NORMALIZED FORWARD CURRENT TRANSFER RATIO VS. AMBIENT TEMPERATURE



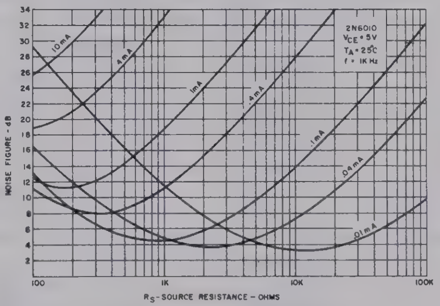
COLLECTOR-BASE CUTOFF CURRENT VS. AMBIENT TEMPERATURE



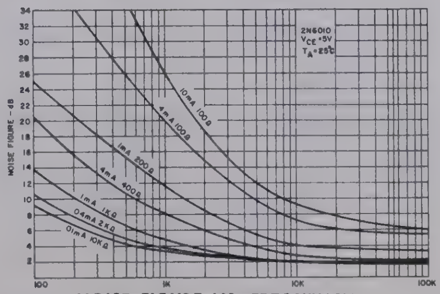
NOISE FIGURE-WIDEBAND VS. SOURCE RESISTANCE



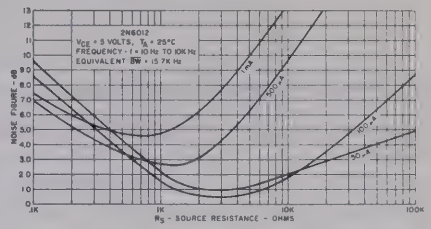
E_n & I_n VS. COLLECTOR CURRENT



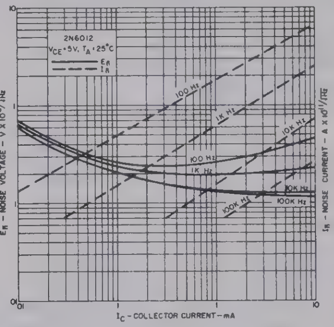
NOISE FIGURE VS. SOURCE RESISTANCE



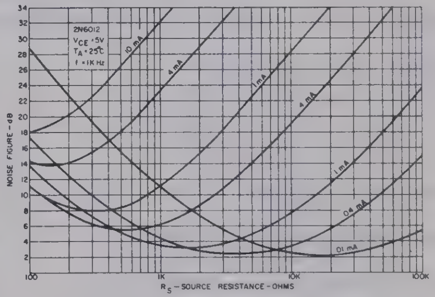
NOISE FIGURE VS. FREQUENCY



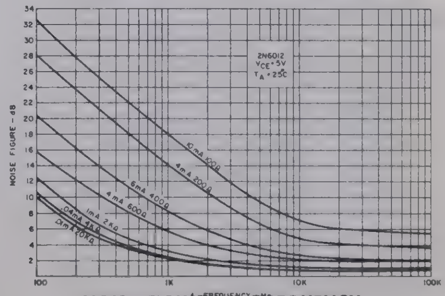
NOISE FIGURE-WIDEBAND VS. SOURCE RESISTANCE



E_n & I_n VS. COLLECTOR CURRENT



NOISE FIGURE VS. SOURCE RESISTANCE

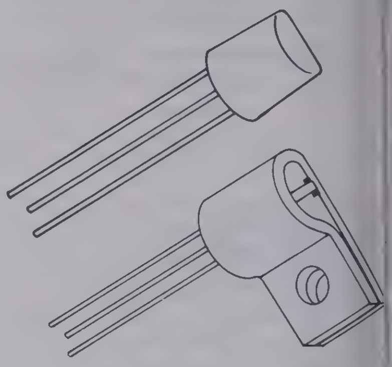


NOISE FIGURE VS. FREQUENCY

Silicon
Transistors

PNP
2N6011
2N6013

The General Electric 2N6011 and 2N6013 devices are silicon PNP, planar epitaxial passivated transistors specifically designed for high level linear amplifiers or medium speed switching circuits, and are especially suited for industrial control applications. Complementary NPN versions are available and are designated as 2N6010 and 2N6012 respectively.



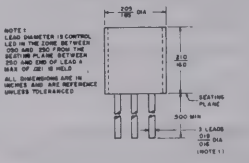
Features

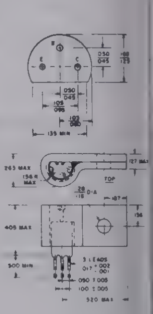
- Epoxy encapsulation with proved reliability
- Performance comparable to hermetic units — excellent charactistic stability under environmental stresses—85°C—85% Relative Humidity.
- 500 mw Power Dissipation
- Excellent Beta Linearity over extremely wide current ranges
- Beta hold-up out to 800 mA
- 40 Volt — $V_{(BR)CEO}$ ratings
- Integral Heat Sinks available—Up to 1 W Power Dissipation.

*Parameters are JEDEC registered values.

absolute maximum ratings: ($T_A = 25°C$, unless otherwise specified)

		2N6011	2N6013	
Voltages				
Collector to Emitter	V_{CEO}*	−40	−40	Volts
Collector to Emitter	V_{CES}*	−50	−50	Volts
Emitter to Base	V_{EBO}*	−5	−5	Volts
Collector to Base	V_{CBO}*	−50	−50	Volts
Current				
Collector	I_C*	−800	−800	mA
Collector (peak, pulsed 10 μsec, ≤ 2% duty cycle)	I_C	−1500	−1500	mA
Dissipation				
Total Power $T_A \leq 25°C$	P_T*	.500	.500	Watts
Derating Factor $T_A \geq 25°C$		4	4	mW/°C
Total Power $T_A \leq 25°C$ Heatsink	P_T*	.625	.625	Watts
Total Power $T_C \leq 25°C$ Heatsink	P_T*	1.0	1.0	Watts
Derating Factor $T_A \geq 25°C$ Heatsink		5	5	mW/°C
Derating Factor $T_C \geq 25°C$ Heatsink		8	8	mW/°C
Temperature				
Storage	T_{STG}*	←— −65 to +150 —→		°C
Operating	T_J*	←— −65 to +150 —→		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L*	←— +260 —→		°C





ORDER HEATSINKED VERSIONS AS: HS6011
HS6013

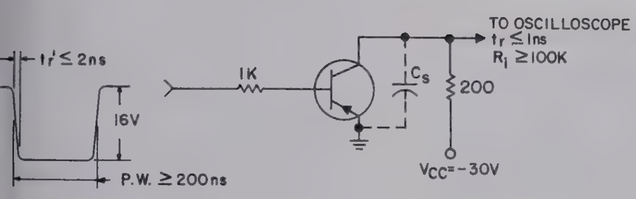
electrical characteristics: ($T_A = 25°C$, unless otherwise specified)

STATIC CHARACTERISTICS	Symbol	2N6011 Min.	2N6011 Max.	2N6013 Min.	2N6013 Max.	
Collector-Emitter Breakdown Voltage ($I_C = -10mA$, $I_B = 0$)†	$V_{(BR)CEO}$*	−40		−40		Volts
Emitter-Base Breakdown Voltage ($I_E = -100\mu A$, $I_C = 0$)	$V_{(BR)EBO}$*	−5		−5		Volts
Collector-Base Breakdown Voltage ($I_C = -100\mu A$, $I_E = 0$)	$V_{(BR)CBO}$*	−50		−50		Volts
Collector-Emitter Breakdown Voltage ($I_C = -100\mu A$, $V_{BE} = 0$)	$V_{(BR)CES}$*	−50		−50		Volts
Collector-Emitter Saturation Voltage						
($I_C = -10mA$, $I_B = -1mA$)†	$V_{CE(SAT)}$*		−.080		−.080	Volts
($I_C = -100mA$, $I_B = -10mA$)†	$V_{CE(SAT)}$*		−.300		−.300	Volts
($I_C = -300mA$, $I_B = -30mA$)†	$V_{CE(SAT)}$*		−.600		−.600	Volts
Base-Emitter Saturation Voltage						
($I_C = -10mA$, $I_B = -1mA$)†	$V_{BE(SAT)}$*	−.60	−.80	−.60	−.80	Volts
($I_C = -100mA$, $I_B = -10mA$)†	$V_{BE(SAT)}$*	−.70	−.95	−.70	−.95	Volts
($I_C = -300mA$, $I_B = -30mA$)†	$V_{BE(SAT)}$*	−.80	−1.10	−.80	−1.10	Volts
Base-Emitter Voltage ($V_{CE} = -5V$, $I_C = -10mA$)†	V_{BE}*	−.55	−.77	−.55	−.77	Volts
Forward Current Transfer Ratio						
($V_{CE} = -1V$, $I_C = -100\mu A$)	h_{FE}*	70		180		
($V_{CE} = -1V$, $I_C = -1mA$)	h_{FE}*	90		225		
($V_{CE} = -1V$, $I_C = -10mA$)†	h_{FE}*	100	300	250	500	
($V_{CE} = -1V$, $I_C = -100mA$)†	h_{FE}*	85		200		
($V_{CE} = -2V$, $I_C = -300mA$)†	h_{FE}*	65		135		
($V_{CE} = -2V$, $I_C = -500mA$)†	h_{FE}*	50		85		
($V_{CE} = -5V$, $I_C = -800mA$)†	h_{FE}*	45		70		
Collector Cutoff Current ($V_{CB} = -25V$, $I_E = 0$)	I_{CBO}*		−10		−10	nA
Emitter-Base Reverse Current ($V_{EB} = -3.0V$, $I_C = 0$)	I_{EBO}*		−20		−20	nA

†Pulsed, 300 μsec, ≤ 2% duty cycle

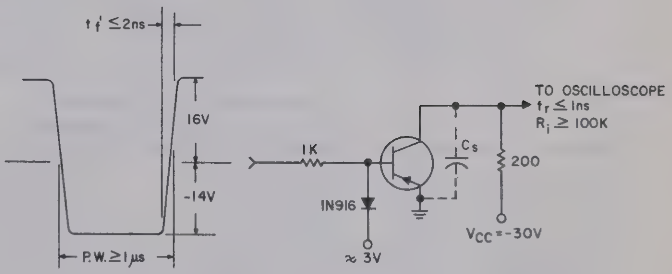
DYNAMIC CHARACTERISTICS

		2N6011		2N6013		
		Min.	Max.	Min.	Max.	
Forward Current Transfer Ratio ($I_E = 1mA$, $V_{CE} = -10V$, f = 1KHz)	h_{fe}*	90	450	225	750	
Input Impedance ($I_E = 1mA$, $V_{CE} = -10V$, f = 1KHz)	h_{ie}*	1	12	3	20	Kohms
Output Conductance ($I_E = 1mA$, $V_{CE} = -10V$, f = 1KHz)	h_{oe}*	20	120	50	200	μmhos
Collector-Base Capacitance ($V_{CB} = -10V$, $I_E = 0$, f = 1 MHz)	C_{cb}*		15		15	pF
Emitter-Base Capacitance ($V_{EB} = -0.5V$, $I_C = 0$, f = 1 MHz)	C_{eb}*		45		40	pF
Magnitude of Forward Current Transfer Ratio ($V_{CE} = -10V$, $I_E = 10mA$, f = 30 MHz)	h_{fe} *	8	18.5	12	20	dB
Noise Figure $V_{CE} = -5V$, $I_E = 100\mu A$, BW = 15.7 KHz, $R_S = 5K\Omega$, f = 10 Hz to 10 KHz)	NF		3		2	dB
Delay Time — see figure 1 ($V_{CC} = -30V$, $I_C(on) = -150mA$, $I_{B1} = -15mA$, $V_{BE}(off) = 0V$)	t_d*		10		10	nsec
Rise Time — see figure 1 ($V_{CC} = -30V$, $I_C(on) = -150mA$, $I_{B1} = -15mA$, $V_{BE}(off) = 0V$)	t_r*		35		35	nsec
Storage Time — see figure 2 ($V_{CC} = -30V$, $I_C(on) = -150mA$, $I_{B1} = -15mA$, $I_{B2} = 15mA$)	t_s*		375		450	nsec
Fall Time — see figure 2 ($V_{CC} = -30V$, $I_C(on) = -150mA$, $I_{B1} = -15mA$, $I_{B2} = 15mA$)	t_f*		50		75	nsec



t'r ≤ 2ns
16V
P.W. ≥ 200ns
1K
Cs
200
TO OSCILLOSCOPE
tr ≤ 1ns
Ri ≥ 100K
VCC = -30V

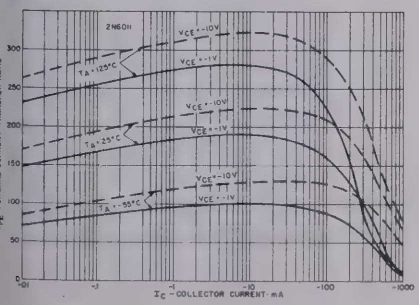
FIGURE 1. DELAY AND RISE TIME EQUIVALENT CIRCUIT



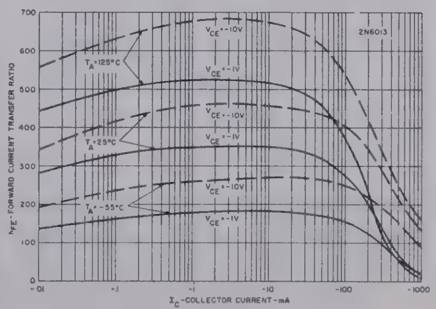
t'f ≤ 2ns
16V
-14V
P.W. ≥ 1μs
1K
IN916
≈ 3V
Cs
200
TO OSCILLOSCOPE
tr ≤ 1ns
Ri ≥ 100K
VCC = -30V

C_s = TOTAL SHUNT CAPACITANCE FIXTURE, CONNECTORS, AND PROBE = 10pF

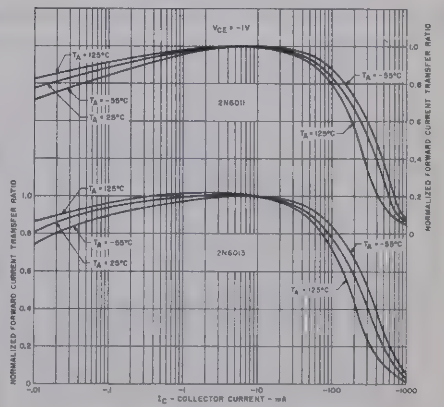
FIGURE 2. STORAGE AND FALL TIME EQUIVALENT CIRCUIT



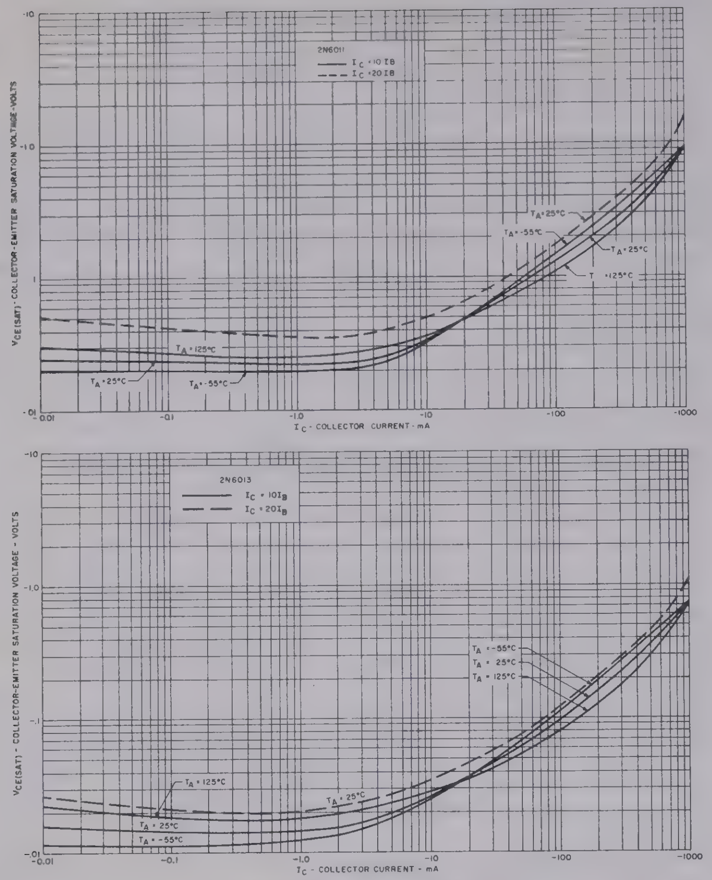
BETA VS. COLLECTOR CURRENT



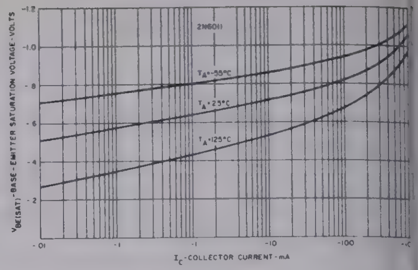
BETA VS. COLLECTOR CURRENT



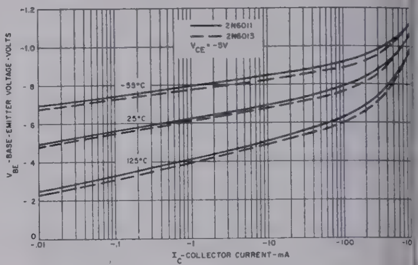
NORMALIZED FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT



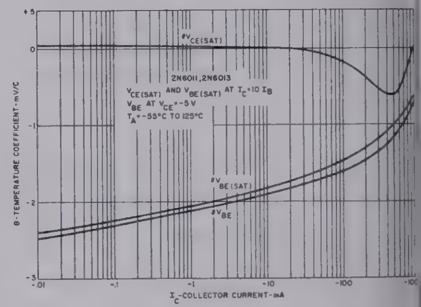
COLLECTOR-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



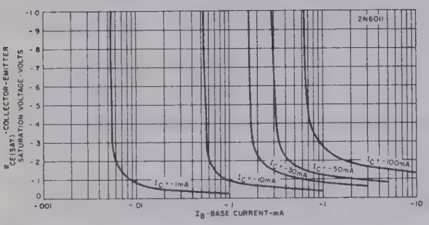
BASE-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



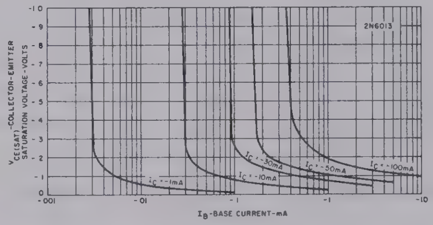
TRANSCONDUCTANCE VS. COLLECTOR CURRENT



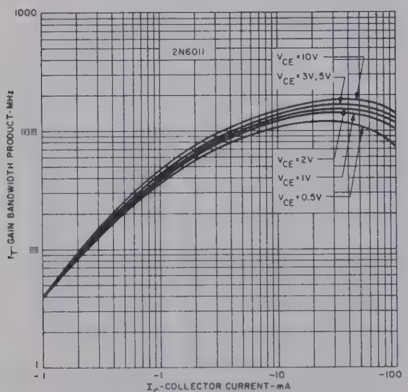
TEMPERATURE COEFFICIENTS VS. COLLECTOR CURRENT



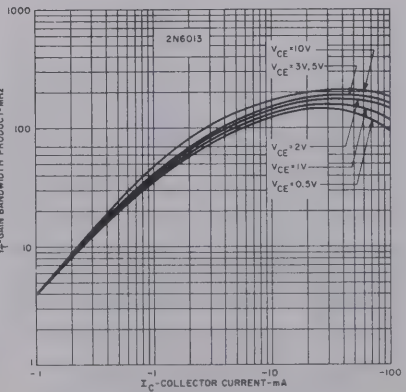
COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT



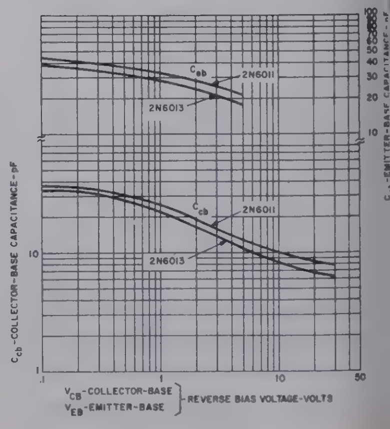
COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT



GAIN BAND WIDTH PRODUCT VS. COLLECTOR CURRENT

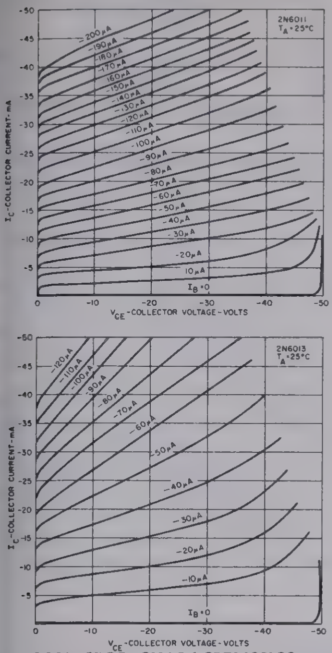


GAIN BAND WIDTH PRODUCT VS. COLLECTOR CURRENT

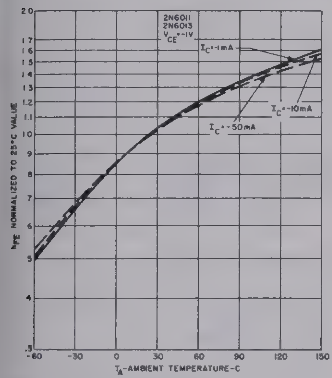


COLLECTOR-BASE & EMITTER-BASE CAPACITANCE VS. REVERSE BIAS VOLTAGE

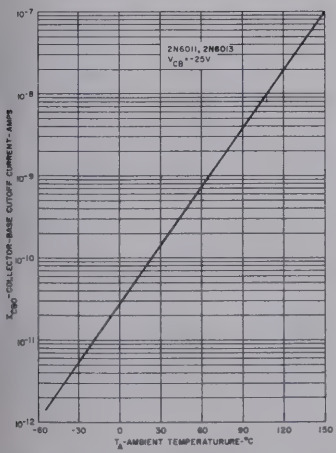
N6011,3



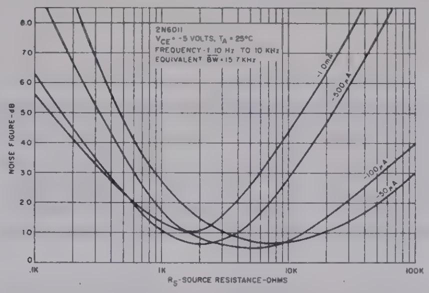
COLLECTOR CHARACTERISTICS



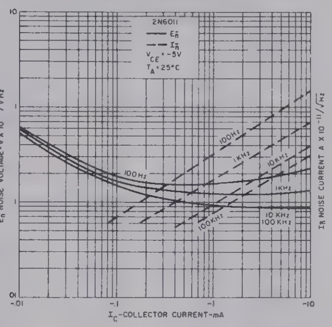
NORMALIZED FORWARD CURRENT TRANSFER RATIO VS. AMBIENT TEMPERATURE



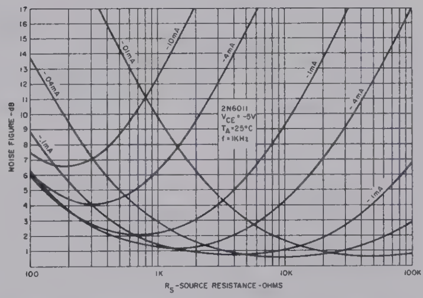
OLLECTOR-BASE CUTOFF CURRENT VS. MBIENT TEMPERATURE



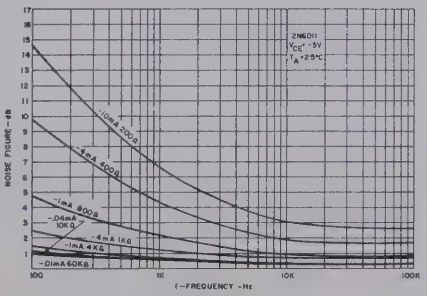
NOISE FIGURE-WIDEBAND VS. SOURCE RESISTANCE



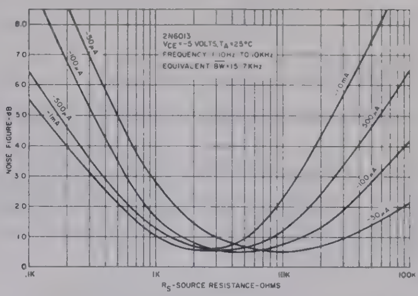
E$_n$ & I$_n$ VS. COLLECTOR CURRENT



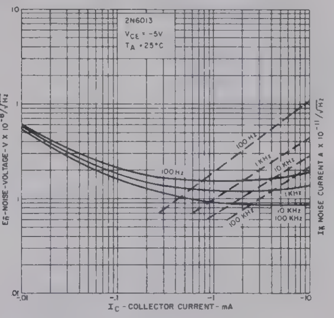
NOISE FIGURE VS. SOURCE RESISTANCE



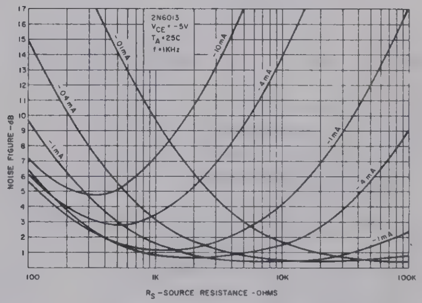
NOISE FIGURE VS. FREQUENCY



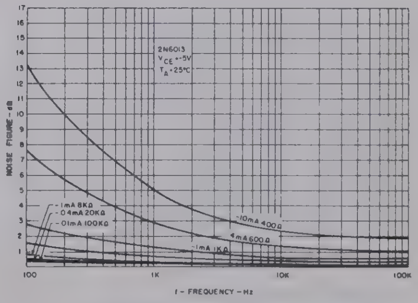
NOISE FIGURE-WIDEBAND VS. SOURCE RESISTANCE



E$_n$ & I$_n$ VS. COLLECTOR CURRENT



NOISE FIGURE VS. SOURCE RESISTANCE

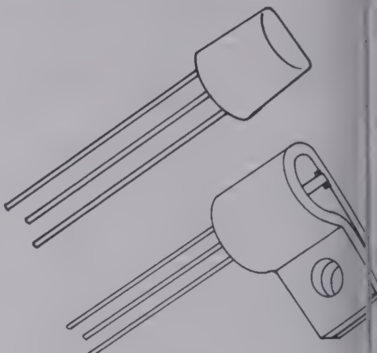


NOISE FIGURE VS. FREQUENCY

Silicon
Transistors

NPN
2N6014
2N6016

The General Electric 2N6014 and 2N6016 devices are silicon, NPN, planar epitaxial passivated transistors designed primarily for high current linear amplifiers or medium speed switching circuits and are especially suited for industrial control applications. Complementary PNP versions of these types are available and are designated as 2N6015 and 2N6017 respectively.

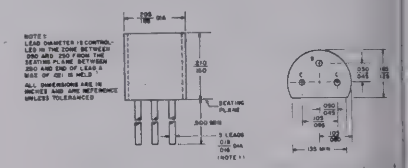


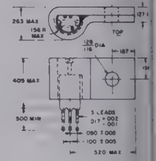
Features
- Epoxy encapsulation with proved reliability.
- Performance comparable to hermetic units—excellent characteristic stability under environmental stresses—85°C—85% Relative Humidity.
- 500 mw Power Dissipation.
- Excellent Beta Linearity over extremely wide current ranges.
- Beta hold-up out to 800 mA.
- 60 Volt $V_{(BR)CEO}$ ratings.
- Integral Heat Sinks available—Up to 1 W Power Dissipation.

* Parameters are JEDEC Registered values.

absolute maximum ratings: ($T_A = 25°C$, unless otherwise specified)

		2N6014	2N6016	
Voltages				
Collector to Emitter	V_{CEO}*	60	60	Volts
Collector to Emitter	V_{CES}*	70	70	Volts
Emitter to Base	V_{EBO}*	5	5	Volts
Collector to Base	V_{CBO}*	70	70	Volts
Current				
Collector	I_C*	800	800	mA
Collector (peak, pulsed 10 μsec, ≦ 2% duty cycle)	I_C	1500	1500	mA
Dissipation				
Total Power $T_A \leq 25°C$	P_T*	.500	.500	Watts
Derating Factor $T_A \geq 25°C$		4	4	mW/°C
Total Power $T_A \leq 25°C$ Heatsink	P_T*	.625	.625	Watts
Total Power $T_C \leq 25°C$ Heatsink	P_T*	1.0	1.0	Watts
Derating Factor $T_A \geq 25°C$ Heatsink		5	5	mW/°C
Derating Factor $T_C \geq 25°C$ Heatsink		8	8	mW/°C
Temperature				
Storage	T_{STG}*	←— −65 to +150 —→		°C
Operating	T_J*	←— −65 to +150 —→		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L*	←— +260 —→		°C





ORDER HEATSINKED VERSIONS AS: HS6014
HS6016

electrical characteristics: ($T_A = 25°C$, unless otherwise specified)

STATIC CHARACTERISTICS	Symbol	2N6014 Min.	2N6014 Max.	2N6016 Min.	2N6016 Max.	
Collector-Emitter Breakdown Voltage ($I_C = 10mA, I_B = 0$) †	$V_{(BR)CEO}$*	60		60		Volts
Emitter-Base Breakdown Voltage ($I_E = 100\mu A, I_C = 0$)	$V_{(BR)EBO}$*	5		5		Volts
Collector-Base Breakdown Voltage ($I_C = 100\mu A, I_E = 0$)	$V_{(BR)CBO}$*	70		70		Volts
Collector-Emitter Breakdown Voltage ($I_C = 100\mu A, V_{BE} = 0$)	$V_{(BR)CES}$*	70		70		Volts
Collector-Emitter Saturation Voltage						
($I_C = 10mA, I_B = 1mA$) †	$V_{CE(SAT)}$*		.050		.050	Volts
($I_C = 100mA, I_B = 10mA$) †	$V_{CE(SAT)}$*		.130		.130	Volts
($I_C = 300mA, I_B = 30mA$) †	$V_{CE(SAT)}$*		.250		.250	Volts
Base-Emitter Saturation Voltage						
($I_C = 10mA, I_B = 1mA$) †	$V_{BE(SAT)}$*	.60	.80	.60	.80	Volts
($I_C = 100mA, I_B = 10mA$) †	$V_{BE(SAT)}$*	.70	.88	.70	.88	Volts
($I_C = 300mA, I_B = 30mA$) †	$V_{BE(SAT)}$*	.80	1.0	.80	1.0	Volts
Base-Emitter Voltage ($V_{CE} = 5V, I_C = 10mA$) †	V_{BE}*	.55	.75	.55	0.75	Volts
Forward Current Transfer Ratio						
($V_{CE} = 1V, I_C = 100\mu A$)	h_{FE}*	45		90		
($V_{CE} = 1V, I_C = 1mA$)	h_{FE}*	65		155		
($V_{CE} = 1V, I_C = 10mA$) †	h_{FE}*	100	300	250	500	
($V_{CE} = 1V, I_C = 100mA$) †	h_{FE}*	105		240		
($V_{CE} = 2V, I_C = 300mA$) †	h_{FE}*	65		60		
($V_{CE} = 2V, I_C = 500mA$) †	h_{FE}*	25		20		
($V_{CE} = 5V, I_C = 800mA$) †	h_{FE}*	15		15		
Collector Cutoff Current ($V_{CB} = 25V, I_E = 0$)	I_{CBO}*		10		10	nA
Emitter-Base Reverse Current ($V_{EB} = 3.0V, I_C = 0$)	I_{EBO}*		20		20	nA

† Pulsed, 300μsec, ≦ 2% duty cycle

DYNAMIC CHARACTERISTICS

	Symbol	2N6014		2N6016		
		Min.	Max.	Min.	Max.	
Forward Current Transfer Ratio ($I_E = -1mA$, $V_{CE} = 10V$, $f = 1KHz$)	h_{fe}*	65	450	155	750	
Input Impedance ($I_E = -1mA$, $V_{CE} = 10V$, $f = 1KHz$)	h_{ie}*	1.5	12	3	20	Kohms
Output Conductance ($I_E = -1mA$, $V_{CE} = 10V$, $f = 1KHz$)	h_{oe}*	10	90	20	150	umhos
Collector-Base Capacitance ($V_{CB} = 10V$, $I_E = 0$, $f = 1$ MHz)	C_{cb}*		10		10	pF
Emitter-Base Capacitance ($V_{EB} = 0.5V$, $I_C = 0$, $f = 1$ MHz)	C_{eb}*		50		45	pF
Magnitude of Forward Current Transfer Ratio ($V_{CE} = 10V$, $I_E = -10mA$, $f = 30$ MHz)	$\|h_{fe}\|$*	11	21	14	23	dB
Noise Figure ($V_{CE} = 5V$, $I_E = -100\mu A$, BW = 15.7KHz, $R_S = 5K\Omega$, f = 10 Hz to 10KHz)	NF*		5		3	dB
Delay Time—See Figure 1 ($V_{CC} = 30V$, $I_C(on) = 150mA$, $I_{B1} = 15mA$, $V_{BE}(off) = 0V$)	t_d*		12		12	nsec
Rise Time—See Figure 1 ($V_{CC} = 30V$, $I_C(on) = 150mA$, $I_{B1} = 15mA$, $V_{BE}(off) = 0V$)	t_r*		25		25	nsec
Storage Time—See Figure 2 ($V_{CC} = 30V$, $I_C(on) = 150mA$, $I_{B1} = 15mA$, $I_{B2} = -15mA$)	t_s*		300		350	nsec
Fall Time—See Figure 2 ($V_{CC} = 30V$, $I_C(on) = 150mA$, $I_{B1} = 15mA$, $I_{B2} = -15mA$)	t_f*		100		150	nsec

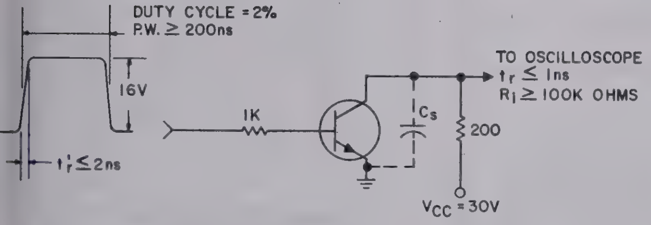
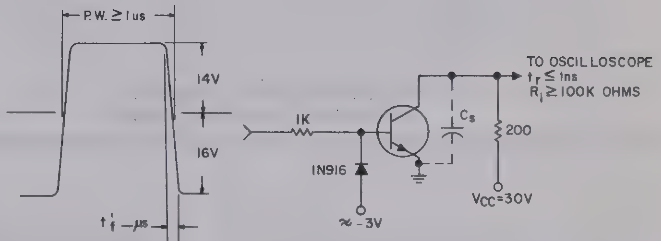
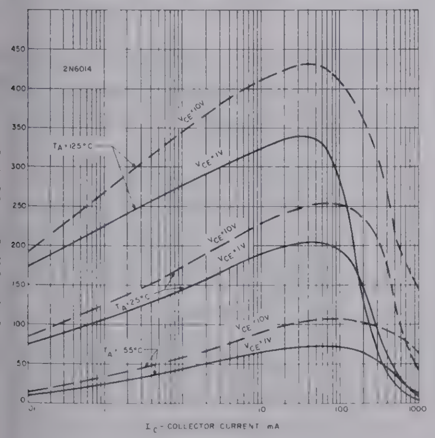

DUTY CYCLE = 2%
P.W. ≥ 200ns
16V
t'r ≤ 2ns
1K
Cs
200
TO OSCILLOSCOPE
tr ≤ 1ns
Ri ≥ 100K OHMS
VCC = 30V

FIGURE 1. DELAY AND RISE TIME EQUIVALENT CIRCUIT

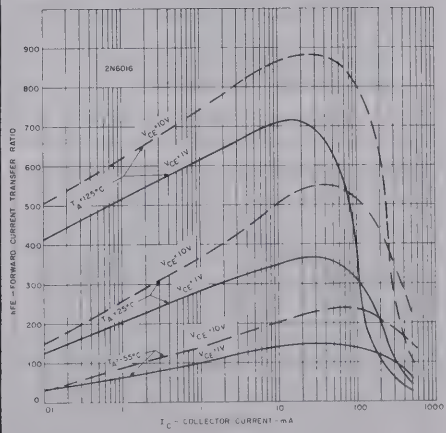

P.W. ≥ 1us
14V
16V
t'f —μs
1K
1N916
≈ -3V
Cs
200
TO OSCILLOSCOPE
tr ≤ 1ns
Ri ≥ 100K OHMS
VCC = 30V

C_s = TOTAL SHUNT CAPACITANCE FIXTURE, CONNECTORS AND PROBE = 10pF

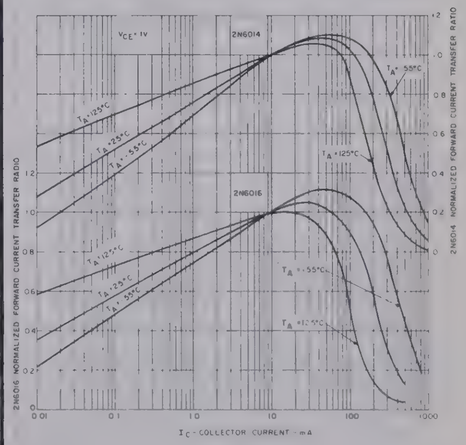
FIGURE 2. STORAGE AND FALL TIME EQUIVALENT CIRCUIT



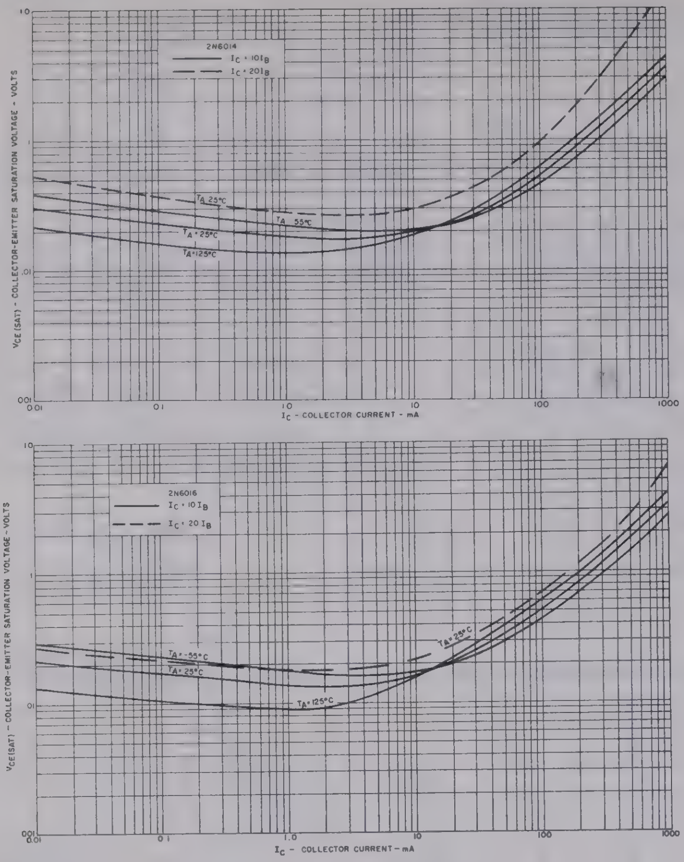
BETA VS. COLLECTOR CURRENT



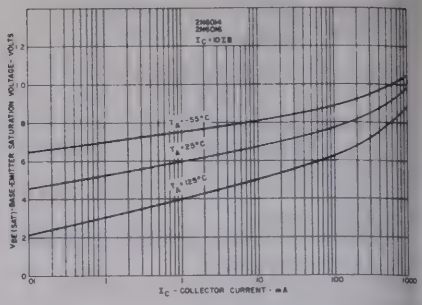
BETA VS. COLLECTOR CURRENT



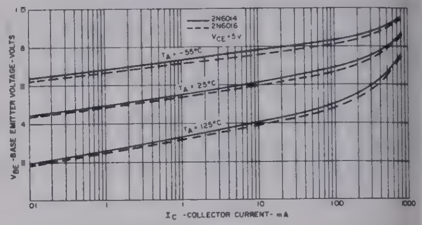
NORMALIZED FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT



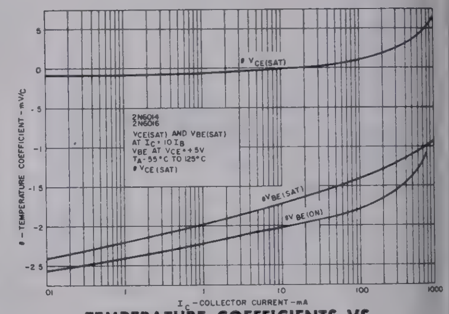
COLLECTOR-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



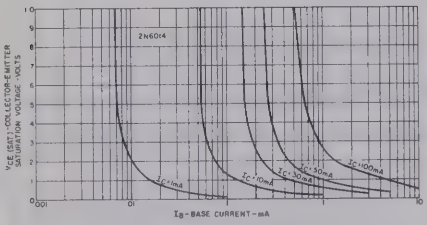
BASE-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



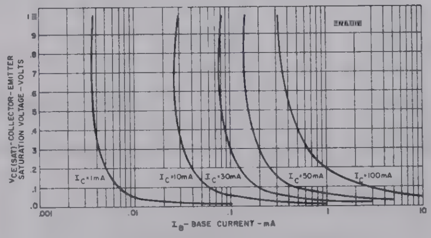
TRANSCONDUCTANCE VS. COLLECTOR CURRENT



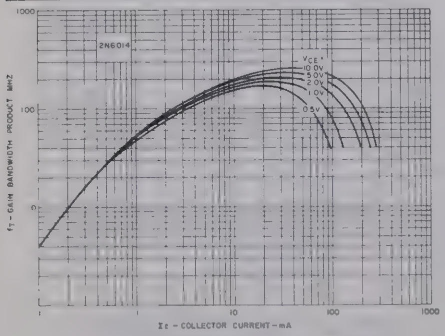
TEMPERATURE COEFFICIENTS VS. COLLECTOR CURRENT



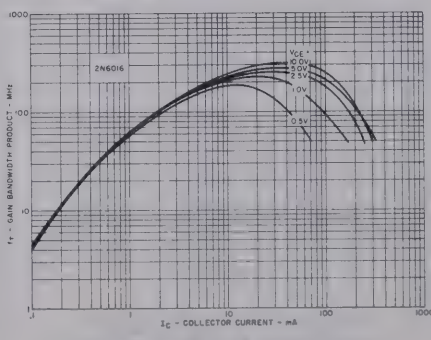
COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT



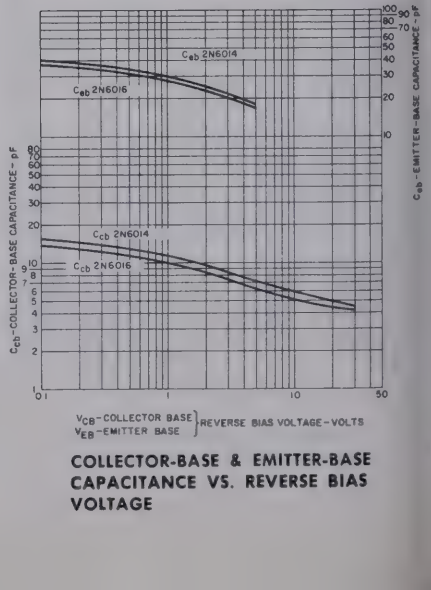
COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT



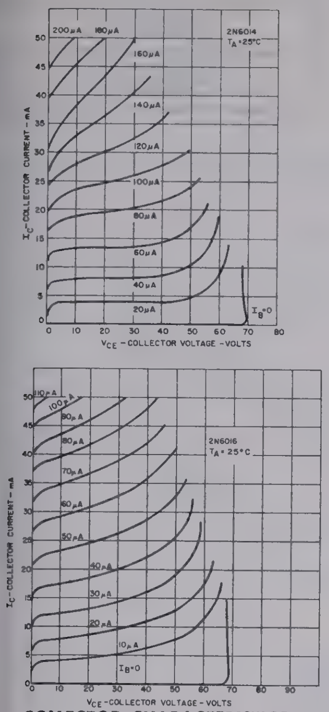
GAINBANDWIDTH PRODUCT VS. COLLECTOR CURRENT



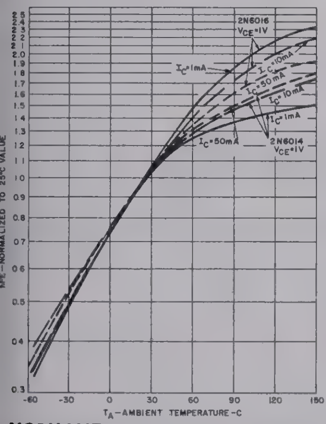
COLLECTOR BASE TIME CONSTANT VS. COLLECTOR CURRENT



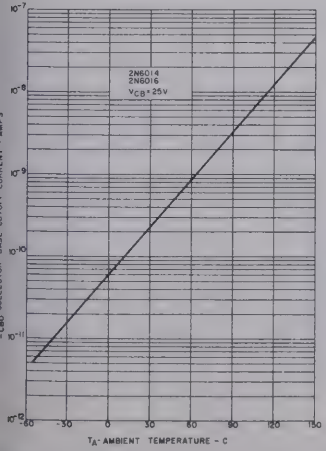
COLLECTOR-BASE & EMITTER-BASE CAPACITANCE VS. REVERSE BIAS VOLTAGE



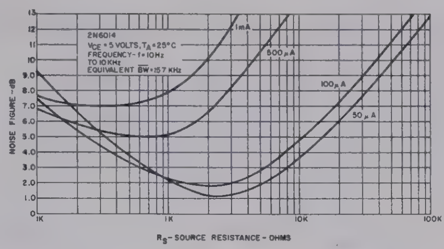
COLLECTOR CHARACTERISTICS



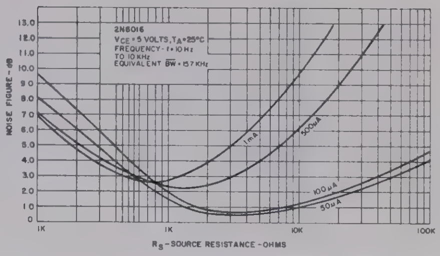
NORMALIZED FORWARD CURRENT TRANSFER RATIO VS. AMBIENT TEMPERATURE



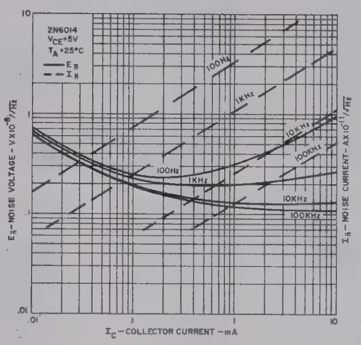
OLLECTOR-BASE CUTOFF CURRENT VS. MBIENT TEMPERATURE



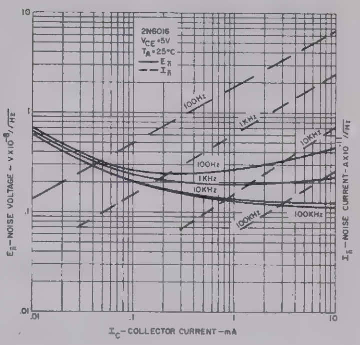
NOISE FIGURE-WIDEBAND VS. SOURCE RESISTANCE



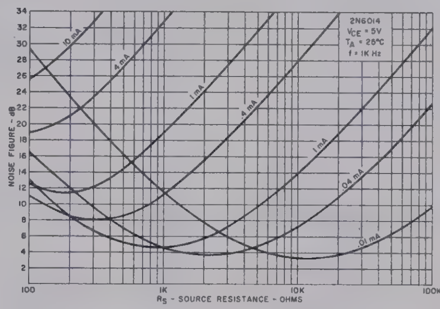
NOISE FIGURE-WIDEBAND VS. SOURCE RESISTANCE



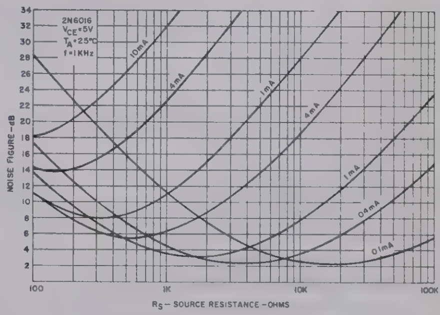
E_n & I_n VS. COLLECTOR CURRENT



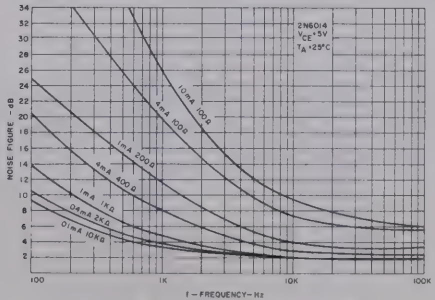
E_n & I_n VS. COLLECTOR CURRENT



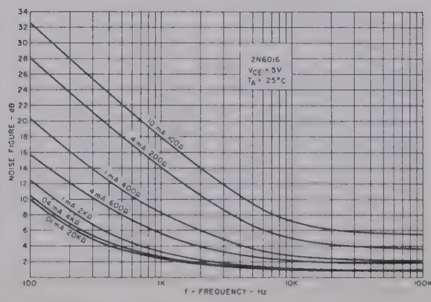
NOISE FIGURE VS. SOURCE RESISTANCE



NOISE FIGURE VS. SOURCE RESISTANCE



NOISE FIGURE VS. FREQUENCY



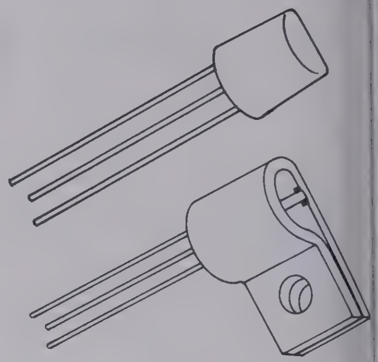
NOISE FIGURE VS. FREQUENCY

Silicon Transistors

PNP

2N6015
2N6017

The General Electric 2N6015 and 2N6017 devices are silicon PNP, planar epitaxial passivated transistors specifically designed for high level linear amplifiers or medium speed switching circuits, and are especially suited for industrial control applications. Complementary NPN versions are available and are designated as 2N6014 and 2N6016 respectively.



Features

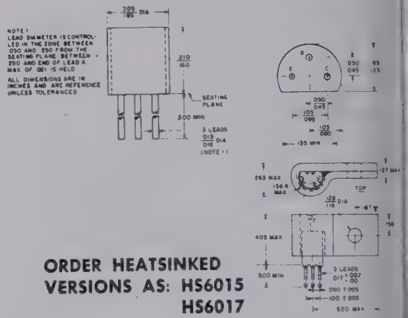
- Epoxy encapsulation with proved reliability
- Performance comparable to hermetic units — excellent characteristic stability under environmental stresses—85°C—85% Relative Humidity.
- 500 mw Power Dissipation

*Parameters are JEDEC registered values.

- Excellent Beta Linearity over extremely wide current ranges
- Beta hold-up out to 800 mA
- 60 Volt — $V_{(BR)CEO}$ ratings
- Integral Heat Sinks available — Up to 1W Power Dissipation.

absolute maximum ratings: ($T_A = 25°C$, unless otherwise specified)

		2N6015	2N6017	
Voltages				
Collector to Emitter	V_{CEO}*	−60	−60	Volts
Collector to Emitter	V_{CES}*	−70	−70	Volts
Emitter to Base	V_{EBO}*	−5	−5	Volts
Collector to Base	V_{CBO}*	−70	−70	Volts
Current				
Collector	I_C*	−800	−800	mA
Collector (peak, pulsed 10 μsec, ≦ 2% duty cycle)	I_C	−1500	−1500	mA
Dissipation				
Total Power ($T_A \leqq 25°C$)	P_T*	.500	.500	Watts
Total Power ($T_A \leqq 25°C$) Heatsink	P_T	.700	.700	Watts
Total Power ($T_C \leqq 25°C$)	P_T*	1	1	Watts
Derate Factor ($T_A \geqq 25°C$)		4	4	mW/°C
Derate Factor ($T_C \geqq 25°C$)Heatsink		8	8	mW/°C
Temperature				
Storage	T_{STG}*	← −65 to +150 →		°C
Operating	T_J*	← −65 to +150 →		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L*	← +260 →		°C


NOTE 1
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND .250 FROM THE SEATING PLANE. BETWEEN .250 AND END OF LEAD A MAX OF .021 IS HELD
ALL DIMENSIONS ARE IN INCHES AND ARE REFERENCE UNLESS TOLERANCED
DIA
SEATING PLANE
.500 MIN
3 LEADS
DIA
(NOTE 1)
B
E
C
.135 MIN
.263 MAX
.156 R MAX
TOP
DIA
.405 MAX
.500 MIN
3 LEADS
.050 ±.005
.100 ±.005
.520 MAX

ORDER HEATSINKED VERSIONS AS: HS6015
HS6017

electrical characteristics: ($T_A = 25°C$, unless otherwise specified)

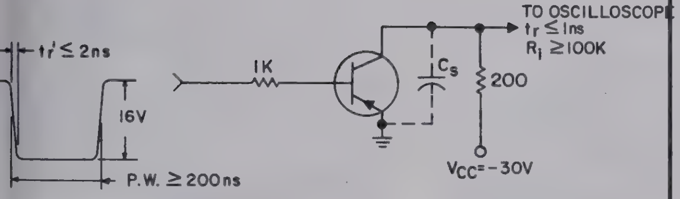
STATIC CHARACTERISTICS	Symbol	2N6015 Min.	2N6015 Max.	2N6017 Min.	2N6017 Max.	
Collector-Emitter Breakdown Voltage ($I_C = -10mA, I_B = 0$)†	$V_{(BR)CEO}$*	−60		−60		Volts
Emitter-Base Breakdown Voltage ($I_E = -100\mu A, I_C = 0$)	$V_{(BR)EBO}$*	−5		−5		Volts
Collector-Base Breakdown Voltage ($I_C = -100\mu A, I_E = 0$)	$V_{(BR)CBO}$*	−70		−70		Volts
Collector-Emitter Breakdown Voltage ($I_C = -100\mu A, V_{BE} = 0$)	$V_{(BR)CES}$*	−70		−70		Volts
Collector-Emitter Saturation Voltage						
($I_C = -10mA, I_B = -1mA$)†	$V_{CE(SAT)}$*		− .080		− .080	Volts
($I_C = -100mA, I_B = -10mA$)†	$V_{CE(SAT)}$*		− .300		− .300	Volts
($I_C = -300mA, I_B = -30mA$)†	$V_{CE(SAT)}$*		− .600		− .600	Volts
Base-Emitter Saturation Voltage						
($I_C = -10mA, I_B = -1mA$)†	$V_{BE(SAT)}$*	− .60	− .80	− .60	− .80	Volts
($I_C = -100mA, I_B = -10mA$)†	$V_{BE(SAT)}$*	− .70	− .95	− .70	− .95	Volts
($I_C = -300mA, I_B = -30mA$)†	$V_{BE(SAT)}$*	− .80	−1.10	− .80	−1.10	Volts
Base-Emitter Voltage ($V_{CE} = -5V, I_C = -10mA$)†	V_{BE}*	− .55	− .77	− .55	− .77	Volts
Forward Current Transfer Ratio						
($V_{CE} = -1V, I_C = -100\mu A$)	h_{FE}*	70		180		
($V_{CE} = -1V, I_C = -1mA$)	h_{FE}*	90		225		
($V_{CE} = -1V, I_C = -10mA$)†	h_{FE}*	100	300	250	500	
($V_{CE} = -1V, I_C = -100mA$)†	h_{FE}*	85		200		
($V_{CE} = -2V, I_C = -300mA$)†	h_{FE}*	60		125		
($V_{CE} = -2V, I_C = -500mA$)†	h_{FE}*	40		75		
($V_{CE} = -5V, I_C = -800mA$)†	h_{FE}*	35		55		
Collector Cutoff Current ($V_{CB} = -25V, I_E = 0$)	I_{CBO}*		−10		−10	nA
Emitter-Base Reverse Current ($V_{EB} = -3.0V, I_C = 0$)	I_{EBO}*		−20		−20	nA

†Pulsed, 300 μsec, ≦ 2% duty cycle

2N6015,7

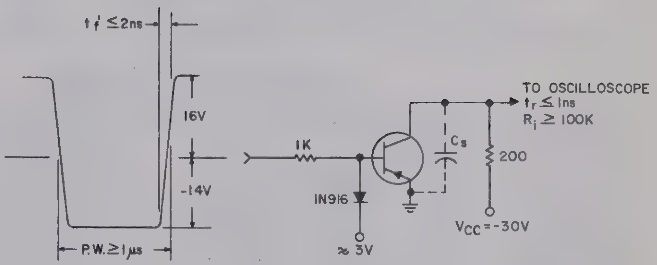
YNAMIC CHARACTERISTICS

		2N6015		2N6017		
		Min.	Max.	Min.	Max.	
orward Current Transfer Ratio ($I_E = 1mA$, $V_{CE} = -10V$, f = 1KHz)	h_{fe}*	90	450	225	750	
put Impedance ($I_E = 1mA$, $V_{CE} = -10V$, f = 1KHz)	h_{ie}*	1	12	3	20	Kohms
utput Conductance ($I_E = 1mA$, $V_{CE} = -10V$, f = 1KHz)	h_{oe}*	20	120	40	150	μmhos
ollector-Base Capacitance ($V_{CB} = -10V$, $I_E = 0$, f = 1 MHz)	C_{cb}*		15		15	pF
mitter-Base Capacitance ($V_{EB} = -0.5V$, $I_C = 0$, f = 1 MHz)	C_{eb}*		45		40	pF
agnitude of Forward Current Transfer Ratio ($V_{CE} = -10V$, $I_E = 10mA$, f = 30 MHz)	h_{fe} *	8	18.5	12	20	dB
oise Figure $V_{CE} = -5V$, $I_E = 100\mu A$, BW = 15.7KHz, $R_s = 5K\Omega$, f = 10 Hz to 10 KHz)	NF		3		2	dB
elay Time — see figure 1 ($V_{CC} = -30V$, I_C(on) = −150mA, $I_{B1} = -15mA$, V_{BE}(off) = 0V)	t_d*		10		10	nsec
ise Time — see figure 1 ($V_{CC} = -30V$, I_C(on) = −150mA, $I_{B1} = -15mA$, V_{BE}(off) = 0V)	t_r*		35		35	nsec
orage Time — see figure 2 ($V_{CC} = -30V$, I_C(on) = −150mA, $I_{B1} = -15mA$, $I_{B2} = 15mA$)	t_s*		375		450	nsec
all Time — see figure 2 ($V_{CC} = -30V$, I_C(on) = −150mA, $I_{B1} = -15mA$, $I_{B2} = 15mA$)	t_f*		50		75	nsec



t_f' ≤ 2ns
16V
P.W. ≥ 200ns
1K
C_s
200
TO OSCILLOSCOPE
t_r ≤ 1ns
R_i ≥ 100K
V_CC = -30V

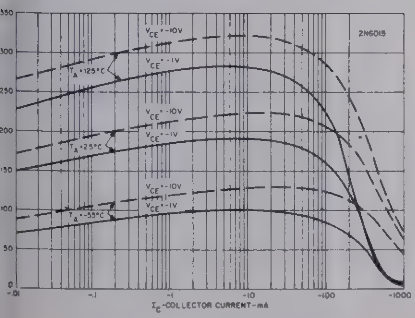
FIGURE 1. DELAY AND RISE TIME EQUIVALENT CIRCUIT



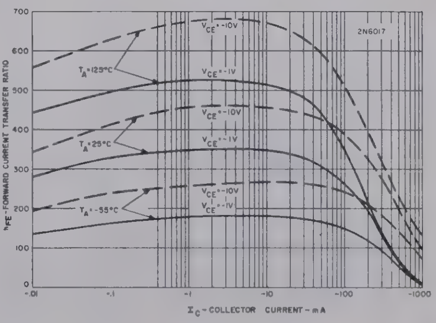
t_f' ≤ 2ns
16V
-14V
P.W. ≥ 1μs
1K
1N916
≈ 3V
C_s
200
TO OSCILLOSCOPE
t_r ≤ 1ns
R_i ≥ 100K
V_CC = -30V

C_s = TOTAL SHUNT CAPACITANCE FIXTURE, CONNECTORS, AND PROBE = 10pF

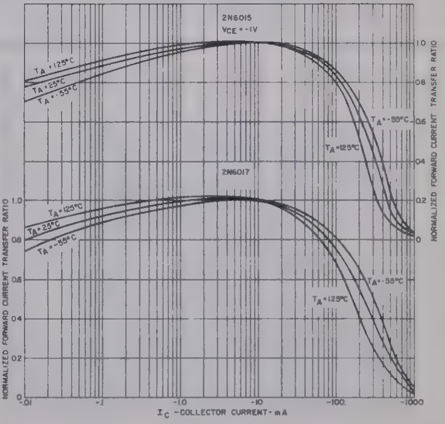
FIGURE 2. STORAGE AND FALL TIME EQUIVALENT CIRCUIT



BETA VS. COLLECTOR CURRENT

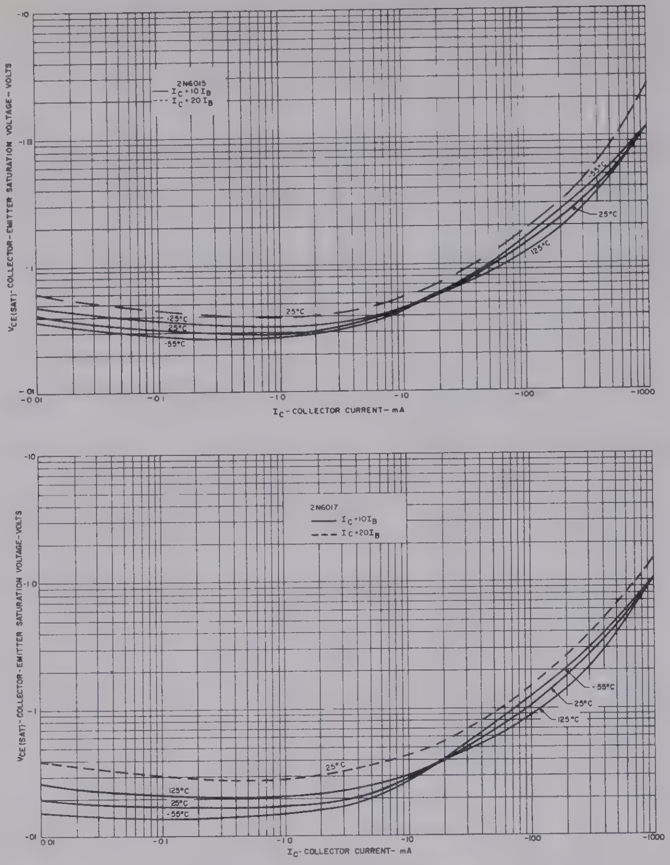


BETA VS. COLLECTOR CURRENT

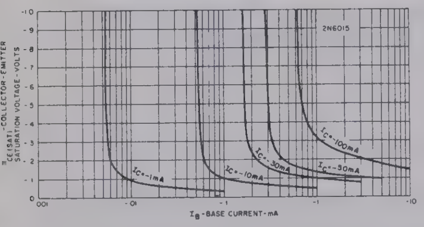


NORMALIZED FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT

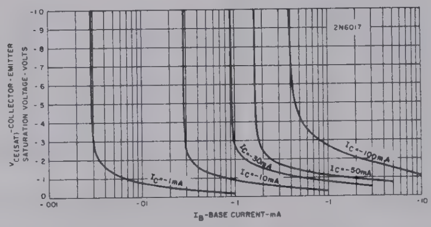
2N6015,7



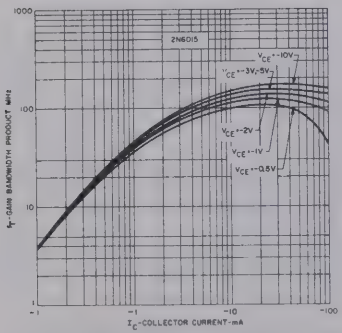
COLLECTOR-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



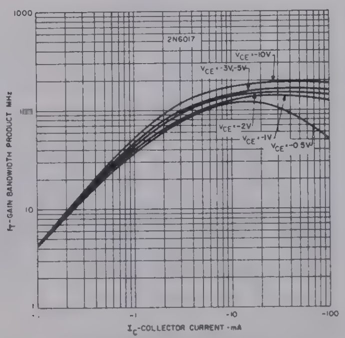
COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT



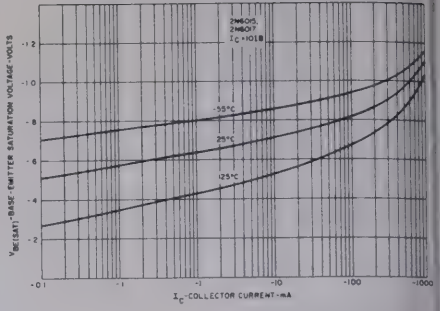
COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT



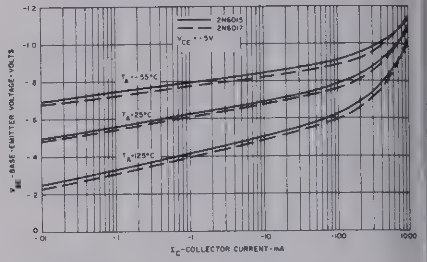
GAIN BAND WIDTH PRODUCT VS. COLLECTOR CURRENT



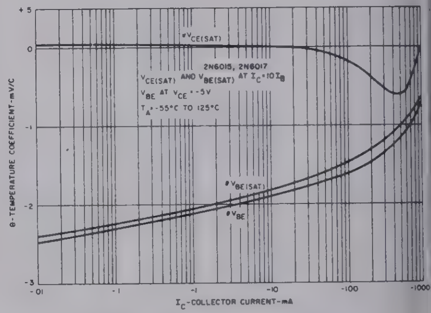
GAIN BAND WIDTH PRODUCT VS. CURRENT CURRENT



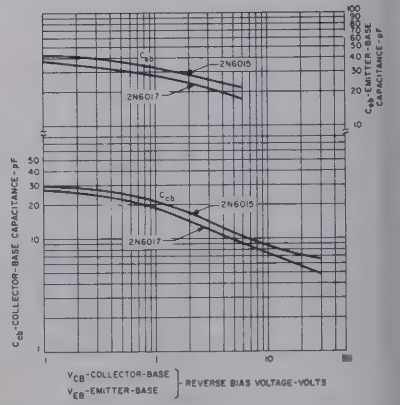
BASE-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



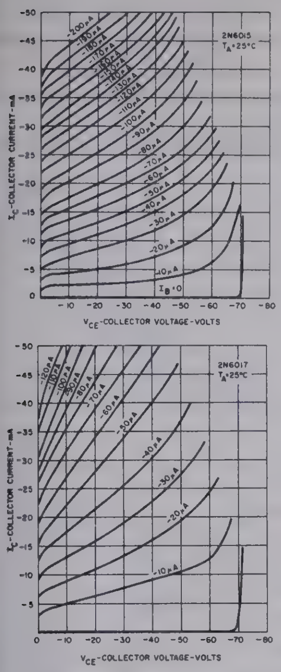
TRANSCONDUCTANCE VS. COLLECTOR CURRENT



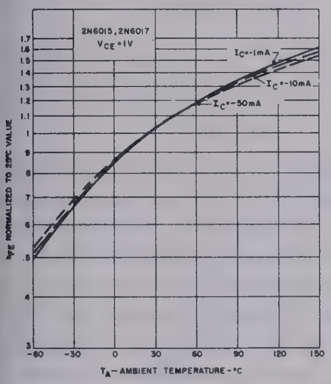
TEMPERATURE COEFFICIENTS VS. COLLECTOR CURRENT



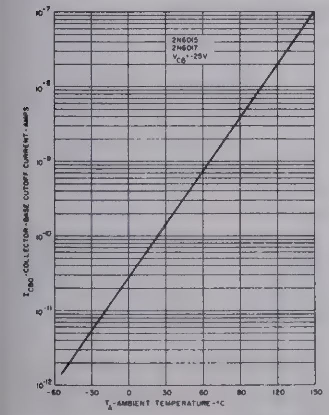
COLLECTOR-BASE & EMITTER-BASE CAPACITANCE VS. REVERSE BIAS VOLTAGE



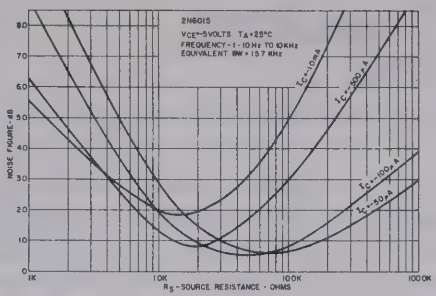
COLLECTOR CHARACTERISTICS



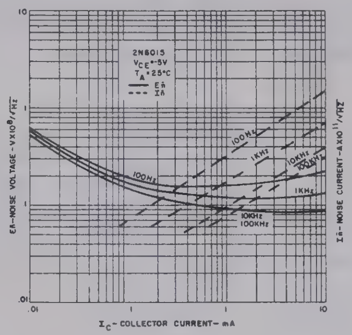
NORMALIZED FORWARD CURRENT TRANSFER RATIO VS. AMBIENT TEMPERATURE



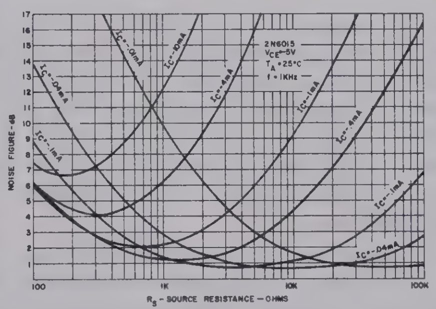
COLLECTOR-BASE CUTOFF CURRENT VS. AMBIENT TEMPERATURE



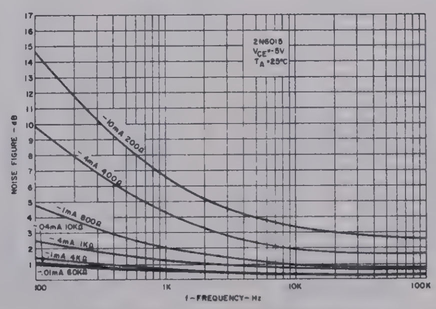
NOISE FIGURE-WIDEBAND VS. SOURCE RESISTANCE



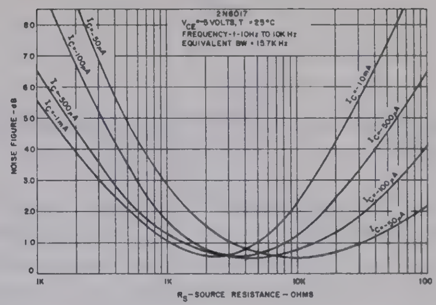
E_n & I_n VS. COLLECTOR CURRENT



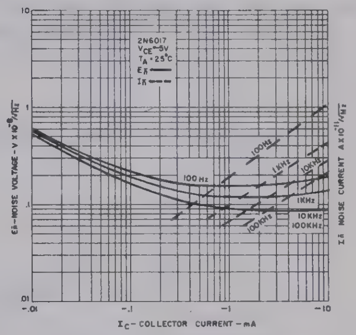
NOISE FIGURE VS. SOURCE RESISTANCE



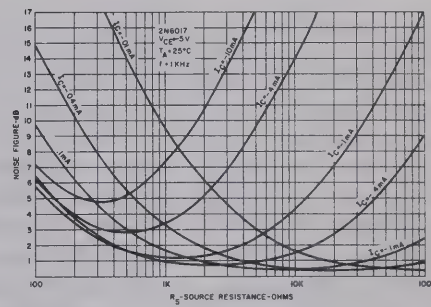
NOISE FIGURE VS. FREQUENCY



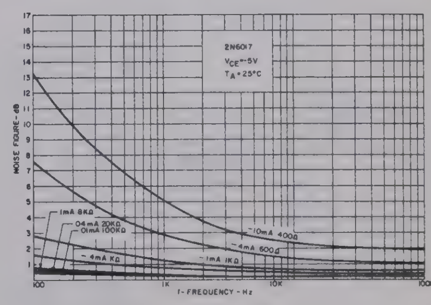
NOISE FIGURE-WIDEBAND VS. SOURCE RESISTANCE



E_n & I_n VS. COLLECTOR CURRENT



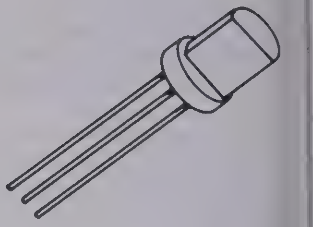
NOISE FIGURE VS. SOURCE RESISTANCE



NOISE FIGURE VS. FREQUENCY

Silicon
Programmable Unijunction Transistor
(PUT)

D13T SERIES
2N6027,8



The General Electric PUT is a three-terminal planar passivated PNPN device in the standard plastic low cost TO-98 package. The terminals are designated as anode, anode gate and cathode.

The 2N6027 and 2N6028 have been characterized as Programmable Unijunction Transistors (PUT), offering many advantages over conventional unijunction transistors. The designer can select R_1 and R_2 to program unijunction characteristics such as η, R_{BB}, I_P and I_V to meet his particular needs.

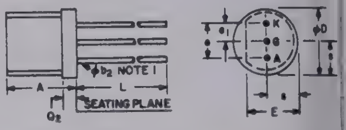
The 2N6028 is specifically characterized for long interval timers and other applications requiring low leakage and low peak point current. The 2N6027 has been characterized for general use where the low peak point current of the 2N6028 is not essential. Applications of the 2N6027 include timers, high gain phase control circuits and relaxation oscillators.

10 Outstanding Features of the PUT:

1. Planar Passivated Structure
2. Low Leakage Current
3. Low Peak Point Current
4. Low Forward Voltage
5. Fast, High Energy Trigger Pulse
6. Programmable η
7. Programmable R_{BB}
8. Programmable I_P
9. Programmable I_V
10. Low Cost

Applications:

- SCR Trigger
- Pulse and Timing Circuits
- Oscillators
- Sensing Circuits
- Sweep Circuits

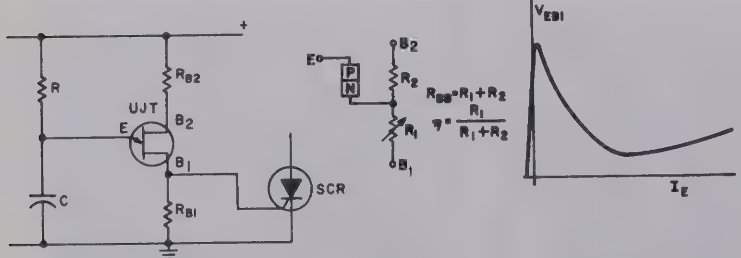


SYMBOL	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	.170	.265	4.32	6.73
ϕb_2	.016	.019	.406	.483
ϕD	.165	.205	4.19	5.21
E	.110	.155	2.79	3.94
e	.095	.105	2.41	2.67
e_1	.045	.055	1.14	1.40
L	.500		12.70	
Q_2		.075		1.90
s	.080	.115	2.03	2.92

NOTE I: LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .070 AND .250 FROM THE SEATING PLANE. BETWEEN .250 AND END OF LEAD A MAX. OF .021 IS HELD.

Operation of the PUT as a unijunction is easily understood. Figure 1(a) shows a basic unijunction circuit. Figure 2(a) shows identically the same circuit except that the unijunction transistor is replaced by the PUT plus resistors R_1 and R_2. Comparing the equivalent circuits of Figure 1(b) and 2(b), it is seen that both circuits have a diode connected to a voltage divider. When this diode becomes forward biased in the unijunction transistor, R_1 becomes strongly modulated to a lower resistance value. This generates a negative resistance characteristic between the emitter E and base one (B_1). For the PUT, the resistors R_1 and R_2 control the voltage at which the diode (anode to gate) becomes forward biased. After the diode conducts, the regeneration inherent in a PNPN device causes the PUT to switch on. This generates a negative resistance characteristic from anode to cathode (Figure 2(b)) simulating the modulation of R_1 for a conventional unijunction.

Resistors R_{B2} and R_{B1} (Figure 1(a)) are generally unnecessary when the PUT replaces a conventional UJT. This is illustrated in Figure 2(c). Resistor R_{B1} is often used to bypass the interbase current of the unijunction which would otherwise trigger the SCR. Since R_1 in the case of the PUT, can be returned directly to ground there is not current to bypass at the SCR gate. Resistor R_{B2} is used for temperature compensation and for limiting the dissipation in the UJT during capacitor discharge. Since R_2 (Figure 2) is *not* modulated, R_{B2} can be absorbed into it.

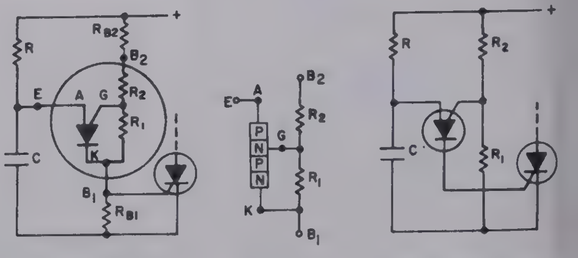


1(a) Typical Circuit

1(b) UJT Equivalent Circuit

1(c) Negative Resistance Characteristic

Figure 1 Unijunction Transistor



2(a) PUT Replacing UJT in Typical Circuit 1(a)

2(b) UJT Equivalent Circuit Using PUT

2(c) Simplified Typical Circuit 1(a)

Figure 2 PUT Equivalent of UJT

2N6027,8

absolute maximum ratings: (25°C)

Voltage	
*Gate-Cathode Forward Voltage	+40 V
*Gate-Cathode Reverse Voltage	–5 V
*Gate-Anode Reverse Voltage	+40 V
*Anode-Cathode Voltage	±40 V
Current	
*DC Anode Current†	150 mA
Peak Anode, Recurrent Forward (100 µsec pulse width, 1% duty cycle)	1 A
*(20 µsec pulse width, 1% duty cycle)	2 A
Peak Anode, Non-recurrent Forward (10 µsec)	5 A
*Gate Current	±20 mA
Capacitive Discharge Energy††	250 µJ
Power	
*Total Average Power†	300 mW
Temperature	
*Operating Ambient† Temperature Range	–50°C to +100°C

†Derate currents and powers 1%/°C above 25°C

††E = ½ CV² capacitor discharge energy with no current limiting

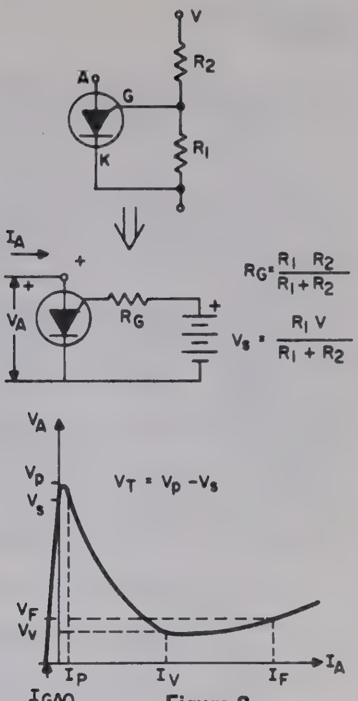

V
R2
A
G
K
R1
I_A
+
V_A
R_G
+
$R_G = \frac{R_1 R_2}{R_1 + R_2}$
$V_s = \frac{R_1 V}{R_1 + R_2}$
V_A
V_P
V_s
$V_T = V_P - V_s$
V_F
V_V
I_P
I_V
I_F
I_A
I_{GAO}

Figure 3

electrical characteristics: (25°C) (unless otherwise specified)

		Fig. No.	2N6027 (D13T1) Min.	2N6027 (D13T1) Max.	2N6028 (D13T2) Min.	2N6028 (D13T2) Max.
***Peak Current** (V_s = 10 Volts)	I_P	3				
(R_G = 1 Meg)				2		.15 µA
(R_G = 10 k)				5		1.0 µA
***Offset Voltage** (V_s = 10 Volts)	V_T	3				
(R_G = 1 Meg)			.2	1.6	.2	.6 Volts
(R_G = 10 k)			.2	.6	.2	.6 Volts
***Valley Current** (V_s = 10 Volts)	I_V	3				
(R_G = 1 Meg)				50		25 µA
(R_G = 10 k)			70		25	µA
(R_G = 200 Ω)			1.5		1.0	mA
Anode Gate-Anode Leakage Current						
*(V_s = 40 Volts, T = 25°C)	I_{GAO}	4		10		10 nA
(T = 75°C)				100		100 nA
Gate to Cathode Leakage Current						
(V_s = 40 Volts, Anode-cathode short)	I_{GKS}	5		100		100 nA
***Forward Voltage** (I_F = 50 mA)	V_F			1.5		1.5 Volts
***Pulse Output Voltage**	V_O	6	6		6	Volts
Pulse Voltage Rate of Rise	t_r	6		80		80 nsecs.

*JEDEC registered data

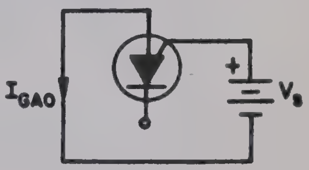


Figure 4

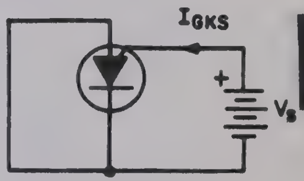


Figure 5

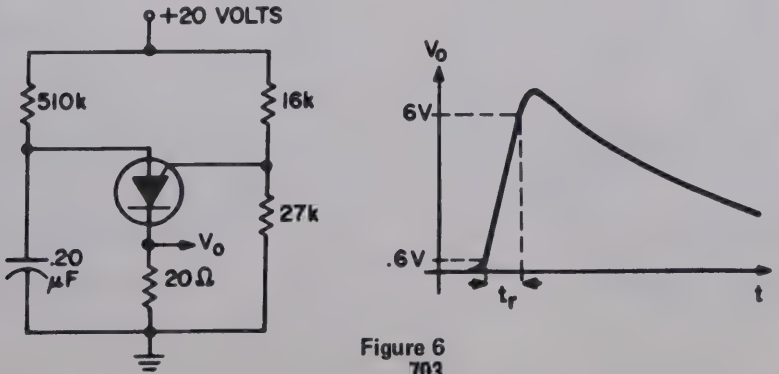
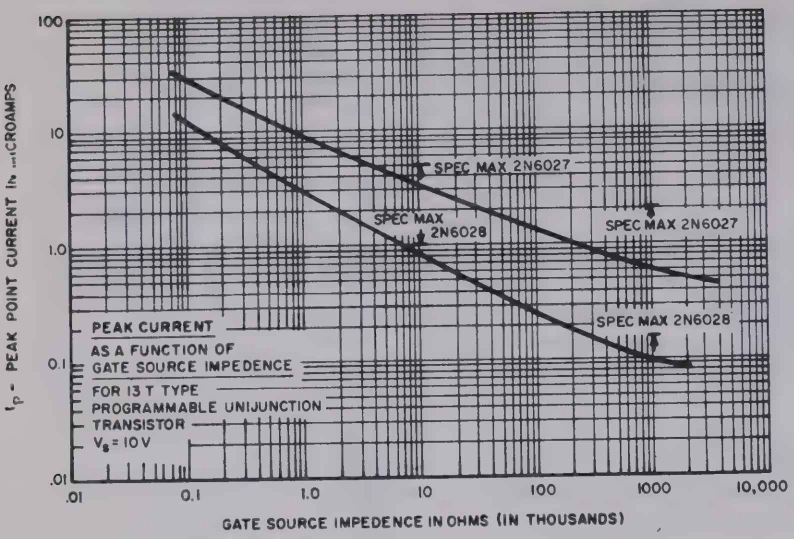
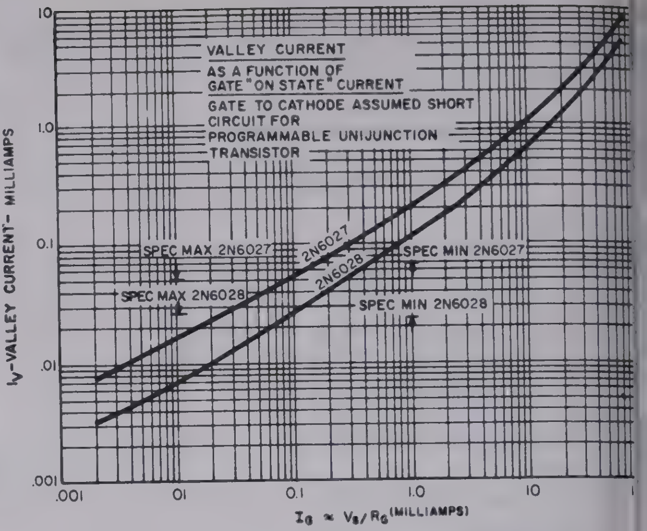

+20 VOLTS
510k
16k
27k
.20 µF
20Ω
V_o
V_o
6V
.6V
t_r
t

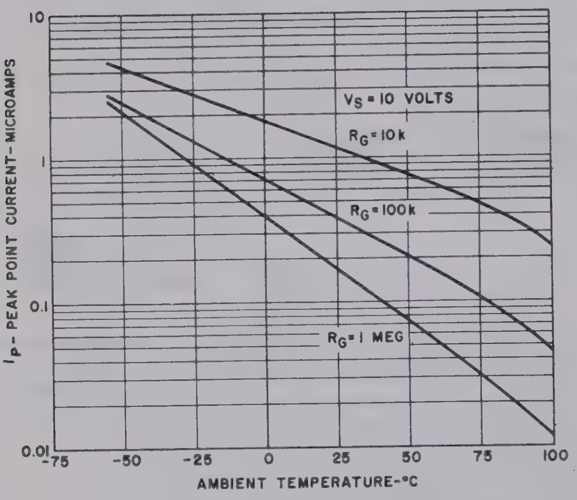
Figure 6



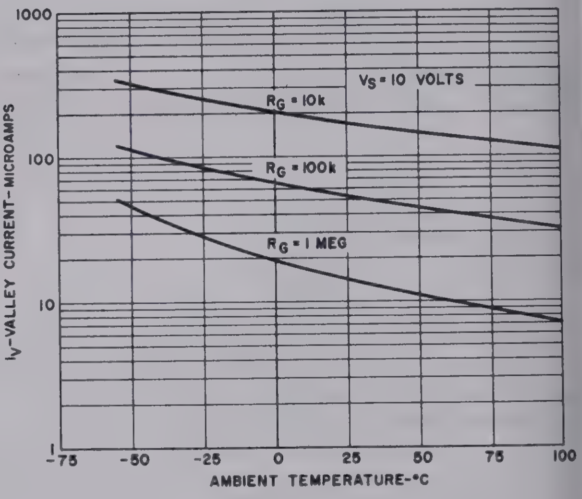
I_p vs Gate Source Impedance



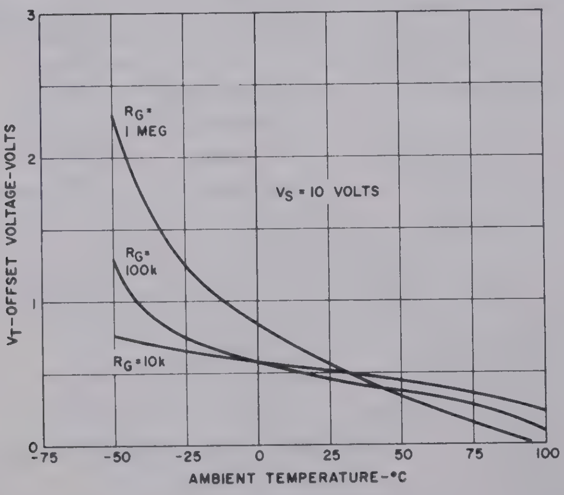
I_v vs Gate "on state" Current



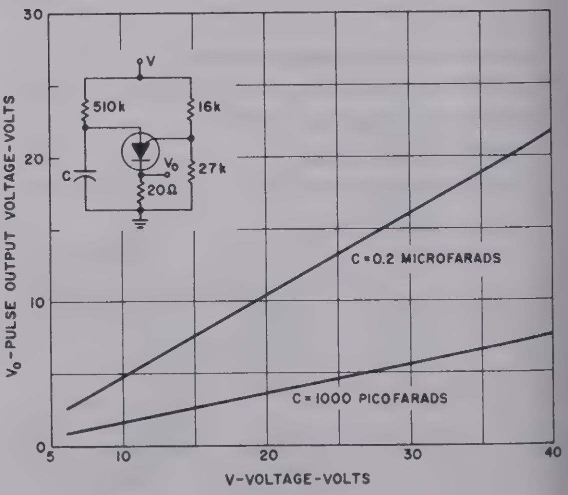
I_p vs Temperature and R_G



I_v vs Temperature and R_G



V_T vs Temperature and R_G

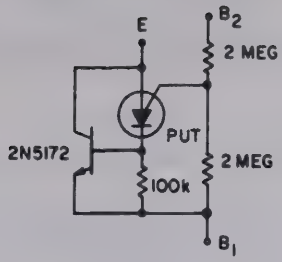


Peak Output Voltage

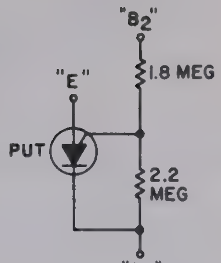
APPLICATIONS

YPICAL UNIJUNCTION CIRCUIT CONFIGURATIONS

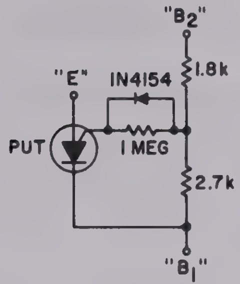
Iere are four ways to use the PUT as a unijunction. Iote the flexibility due to "programmability." Appli-ations from long time interval latching timers to vide range relaxation oscillators are possible.


E
B2
2 MEG
PUT
2N5172
2 MEG
100k
B1

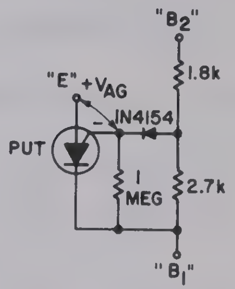
LOW I_P
VERY HIGH I_V
TEMPERATURE
AND V_{BB} COMPENSATION


"B2"
"E"
1.8 MEG
PUT
2.2 MEG
"B1"

LOW I_P, LOW I_V


"B2"
"E"
1N4154
1.8k
PUT
1 MEG
2.7k
"B1"

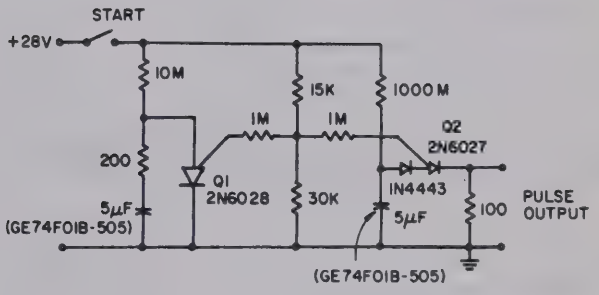
LOW I_P, MEDIUM I_V


"B2"
"E" +VAG
1.8k
–
1N4154
PUT
1 MEG
2.7k
"B1"

LOW I_P, MEDIUM I_V
TEMPERATURE
COMPENSATION
V_{AG}

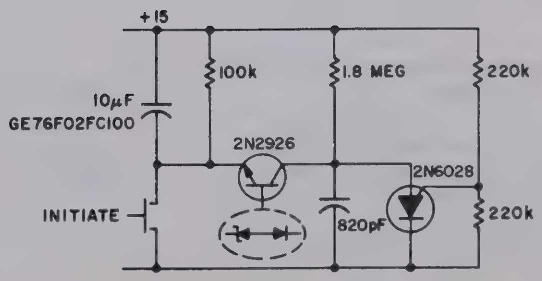
IOUR TIME DELAY AMPLING CIRCUIT

his sampling circuit lowers the effective peak cur-ent of the output PUT, Q2. By allowing the apacitor to charge with high gate voltage and eriodically lowering gate voltage, when Q1 fires, the ming resistor can be a value which supplies a much ower current than I_P. The triggering requirement ere is that minimum charge to trigger flow through ne timing resistor during the period of the Q1 scillator. This is not capacitor size dependent, only apacitor leakage and stability dependent.


START
+28V
10M
15K
1000 M
1M
1M
Q2
2N6027
200
Q1
2N6028
30K
1N4443
5μF
(GE74F01B-505)
5μF
100
PULSE OUTPUT
(GE74F01B-505)

SECOND, 1kHz OSCILLATOR

Iere is a handy circuit which operates as an oscillator nd a timer. The 2N6028 is normally on due to xcess holding current through the 100 kohm resis-or. When the switch is momentarily closed, the 10 F capacitor is charged to a full 15 volts and 2N6028 tarts oscillating (1.8 Meg and 820 pF). The circuit itches when 2N2926 zener breaks down again.

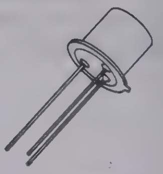

+15
100k
1.8 MEG
220k
10μF
GE76F02FC100
2N2926
2N6028
INITIATE
820pF
220k

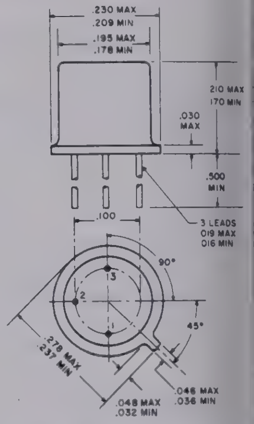
Silicon Programmable Unijunction Transistor

(PUT)

D13K Series
2N6116
2N6117
2N6118

This General Electric PUT is a three-terminal planar passivated PNPN device in a TO-18 hermetic package. These programmable unijunctions allow the designer to select R_1 and R_2 in order to program unijunction characteristics such as n, R_{BB}, t_P, and I_V to meet his particular needs. See application notes 90.70 and 90.93 for additional information, circuit techniques and design data.




.230 MAX
.209 MIN
.195 MAX
.178 MIN
210 MAX
170 MIN
.030 MAX
.500 MIN
.100
3 LEADS
019 MAX
016 MIN
90°
13
2
1
45°
.278 MAX
.237 MIN
.046 MAX
.036 MIN
.048 MAX
.032 MIN

Terminal
1 **Cathode**
2 **Gate**
3 **Anode**

Applications Include:

- SCR Trigger
- Pulse and Timing Circuits
- Oscillators
- Sensing Circuits
- Sweep Circuits

absolute maximum ratings: (25°C)

Voltage	
*Gate-Cathode Forward Voltage	+40 V
*Gate-Cathode Reverse Voltage	- 5 V
*Gate-Anode Reverse Voltage	+40 V
*Anode-Cathode Voltage	±40 V
Current	
*DC Anode Current	200 mA
Peak Anode, Recurrent Forward	
(100 μsec pulse width, 1% duty cycle)	1 A
*(20 μsec pulse width, 1% duty cycle)	2 A
Peak Anode, Non-recurrent Forward	
(10 μsec)	5 A
*Gate Current	±20 mA
Power	
*Total Average Power	250 mW
Temperature	
* Operating Junction Temperature range, T_J	-55 to +125 °C
* Storage temperature range, T_{STG}	-65 to +200 °C

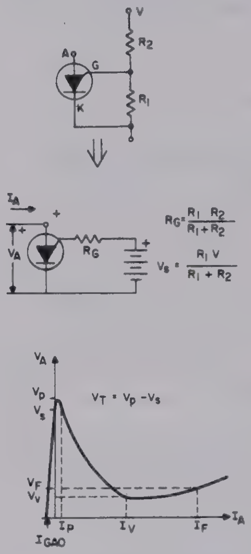

V
R2
A
G
K
R1
IA
+
VA
RG
$R_G = \frac{R_1 R_2}{R_1 + R_2}$
$V_s = \frac{R_1 V}{R_1 + R_2}$
VA
Vp
Vs
$V_T = V_p - V_s$
VF
VV
IP
IV
IF
IA
IGAO

Figure 1

electrical characteristics: (25°C) (unless otherwise specified)

		Fig. No.	2N6116 (D13K1) Min.	2N6116 (D13K1) Max.	2N6117 (D13K3) Min.	2N6117 (D13K3) Max.	2N6118 (D13K2) Min.	2N6118 (D13K2) Max.	
***Peak Current** (V_s = 10 Volts)	I_P	1							
(R_G = 1 Meg)			–	2.0	–	0.3	–	0.15	μA
(R_G = 10k)			–	5.0	–	2.0	–	1.0	μA
***Offset Voltage** (V_s = 10 Volts)	V_T	1							
(R_G = 1 Meg)			0.2	1.6	0.2	0.6	0.2	0.6	Volts
(R_G = 10k)			0.2	0.6	0.2	0.6	0.2	0.6	Volts
***Valley Current** (V_s = 10 Volts)	I_V	1							
(R_G = 1 Meg)			–	50	–	50	–	25	μA
(R_G = 10k)			70	–	50	–	50	–	μA
***Anode Gate-Anode Leakage Current**									
(V_s = 40 Volts, T = 25°C)	I_{GAO}	2	–	5	–	5	–	5	nA
(T = 75°C)			–	75	–	75	–	75	n
***Gate to Cathode Leakage Current**									
(V_s = 40 Volts, Anode-Cathode short)	I_{GKS}	3	–	50	–	50	–	50	nA
***Forward Voltage** (I_F = 50 mA)	V_F		–	1.5	–	1.5	–	1.5	Volts
***Pulse Output Voltage**	V_O	4	6	–	6	–	6	–	Volts
***Pulse Voltage Rate of Rise**	t_r	4	–	80	–	80	–	80	nsec

*JEDEC registered data

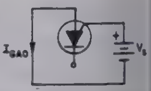


Figure 2

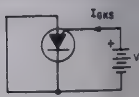


Figure 3

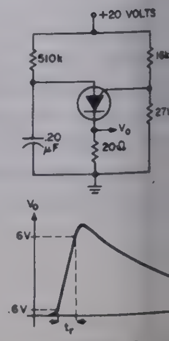
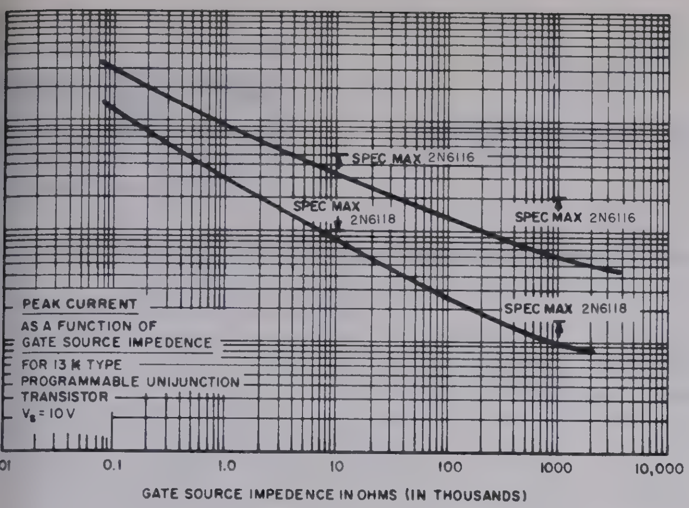
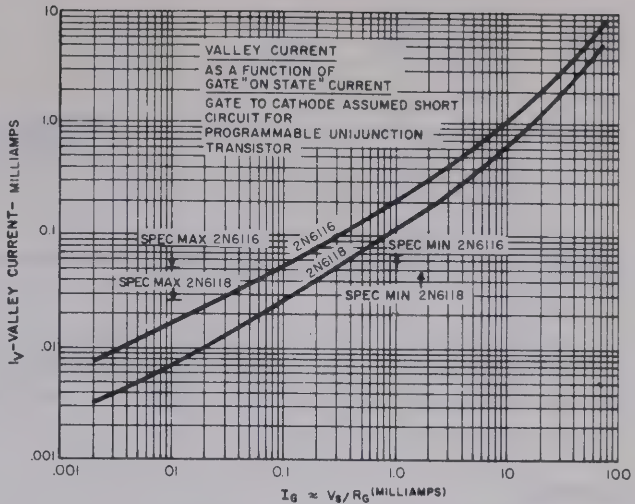

+20 VOLTS
510k
.20 μF
Vo
20Ω
Vo
6V
.6V
tr

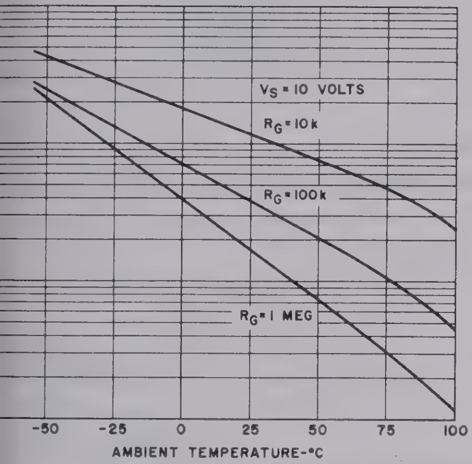
Figure 4



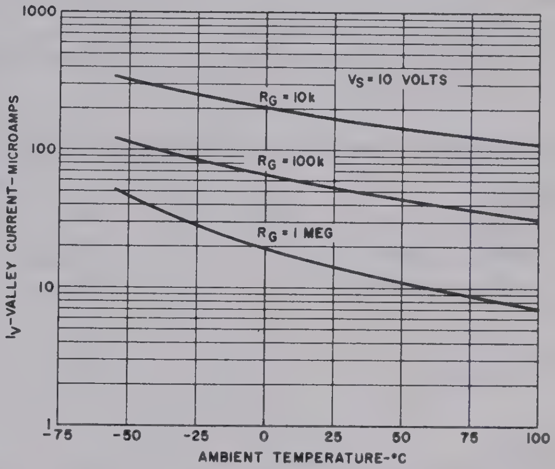
I_p vs Gate Source Impedance



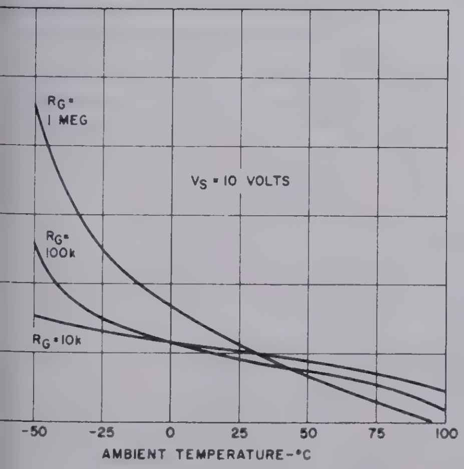
I_v vs Gate "on state" Current



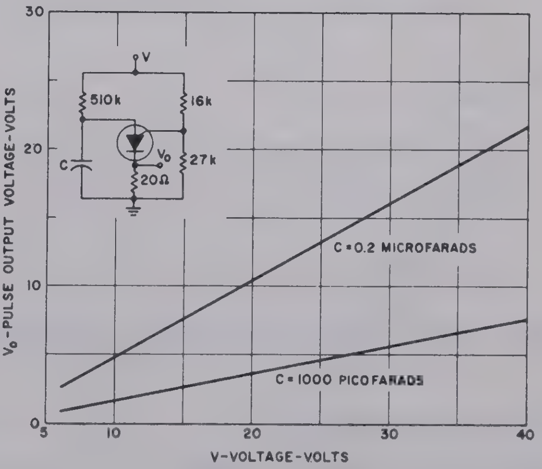
I_p vs Temperature and R_G



I_v vs Temperature and R_G



V_T vs Temperature and R_G



Peak Output Voltage

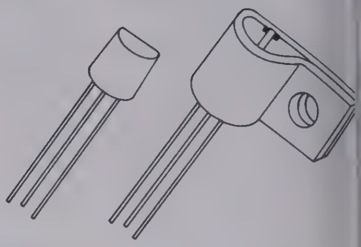
Silicon

Signal Transistor

NPN

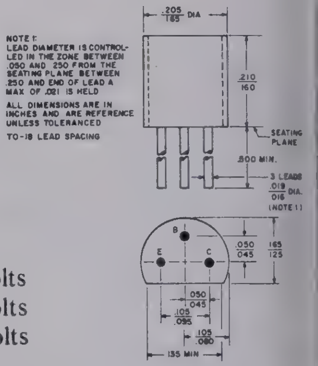
2N6218,19,20,2

The General Electric 2N6218, 2N6219, 2N6220, and 2N6221 are NPN epoxy encapsulated transistors with TO-18 lead configuration. The device is intended primarily for use in T.V., nixie-neon tube and other general high voltage applications.



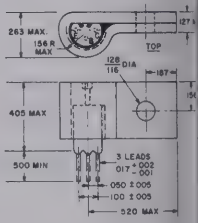
FEATURES:

- Epoxy encapsulation with proved reliability
- Performance comparable to hermetic units—excellent characteristics stability under environmental stresses - 85°C - 85% Relative Humidity
- 500 mW Power Dissipation.
- Excellent Beta Linearity over extremely wide current ranges.
- 300V BV_{CEO} ratings available.
- Integral Heat Sinks available - up to 625mW Power Dissipation.


.205
.185 DIA
NOTE 1:
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND .250 FROM THE SEATING PLANE BETWEEN .250 AND END OF LEAD A MAX OF .021 IS HELD
ALL DIMENSIONS ARE IN INCHES AND ARE REFERENCE UNLESS TOLERANCED
TO-18 LEAD SPACING
.210
.160
SEATING PLANE
.500 MIN.
3 LEADS
.019
.016 DIA.
(NOTE 1)
B
E
C
.050
.045
.165
.125
.050
.045
.105
.095
.105
.080
.135 MIN

absolute maximum ratings: (25°C unless otherwise specified)

		2N6218	2N6219	2N6220	2N6221	
Voltages						
Collector to emitter	V_{CEO*}	300	250	200	150	Volts
Emitter to base	V_{EBO*}	5	5	5	5	Volts
Collector to base	V_{CBO*}	300	250	200	150	Volts
Current						
Collector	I_{c*}	50	50	50	50	mA
Dissipation						
Total Power $T_A \leq 25°C$	P_{T*}	.500	.500	.500	.500	Watts
Derating Factor $T_A > 25°C$		4	4	4	4	mW/°C
Total Power $T_A \leq 25°C$ HS Types	P_{T*}	.625	.625	.625	.625	Watts
Derating Factor $T_A > 25°C$ HS Types		5	5	5	5	mW/°C
Total Power $T_C \leq 25°C$ HS Types	P_{T*}	1.0	1.0	1.0	1.0	Watts
Derating Factor $T_C > 25°C$ HS Types		8	8	8	8	mW/°C
Temperature						
Storage	T_{stg*}	-65 to +150				°C
Operating	T_{j*}	-65 to +150				°C
Lead (1/16" ±1/32" from case for 10 sec.)	T_{L*}	+260				°C


263 MAX.
156 R MAX
127
TOP
128
116 DIA
187
405 MAX
500 MIN
3 LEADS
017 +.002 -.001
050 ±.005
100 ±.005
520 MAX

ORDER HEATSINK VERSIONS AS
HS6218
HS6219
HS6220
HS6221

electrical characteristics: (25°C unless otherwise specified)

		2N6218 Min.	2N6218 Max.	2N6219 Min.	2N6219 Max.	2N6220 Min.	2N6220 Max.	2N6221 Min.	2N6221 Max.	
STATIC CHARACTERISTICS										
Collector - Emitter Breakdown Voltage ($I_C = 10mA$, $I_B = 0$)	$V_{(BR)CEO*}$	300		250		200		150		Volts
Emitter - Base Breakdown Voltage ($I_E = 100uA$, $I_C = 0$)	$V_{(BR)EBO*}$	5		5		5		5		Volts

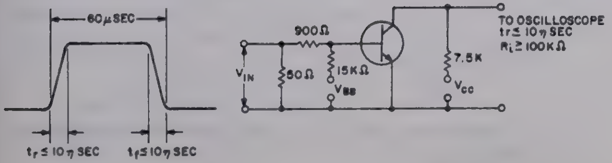
STATIC CHARACTERISTICS CONT'D.

	Symbol	2N6218		2N6219		2N6220		2N6221		
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Collector-Base Breakdown Voltage										
($I_C = 100uA$, $I_E = 0$)	$V_{(BR)CBO}$*	300		250		200		150		Volts
Collector Cutoff Current										
($V_{CB} = 250V$, $I_E = 0$)	I_{CBO}*		0.50							uA
($V_{CB} = 200V$, $I_E = 0$)	I_{CBO}*				1.0					uA
($V_{CB} = 150V$, $I_E = 0$)	I_{CBO}*						1.0			uA
($V_{CB} = 100V$, $I_E = 0$)	I_{CBO}*								10	uA
Forward Current Transfer Ratio										
($V_{CE} = 10V$, $I_C = 2mA$)	h_{FE}*	10		10		10		10		
($V_{CE} = 10V$, $I_C = 20mA$)	h_{FE}*	20		20		20		20		
Base-Emitter Voltage										
($V_{CE} = 10V$, $I_C = 20mA$)	V_{BE}*	0.55	0.75	0.55	0.75	0.55	0.75	0.55	0.75	Volts
Collector-Emitter Saturation Voltage										
($I_C = 10mA$, $I_B = 1mA$)	$V_{CE(sat)}$*	0.3	1.0							Volts
($I_C = 10mA$, $I_B = 1mA$)	$V_{CE(sat)}$*			0.3	1.0					Volts
($I_C = 20mA$, $I_B = 2mA$)	$V_{CE(sat)}$*					0.3	2.0			Volts
($I_C = 20mA$, $I_B = 2mA$)	$V_{CE(sat)}$*							0.3	2.3	Volts
Base-Emitter Saturation Voltage										
($I_C = 10mA$, $I_B = 1mA$)	$V_{BE(sat)}$*	0.60	0.75							Volts
($I_C = 10mA$, $I_B = 1mA$)	$V_{BE(sat)}$*			0.60	0.75					Volts
($I_C = 20mA$, $I_B = 2mA$)	$V_{BE(sat)}$*					0.65	0.86			Volts
($I_C = 20mA$, $I_B = 2mA$)	$V_{BE(sat)}$*							0.65	0.85	Volts

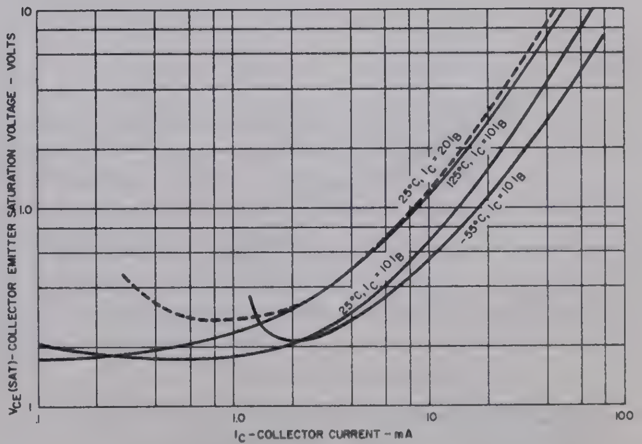
DYNAMIC CHARACTERISTICS ($T_A = 25°C$ unless otherwise specified)

		Min.	Max.	
Forward Current Transfer Ratio ($V_{CE} = 10V$, $I_C = 20mA$, f=1KHz)	h_{fe}*	20	300	
Collector Base Capacitance ($V_{CB} = 10V$, $I_E = 0$, f=1MHz)	C_{cb}*		5	pF
Emitter Base Capacitance ($V_{EB} = 0.5V$, $I_C = 0$, f=1MHz)	C_{eb}*		70	pF
Magnitude of Forward Current Transfer Ratio ($V_{CE} = 10V$, $I_C = 10mA$, f=20MHz)	h_{fe} *	8		dB
Gain Bandwidth Product ($I_C = 10mA$, $V_{CE} = 10V$, f=20MHz)	f_T*	50		MHz
Turn On Time (See Figure 1) ($V_{CC} = 150V$, $V_{BB} = 30V$, $V_{IN} = 5V$. $I_C = 20mA$, $I_{B1} = I_{B2} = 2.75mA$)	t_{ON}		0.5	usec.
Turn Off Time (See Figure 1) ($V_{CC} = 150V$, $V_{BB} = 30V$, $V_{IN} = 5V$, $I_C = 20mA$, $I_{B1} = I_{B2} = 2.75mA$)	t_{OFF}		5.0	usec.

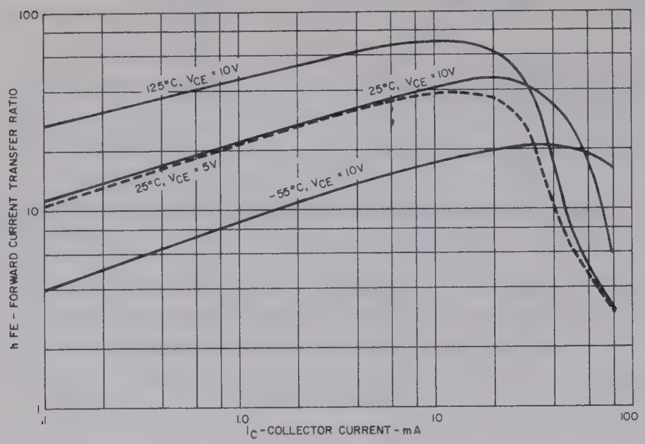
* Indicates JEDEC Registered Values



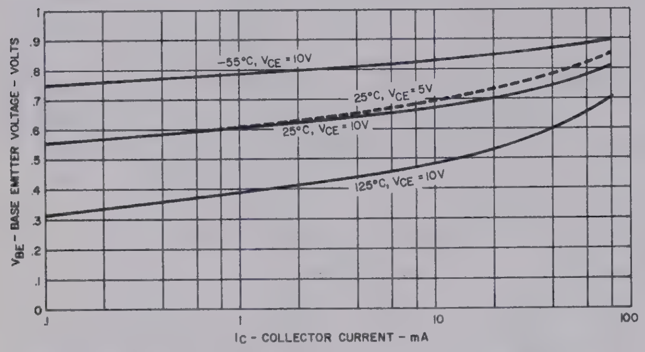
SWITCHING-ON AND OFF TIME EQUIVALENT CIRCUIT



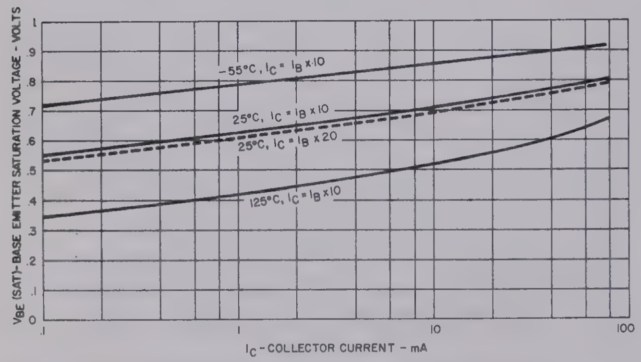
COLLECTOR-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



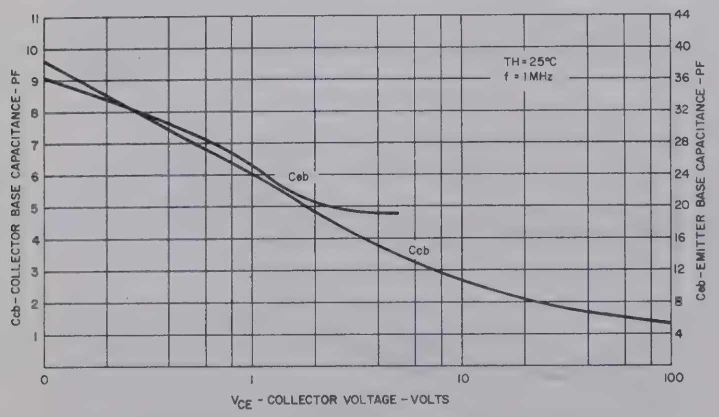
FORWARD CURRENT TRANSFER VS. COLLECTOR CURRENT



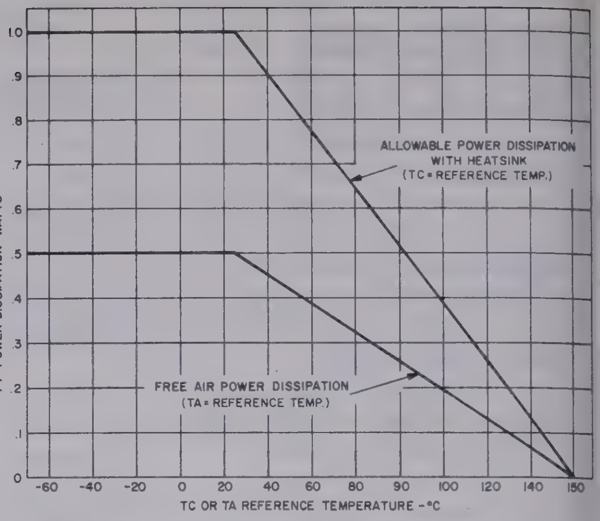
BASE-EMITTER VOLTAGE VS. COLLECTOR CURRENT



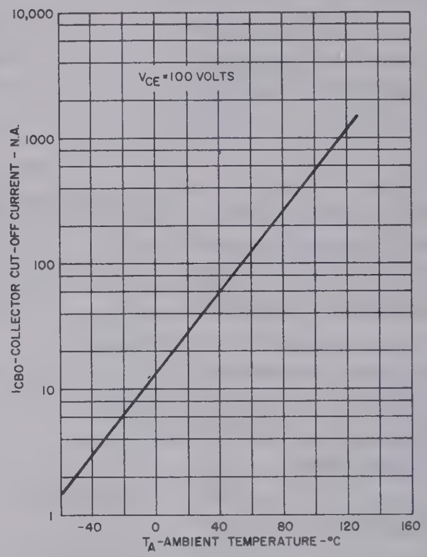
BASE-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



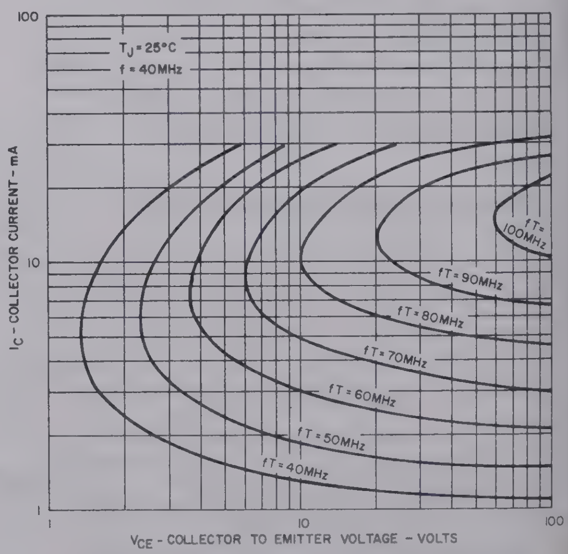
COLLECTOR-BASE CAPACITANCE AND EMITTER-BASE CAPACITANCE VS. REVERSE VOLTAGE



MAXIMUM PERMISSIBLE DC POWER DISSIPATION



COLLECTOR CUT-OFF CURRENT VS. TEMPERATURE

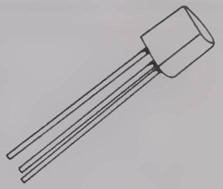


CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT

Silicon
Signal Transistors

NPN	PNP
2N6222	2N6223
2N6224	2N6225

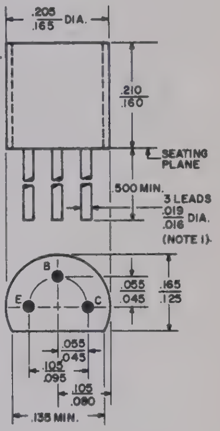
SILICON TRANSISTORS NPN/PNP COMPLEMENTARY PAIRS



These silicon planar passivated epitaxial transistors are intended to satisfy a broad range of general purpose signal level applications at audio and intermediate frequencies.

FEATURES:

- Excellent gain linearity—particularly designed for operation in the 10μA to 20 mA range.
- Low collector saturation voltage.
- 60 volt $V_{BR(CEO)}$ rating.
- Epoxy encapsulation with proven reliability—excellent characteristic stability under environmental stresses—85°C-85% RH.
- Low capacitance



NOTE 1:
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND .250 FROM THE SEATING PLANE. BETWEEN .250 AND END OF LEAD A MAX. OF .021 IS HELD.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.

TO-18 LEAD SPACING

absolute maximum ratings: (25°C unless otherwise specified)

(Voltage and current values for PNP devices are negative; observe proper bias polarity.)

Voltages			
Collector to emitter	V_{CEO}*	60	Volts
Emitter to base	V_{EBO}*	5	Volts
Collector to base	V_{CBO}*	60	Volts
Current			
Collector (continuous)	I_C*	100	mA
Dissipation			
Total power (free air, $T_A \leq 25$°C)	P_T*	360	mW
Derate factor (free air, $T_A > 25$°C)		2.88	mW/°C
Temperature			
Storage	T_{stg}*	−65 to +150	°C
Operating	T_J	−65 to +150	°C
Lead soldering (1/16" ± 1/32" from case for 10 sec. max.)	T_L*	+260	°C

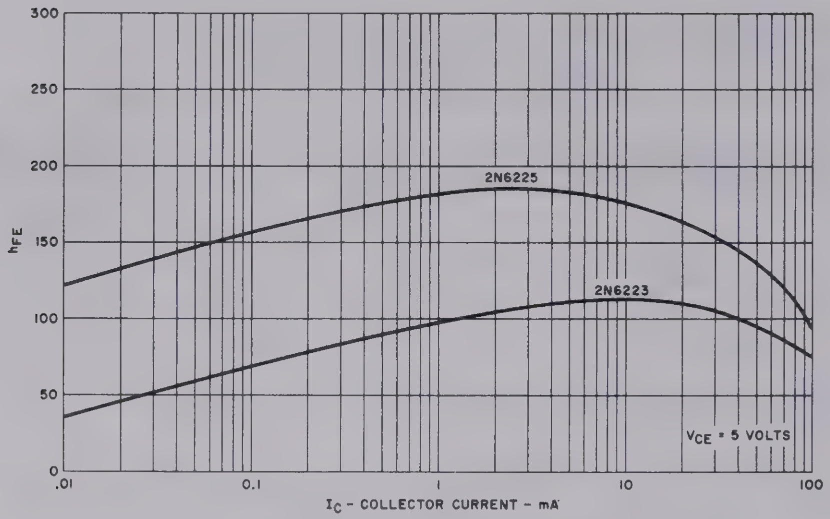
electrical characteristics: (25°C unless otherwise specified)

Static		Min.	Max.	
Collector base leadage current ($V_{CB} = 60V, I_E = 0$)	I_{CBO}*		50	nA
Emitter base leadage current ($V_{EB} = 5V, I_C = 0$)	I_{EBO}*		50	nA
Forward current transfer ratio				
($I_C = 10\mu A, V_{CE} = 5V$)				
2N6222	h_{FE}*	20		
2N6223	h_{FE}*	30		
2N6224	h_{FE}*	40		
2N6225	h_{FE}*	45		
($I_C = 2mA, V_{CE} = 5V$)				
2N6222, 2N6223	h_{FE}*	75	200	
2N6224, 2N6225	h_{FE}*	150	300	
($I_C = 100mA, V_{CE} = 5V$)				
2N6222	h_{FE}*	20		
2N6223	h_{FE}*	30		
2N6224	h_{FE}*	40		
2N6225	h_{FE}*	45		
Collector-emitter breakdown voltage ($I_C = 10mA, I_B = 0$)	$V_{BR(CEO)}$*	60		Volt
Collector-base breakdown voltage ($I_C = 100\mu A, I_E = 0$)	$V_{BR(CBO)}$*	60		Volt
Emitter-base breakdown voltage ($I_C = 100\mu A, I_C = 0$)	$V_{BR(EBO)}$*	5		Volt
Base-emitter voltage ($I_C = 2mA, V_{CE} = 5V$)	$V_{BE(ON)}$*	0.5	0.9	Volt
Collector-emitter saturation voltage				
($I_C = 10mA, I_B = 1mA$)				
2N6222, 2N6224	$V_{CE(sat)}$*	0.020	0.125	Volt
2N6223, 2N6225	$V_{CE(sat)}$*	0.050	0.250	Volt
Base-emitter saturation voltage				
($I_C = 10mA, I_B = 1mA$)				
2N6222, 2N6224	$V_{BE(sat)}$*		.78	Volt
2N6223, 2N6225	$V_{BE(sat)}$*		.85	Volt

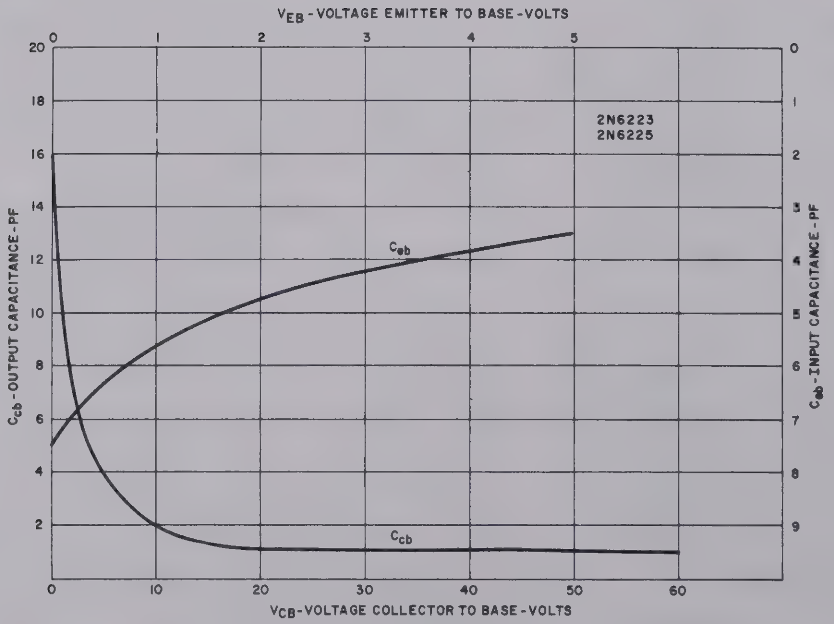
Dynamic

Forward current transfer ratio (I_C = 2mA, V_{CE} = 5V, f = 1KHz)				
2N6222, 2N6223	h_{fe}*	75	300	
2N6224, 2N6225	h_{fe}*	150	400	
Collector-base capacitance (V_{CB} = 10V, I_E = 0, f = 1MHz)	C_{cb}*		4	pF

*indicates JEDEC registered values

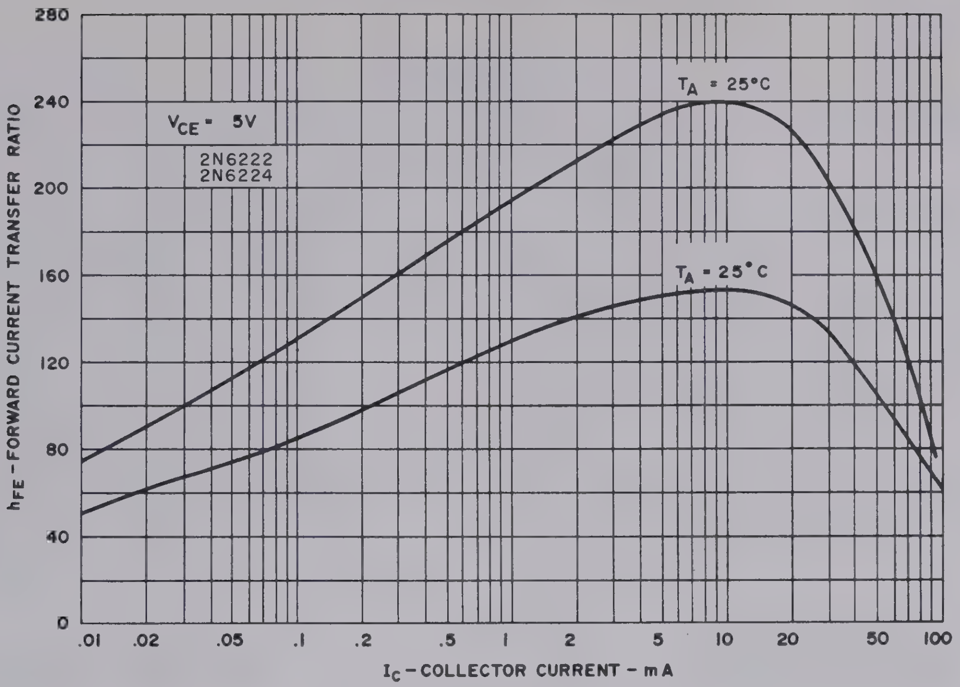


FORWARD CURRENT TRANSFER
RATIO VS. COLLECTOR CURRENT



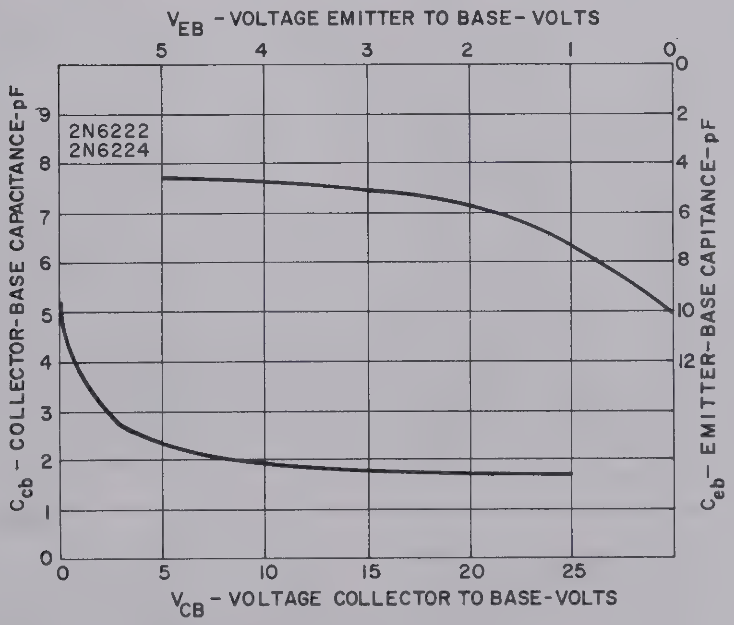
INPUT AND OUTPUT
CAPACITANCE VS. VOLTAGE

FORWARD CURRENT TRANSFER RATIO vs. COLLECTOR CURRENT



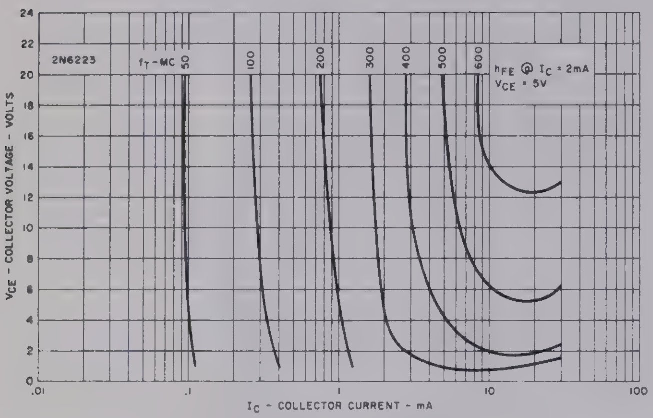
2N6222
2N6224

TYPICAL ELECTRICAL CHARACTERISTICS

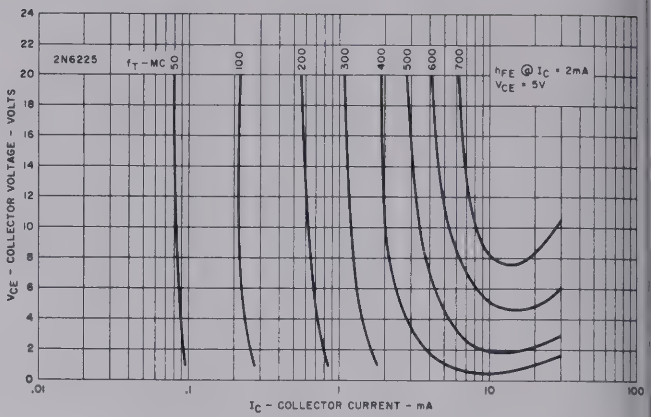


Capacitance
vs.
VOLTAGE

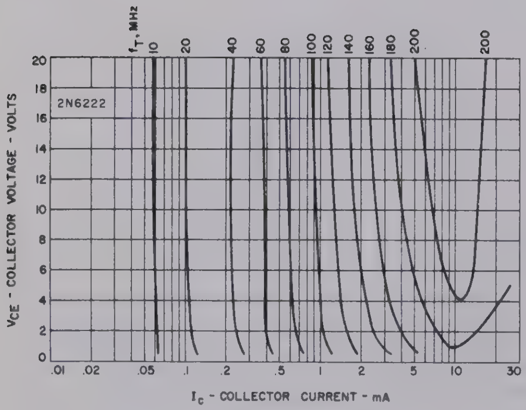
GAIN BANDWIDTH PRODUCT
vs.
COLLECTOR CURRENT



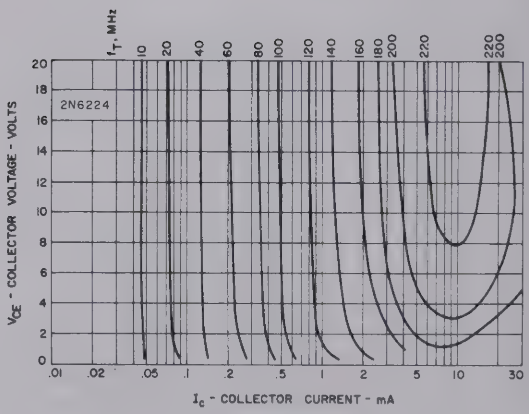
GAIN BANDWIDTH PRODUCT VS. COLLECTOR CURRENT



GAIN BANDWIDTH PRODUCT VS. COLLECTOR CURRENT



2N6222



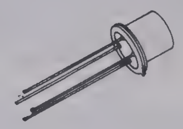
2N6224

Silicon
Control Switch

PNPN
3N81,2

The General Electric Types 3N81 and 3N82 are PLANAR PNPN silicon controlled switches (SCS) offer-ng outstanding circuit design flixibility by providing leads to all four semiconductor regions. Unique fab-rication processes based on planar oxide passivation have resulted in high reliability and uniformity at low ost. The SCS is thoroughly characterized at temperature extremes to permit worst-case circuit design.

ypes 3N81 and 3N82 can be considered an integrated PNP-NPN transistor pair in a positive feedback onfiguration. As such they offer fewer connections, fewer parts, lower cost and better characterization han are available from two separte transistors. Their characterization permits them to be used as an ex-remely sensitive SCR, as a complementary SCR, or as a "transistor" with "latching" capabilities.



EATURES:

- **Completely eliminates rate effect problems**
- **Dynamic and static breakover voltages are identical**
- **Extremely high triggering sensitivity**
- **Design parameters specified at worst-case temperatures**
- **Characterized for SCR and complementary SCR type applications**
- **Characterized as PNPN and also as transistor integrated pair**
- **All planar, completely oxide passivated**
- **Leads to all four semiconductor regions**

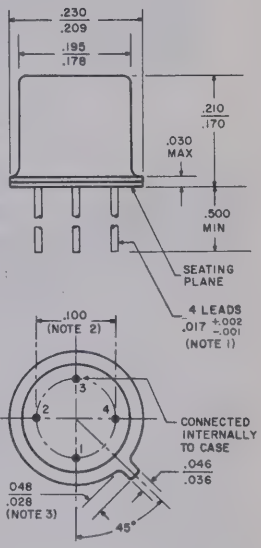
bsolute maximum ratings:[1] (25°C) (unless otherwise specified)

	3N81	3N82	
Voltage			
Anode to cathode forward and reverse	65	100	volts
Anode gate to anode reverse	65	100	volts
Cathode gate to cathode reverse	5	5	volts
Total Current			
Continuous DC forward[2]	200	200	ma
Peak recurrent forward ($T_A = 100°C$, 100 μsec. pulse width, 1% duty cycle)	1.0	1.0	amps
Peak non-recurrent forward (10 μsec. pulse width)	5.0	5.0	amps
Gate Current (Forward Bias)			
Continuous DC anode gate	100[2]	100[2]	ma
Peak anode gate ($T_A = 100°C$, 100 μsec. pulse width, 1% duty cycle)	200	200	ma
Peak cathode gate ($T_A = 100°C$, 100 μsec. pulse width, 1% duty cycle)	500	500	ma
Continuous DC cathode gate	20	20	ma
Dissipation			
Total power[2]	400	400	mw
Cathode gate power[2]	100	100	mw
Temperature			
Operating junction	−65 to +150		°C
Storage	−65 to +200		°C

OTE 1: Symbols and nomenclature are defined below.

OTE 2: Derate currents and power linearly to 150°C, the maximum rated temperature. The absolute maximum rating at any given temperature shall be in terms of the more conservative of the two parameters, i.e. current or power.

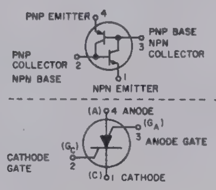
DIMENSIONS WITHIN
JEDEC OUTLINE TO-18
EXCEPT FOR
LEAD CONFIGURATION


.230
.209
.195
.178
.210
.170
.030
MAX
.500
MIN
SEATING
PLANE
4 LEADS
.017 +.002 −.001
(NOTE 1)
.100
(NOTE 2)
3
2
4
1
CONNECTED
INTERNALLY
TO CASE
.046
.036
048
.028
(NOTE 3)
45°

NOTE 1: Lead diameter is controlled in the zone between .050 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

NOTE 2: Leads having maximum diameter (.019) measured in gaging plane .054 + .001 − .000 below the seating plane of the device shall be within .007 of true position relative to a maximum width tab.

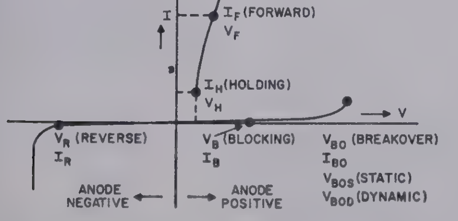
NOTE 3: Measured from max. diameter of the actual device.


PNP EMITTER 4
PNP BASE
NPN
COLLECTOR
3
PNP
COLLECTOR 2
NPN BASE
1
NPN EMITTER
(A) 4 ANODE
(G_A)
3 ANODE GATE
(G_C)
CATHODE
GATE
2
(C) 1 CATHODE

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

definition of terms used in scs specifications

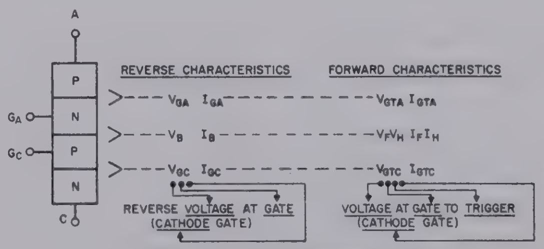
PNPN devices available at present do not have a common nomenclature. In part, this is due to their different construction and varied applications. SCS nomenclature permits the reverse characteristics of all three junctions to be specifed. The anode forward characteristics and gate triggering characteristics can also be specified fully. The principles used in assigning symbols are illustrated below, and with outline drawing above.



ANODE TO CATHODE CHARACTERISTICS

NOTE —ABSENCE OF G INDENTIFIES ANODE TO CATHODE SYMBOLS. DOT IDENTIFIES OPERATING POINT. BRACKETS INDICATE MEANING OF SUBSCRIPT LETTER.

FIG. 1


A
P
N
P
N
C
G_A
G_C
REVERSE CHARACTERISTICS
FORWARD CHARACTERISTICS
V_{GA} I_{GA}
V_{GTA} I_{GTA}
V_B I_B
$V_F V_H$ $I_F I_H$
V_{GC} I_{GC}
V_{GTC} I_{GTC}
REVERSE VOLTAGE AT GATE (CATHODE GATE)
VOLTAGE AT GATE TO TRIGGER (CATHODE GATE)

NOTE: G IDENTIFIES GATE SYMBOLS. LAST LETTER (A OR C) MAY BE DROPPED IF NO AMBIGUITY RESULTS IN SPECIFIC CHARACTERIZATION. F MEANS "FORWARD" AND T MEANS "TRIGGER"

FIG. 2

SCS CHARACTERIZATION

electrical characteristics:(1)

	Symbol(1)	Temp.	3N81	3N82		Typical Curves Fig. #
CUTOFF CHARACTERISTICS						
Forward Blocking Current ($R_{GC} = 10K$, $V_{AC} =$ Rated Voltage)	$I_{B\ max}$	@ 25°C	1.0		μa max	14
		@ 150°C	20		μa max	
Reverse Blocking Current ($R_{GC} = 10K$, $V_{CA} =$ Rated Voltage)	$I_{R\ max}$	@ 25°C	1.0		μa max	20
		@ 150°C	20		μa max	
Cathode Gate Reverse Cutoff Current (at Rated Voltage)	I_{GC}	@ 25°C	20		μa max	
Anode Gate Reverse Cutoff Current (at Rated Voltage)	I_{GA}	@ 25°C	1.0		μa max	
CONDUCTING CHARACTERISTICS						
Forward Voltage (at 200 ma Anode current $R_{GC} = 10K$)	$V_{F\ max}$	@ 25°C	2.0	2.0	V max	15, 16
		@ −65°C	2.5	2.5	V max	
Holding Current ($R_{GC} = 10K$)	$I_{H\ max}$	@ 25°C	1.5	1.5	ma max	11, 12, 13
		@ −65°C	6.0	6.0	ma max	
Saturation Voltage (G_A to C) ($I_{GC} = 5ma$, $I_{GA} = 50ma$, $I_A = 0$)	$V_{CEsat\ NPN}$	@ 25°C	2.0	2.0	V max	22, 23, 25
TRIGGERING CHARACTERISTICS						
Cathode Gate Current to Trigger (I_{GTC} from current source, $V_{AC} = 40V$, $R_A = 800\Omega$)	$I_{GTC\ max}$	@ 25°C	1.0	1.0	μa max	4
		@ −65°C	50	50	μa max	
Cathode Gate Voltage to Trigger ($V_{AC} = 40V$, $R_A = 800\Omega$, $R_{GC} = 10K$, $R_{GA} = \infty$, I_{GTC} from current source)	$V_{GTC\ max}$	@ 25°C	.65	.65	V max	5
		@ −65°C	1.0	1.0	V max	
	$V_{GTC\ min}$	@ 25°C	0.4	0.4	V min	
		@ 150°C	0.15	0.15	V min	
Anode Gate Current to Trigger (I_{GTA} from current source, $V_{AC} = 40V$, $R_C = 800\Omega$, $R_{GC} = 10K$)	$I_{GTA\ max}$	@ 25°C	1.0	1.0	ma max	3
		@ −65°C	3.0	3.0	ma max	
Anode Gate Voltage to Trigger (I_{GTA} from current source, $V_{AC} = 40V$, $R_C = 800\Omega$, $R_{GC} = 10K$, $R_{GA} = 1K$)	$V_{GTA\ max}$	@ 25°C	0.8	0.8	V max	6
		@ −65°C	1.0	1.0	V max	
	$V_{GTA\ min}$	@ 25°C	0.4	0.4	V min	
		@ 150°C	0.2	0.2	V min	
TRANSIENT CHARACTERISTICS						
Turn-On Time ($V_{AC} = 20V$, $I_A = 100$ ma, $I_{GC} = 100\ \mu a$) (See circuits Fig. 9 and 10)	$t_{on\ max}$	@ 25°C	1.5	1.5	μs max	7, 8
		@ −65°C	2.0	2.0	μs max	
Recovery Time ($V_{AC} = 20V$, $I_A = 100ma$, $R_{GC} = 10K$) (See circuit Fig. 17)	$t_{rec\ max}$	@ 25°C	15	15	μs max	18, 19
		@ 150°C	25	25	μs max	
Collector Capacitance Voltage Gate to Gate = 20V	$C_{ob\ max}$	@ 25°C	15	15	pf	26
Rate of Rise of Forward Blocking Voltage	dv/dt max	@ 25°C	See Note 5		V/μs max	

NOTE 3: The transistor characterization is essentially a restatement of the SCS characterization and is meant to facilitate using the SCS as a complementary PNP-NPN integrated transistor pair.

NOTE 4: The [±] sign indicates that the PNP and NPN transistors require opposite polarites as identified by the test conditions.

NOTE 5: The dv/dt rating is unlimited when the anode gate lead is returne to the anode voltage through a current limiting resistor. An ex ample of this technique is shown in Figure 33 .

TRANSISTOR CHARACTERIZATION(3)

electrical characteristics: (25°C) (unless otherwise specified)

		3N81				3N82					Typical Curves
		PNP[1]		NPN[1]		PNP[1]		NPN[1]			
DC CHARACTERISTICS		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.		Fig. #
Collector to Base Breakdown Voltage ($I_C = [\pm]^{(4)}\ 1.0\mu a$, $I_E = 0$)	BV_{CBO}	−65		65		−100		100		volts	
Emitter to Base Breakdown Voltage ($I_C = 0$, I_E [NPN] $= 20\mu a$, I_E [PNP] $= -1\mu a$)	BV_{EBO}	−65		5		−100		5		volts	
Collector Saturation Voltage ($I_C = 50ma$, $I_B = 5ma$)	$V_{CE(SAT)}$				2				2	volts	22, 23, 25
Base Saturation Voltage ($I_B = 1ma$, $I_C = 5ma$)	$V_{BE(SAT)}$				0.9				0.9	volts	
Forward Current Transfer Ratio ($V_{CE} = 0.5V$, $I_C = 3ma$)	h_{FE}			15				15			21
Forward Current Transfer Ratio ($V_{CE} = -2.0V$, $I_C = -1ma$)	h_{FE}	0.1				0.1					24
CUTOFF CHARACTERISTICS (3N81 at 65 volts; 3N82 at 100 volts)											
Collector to Emitter Leakage Current ($T_A = 150°C$)	I_{CEO}		−20				−20			μa	
($R_B = 10K\ \Omega$ $T_A = 150°C$)	I_{CER}				20				20	μa	
Collector to Base Leakage Current ($I_E = 0$, $T_A = 150°C$)	I_{CBO}		−20		20		−20		20	μa	
Emitter to Base Leakage Current ($I_C = 0$, $T_A = 150°C$)	I_{EBO}		−20				−20			μa	
($V_{EB} = 5Vdc$, $I_C = 0$)	I_{EBO}				20				20	μa	
TRANSIENT CHARACTERISTICS											
Collector Capacitance ($I_E = 0$, $V_{CB} = [\pm]^{(4)}\ 20V$)	C_{ob}		15		15		15		15	pf	26
Gain Bandwidth Product	f_T			75				75		mc	

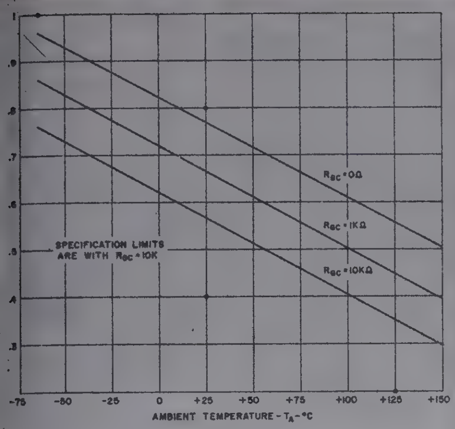


FIG. 6

turn-on time

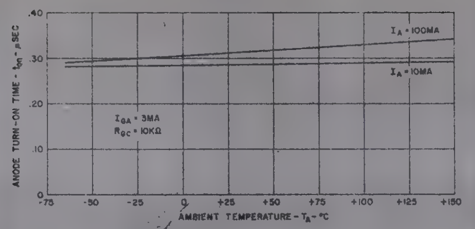


FIG. 7

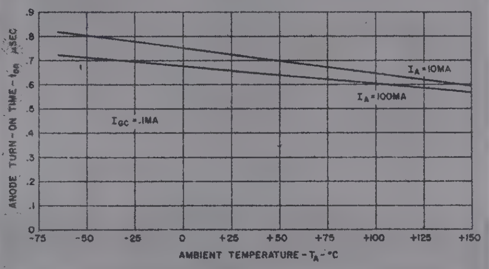
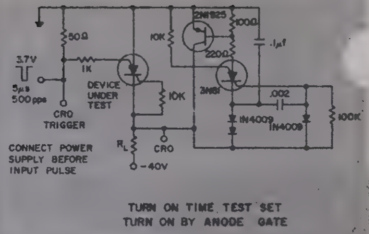
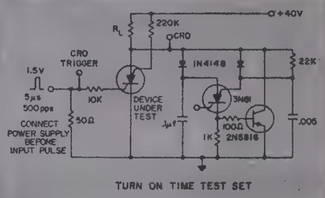


FIG. 8


50Ω
3.7V
5μs
500pps
1K
CRO TRIGGER
DEVICE UNDER TEST
10K
10K
2N1925
100Ω
220Ω
.1μf
3N81
.002
1N4009
1N4009
100K
R_L
CRO
-40V
CONNECT POWER SUPPLY BEFORE INPUT PULSE

TURN ON TIME TEST SET
TURN ON BY ANODE GATE

FIG. 9


+40V
R_L
220K
CRO
CRO TRIGGER
1.5V
5μs
500pps
10K
1N4148
22K
DEVICE UNDER TEST
3N81
.1μf
.005
50Ω
100Ω
1K
2N5816
CONNECT POWER SUPPLY BEFORE INPUT PULSE

TURN ON TIME TEST SET

FIG. 10

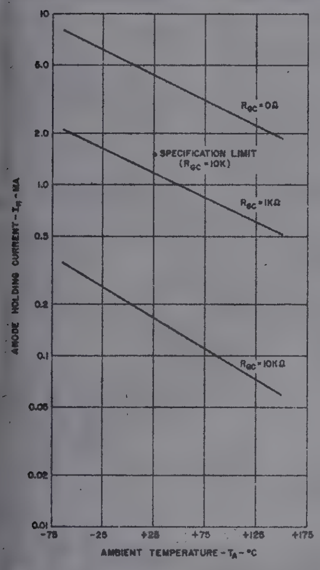


FIG. 11

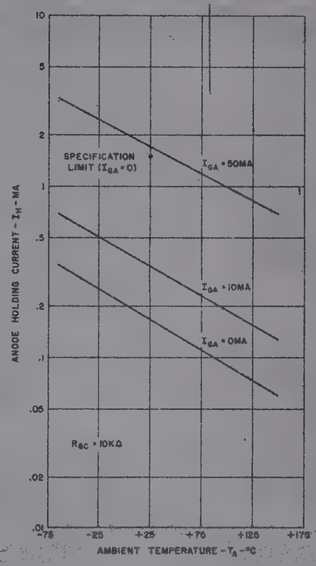


FIG. 12

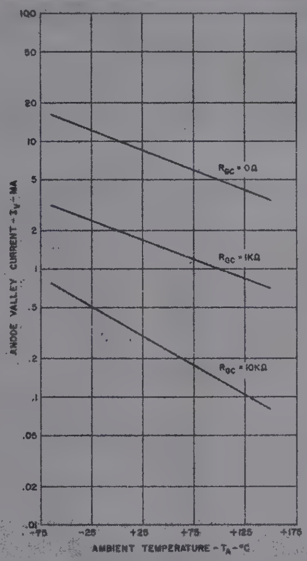


FIG. 13

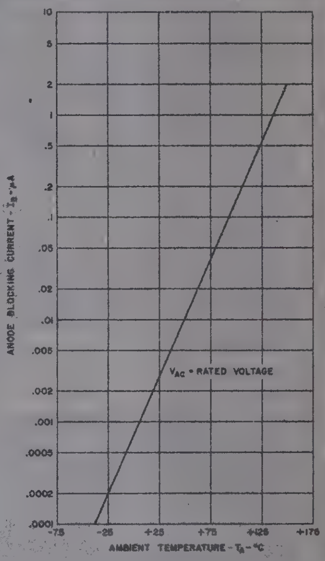


FIG. 14

forward characteristics

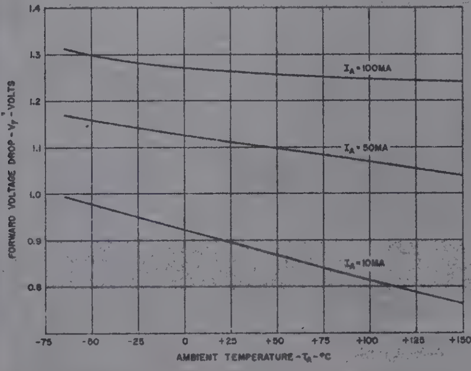


FIG. 15

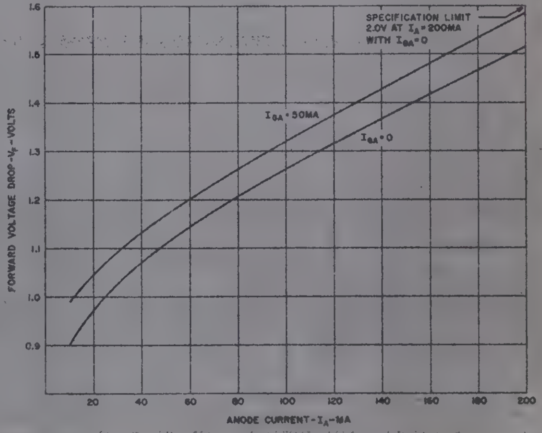
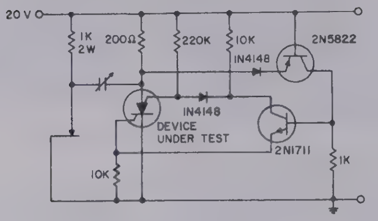


FIG. 16

reverse characteristics


20 V
1K
2W
200Ω
220K
10K
IN4148
2N5822
IN4148
DEVICE
UNDER TEST
2N1711
10K
1K

RECOVERY TEST SET

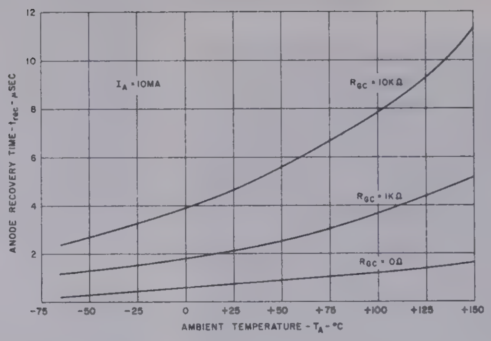


FIG. 18

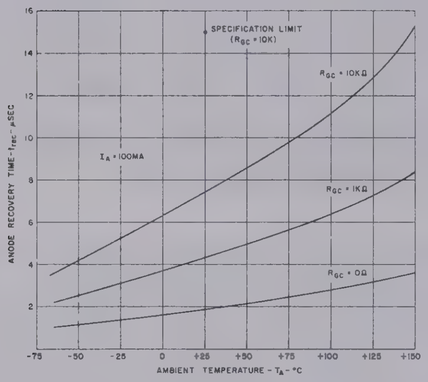


FIG. 19

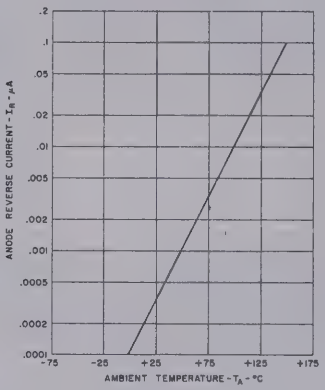


FIG. 20

triggering characteristics

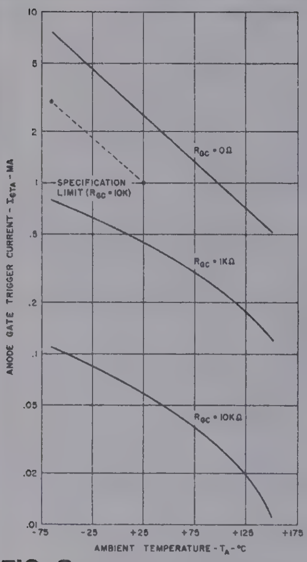


FIG. 3

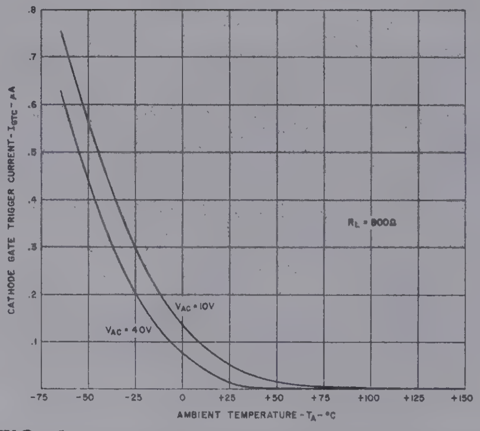


FIG. 4

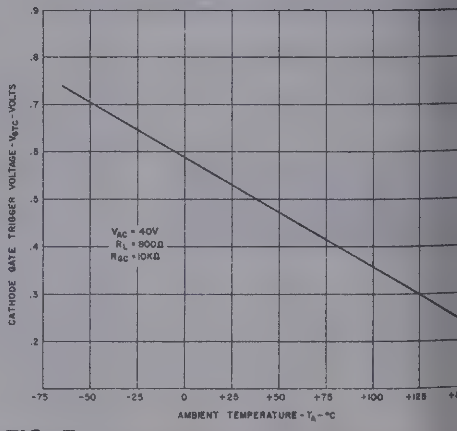


FIG. 5

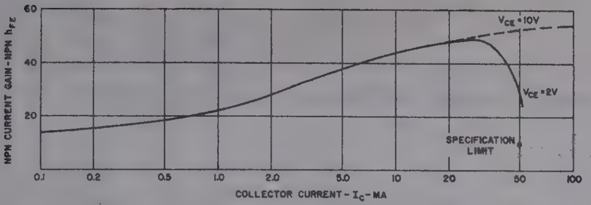


FIG. 21

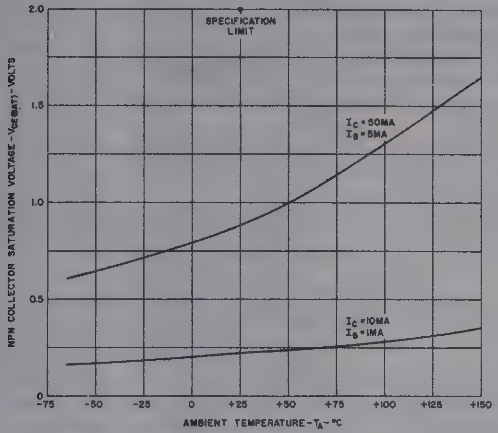


FIG. 22

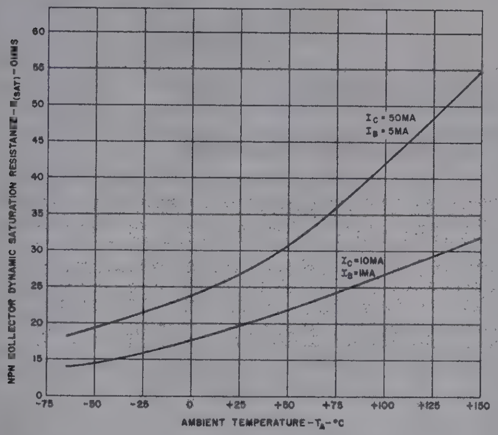


FIG. 23

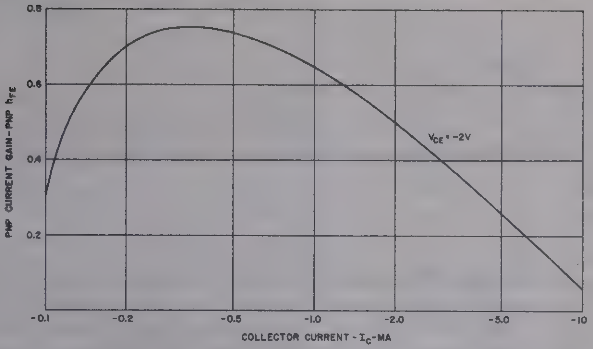


FIG. 24

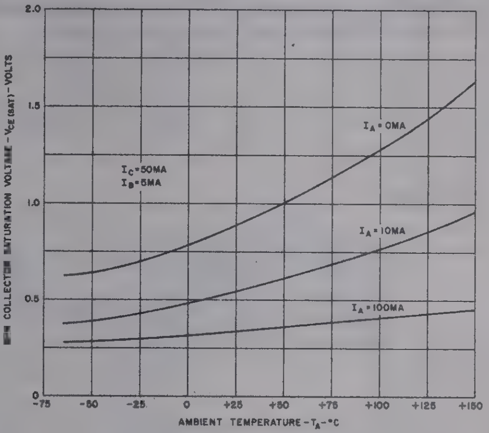


FIG. 25

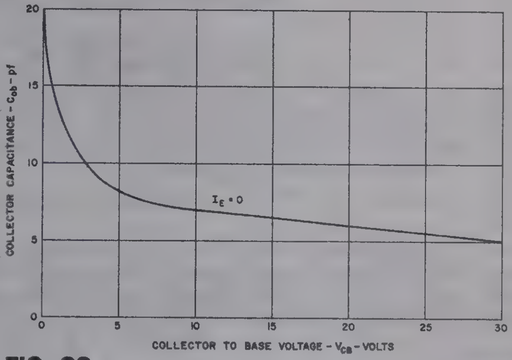
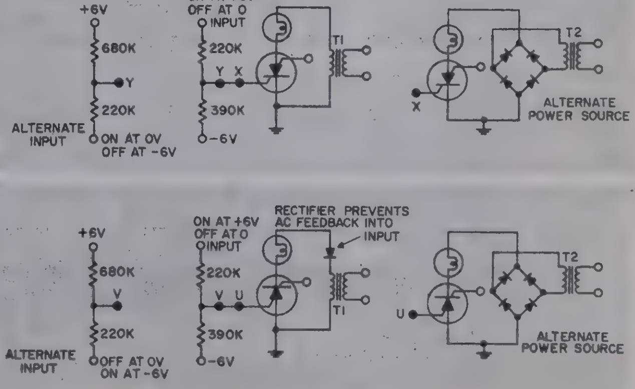


FIG. 26

APPLICATIONS

LAMP	RATING		SCS	SEC. VOLTS RMS	
	VOLTS	AMPS		T1*	T2
24	24	.035	3N81	34	24
327	28	.04	3N81	40	28
330	14	.08	3N81	20	14
344	10	.015	3N81	14	10
1829	28	.07	3N81	40	28

* INCREASED VOLTAGE GIVES NORMAL BRIGHTNESS IN HALF WAVE CIRCUIT


+6V
680K
Y
220K
ALTERNATE INPUT
ON AT 0V
OFF AT -6V
ON AT +6V
OFF AT 0
INPUT
220K
Y
X
390K
-6V
T1
X
T2
ALTERNATE POWER SOURCE
+6V
680K
V
220K
ALTERNATE INPUT
OFF AT 0V
ON AT -6V
ON AT +6V
OFF AT 0
INPUT
220K
V
U
390K
-6V
RECTIFIER PREVENTS AC FEEDBACK INTO INPUT
T1
U
T2
ALTERNATE POWER SOURCE

INCANDESCENT LAMP DRIVERS

FIG. 27

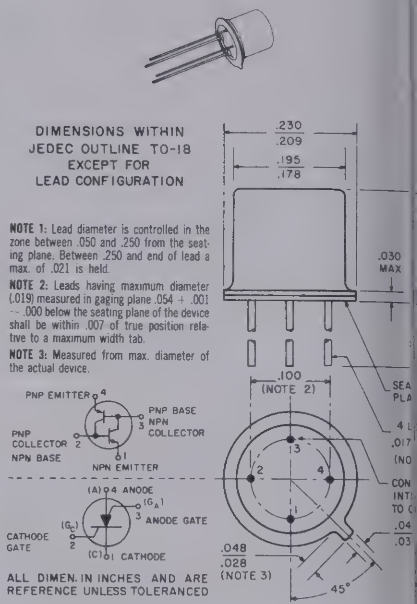
Silicon
Controlled Switch

PNPN

3N83

The General Electric Type 3N83 is PLANAR PNPN switch with separate leads provided to each of its four semiconductor regions to form the equivalent of an integrated PNP-NPN complementary transistor pair. It has been characterized as a low-cost, latching-type driver for Nixie tubes, alphanumeric display tubes and neon lamps. As such, it is ideally suited for very simple counter circuitry and applicatins requiring gate turn-off as well as gate turn-on. Special features of the 3N83 neon driver include its ability to operate independently of the changes in ionization and deionization time of the lamp and its total freedom from inadvertant triggering caused by line transients (dv/dt).

The 3N83 is housed in a four-leaded TO-18 size package. All junctions are completely oxide passivated to provide maximum long term reliability. Other PNPN devices in this series provide characterization suitable for a wide variety of switching functions and are described in General Electric Publications 65.16, 65.18 and 65.19.


DIMENSIONS WITHIN
JEDEC OUTLINE TO-18
EXCEPT FOR
LEAD CONFIGURATION
.230
.209
.195
.178
.030
MAX
.100
(NOTE 2)
SEA
PLA
4 L
.017
(NO
CON
INT
TO C
.04
.03
.048
.028
(NOTE 3)
45°
3
2
4
1
PNP EMITTER 4
PNP BASE
NPN
COLLECTOR 3
PNP
COLLECTOR 2
NPN BASE
1
NPN EMITTER
(A) 4 ANODE
(G_A)
3 ANODE GATE
(G_C)
CATHODE
GATE 2
(C) 1 CATHODE
ALL DIMEN. IN INCHES AND ARE
REFERENCE UNLESS TOLERANCED

NOTE 1: Lead diameter is controlled in the zone between .050 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

NOTE 2: Leads having maximum diameter (.019) measured in gaging plane .054 + .001 − .000 below the seating plane of the device shall be within .007 of true position relative to a maximum width tab.

NOTE 3: Measured from max. diameter of the actual device.

Features:

- Latching driver for neon lamps
- Design parameters specified at worst-case temperatures
- Gate turn-on and turn-off
- Eliminates lamp ionization and deionization-time problems
- All planar, completely oxide passivated
- TO-18 size

PNPN NEON DRIVER CHARACTERIZATION

THEORY OF OPERATION

Considering a PNPN device as an integrated circuit in which an NPN transistor drives the lamp load and a PNP transistor provides the NPN with latching characteristics results in a family of outstanding driver circuits.

Figure 1 compares the SCR and integrated circuit symbols of a PNPN.

Figure 2 illustrates operation in a typical circuit. Initially, assume the NPN transistor is reverse biased. Its collector voltage (pin 3) will be at the collector supply voltage minus the lamp extinction voltage. Typically this will be 50 volts, which reverse biases the PNP transistor. The lamp is extinquished.

Applying a positive trigger pulse saturates the NPN transistor lowering its collector voltage within 1.0 volt of ground. This forward biases the PNP transistor turning it on and supplying additional base drive to the NPN transistor. The 3N83 is characterized so that the NPN transistor remains saturated even after the triggering input is removed. The minimum PNP emitter current to guarantee this is defined as the holding current (I_H).

To turn off the 3N83 it is only necessary to interrupt the PNP emitter current momentarily. This removes the NPN base drive allowing the collector to rise to the lamp extinction voltage reverse biasing the PNP. The 3N83 is also characterized to turn off by a negative pulse at the NPN base. This is equivalent to gate turn-off of an SCR. The negative pulse diverts all the PNP collector current to reverse bias the NPN thus turning off the driver.

The advantages of this circuit include (a) latching characteristics (b) no rate effect problems because the PNP emitter is normally reverse biased (c) spikes and ripple on either power supply will not turn on the driver accidentally (d) turn-off is readily achieved in the low voltage, low power PNP emitter or NPN base circuits (e) lamp ionization and deionization characteristics do not affect the circuit (f) dissipation is low since I_H is generated from a low voltage supply and (g) the circuit is low cost.

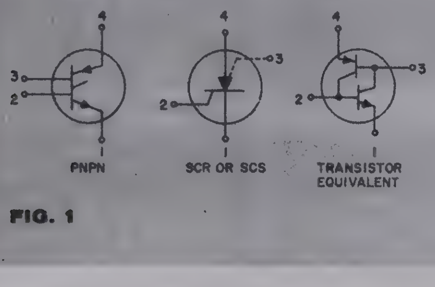
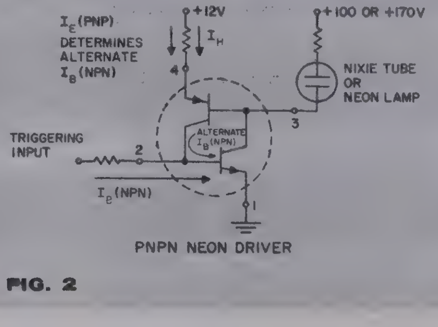

4
3
2
1
PNPN
4
3
2
1
SCR OR SCS
4
3
2
1
TRANSISTOR
EQUIVALENT

FIG. 1


I_E (PNP)
DETERMINES
ALTERNATE
I_B (NPN)
+12V
I_H
+100 OR +170V
NIXIE TUBE
OR
NEON LAMP
4
3
ALTERNATE
I_B (NPN)
TRIGGERING
INPUT
2
I_B (NPN)
1

PNPN NEON DRIVER

FIG. 2

3N83

absolute maximum ratings: (25°C) (unless otherwise noted)

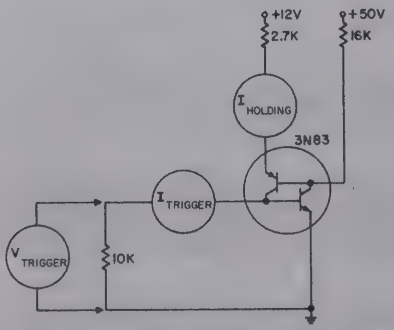
		PNP[1]	NPN[1]	
Voltages				
Collector to Emitter (R = 10K)	V_{CER}	−70	70	volts
Collector to Base	V_{CBO}	−70	70	volts
Emitter to Base	V_{EBO}	−70	5	volts
Emitter Current				
Continuous DC[2]	I_E	50	−50	ma
Peak Recurrent (T_A = 100°C, 100 μsec. pulse width, 1% duty cycle)	$I_{E(PEAK)}$	0.1	−0.1	amp
Peak Non-Recurrent (10 μsec. pulse width)	$I_{E(PEAK)}$	0.5	−0.5	amp
Collector Current[3]				
Continuous DC[2]	I_C	−10	25	ma
Peak Recurrent (T_A = 100°C, 100 μsec. pulse width, 1% duty cycle)	$I_{C(PEAK)}$	−50	50	ma
Dissipation				
Total Power[2]	P_T	200	200	mw
Temperature				
Operating Junction	T_J	−55 to +125		°C
Storage	T_{STG}	−65 to +200		°C

electrical characteristics: (25°C) (unless otherwise specified)

		PNP[2]		NPN[2]		
DC CHARACTERISTICS		Min.	Max.	Min.	Max.	
Collector to Emitter Breakdown Voltage						
(I_C = 0.1 μa)	BV_{CEO}	−70				volts
(I_C = 0.1 μa, R = 10 K Ω)	BV_{CER}			70		volts
Collector to Base Breakdown Voltage (I_C = [±][4] 0.1 μa, I_E = 0)	BV_{CBO}	−70		70		volts
Emitter to Base Breakdown Voltage (I_C = 0, I_E [NPN] = 20 μa, I_E [PNP] = −1 μa)	BV_{EBO}	−70		5		volts
Collector Saturation Voltage (I_C = 25 ma, I_B = 2.5 ma)	$V_{CE(SAT)}$[5]				1.2	volts
Base Saturation Voltage (I_B = 1 ma, I_C = 5 ma)	$V_{BE(SAT)}$				0.9	volts
Forward Current Transfer Ratio (V_{CE} = 0.5 V, I_C = 3 ma)	h_{FE}			15		
(V_{CE} = −2.0V, I_C = 1.0 ma)	h_{FE}	0.1				
CUTOFF CHARACTERISTICS						
Collector to Emitter Leakage Current (V_{CE} = −70 Vdc, T_A = 125°C)	I_{CEO}		−20			μa
(V_{CE} = 70 Vdc, R_B = 10K Ω, T_A = 125°C)	I_{CER}				20	μa
Collector to Base Leakage Current (V_{CB} = [±][4] 70 Vdc, I_E = 0, T_A = 125°C)	I_{CBO}		−20		20	μa
Emitter to Base Leakage Current (V_{EB} = −70 Vdc, I_C = 0, T_A = 125°C)	I_{EBO}		−20			μa
(V_{EB} = 5 Vdc, I_C = 0)	I_{EBO}				20	μa
COMBINED DEVICE CHARACTERISTICS		Min.		Max.		
Collector Capacitance[6] (I_E = 0, V_{CB} = 20 Vdc)	C_{ob}			20		pf
Forward Voltage (I_E = 50 ma)	V_F			1.4		volts
(I_E = 50 ma, T_A = −55°C)	V_F			1.9		volts
Holding Current (See test circuit below)	I_H			4.0		ma
Current to Trigger (See test circuit below)	$I_{TRIGGER}$			150		μa
Voltage to Trigger (See test circuit below, T_A = −55°C)	$V_{TRIGGER}$			1.1		volts
(See test circuit below, T_A = 125°C)	$V_{TRIGGER}$	0.2				volts
Turn-On Time (See test circuit below, I_B [NPN] = 0.4 ma)	t_{on}			1.5		μsec.
Turn-Off Time (See test circuit below, V_F = 0 during recovery)	t_{off}			8		μsec.
(See test circuit below, T_A = 125°C)	t_{off}			15		μsec.

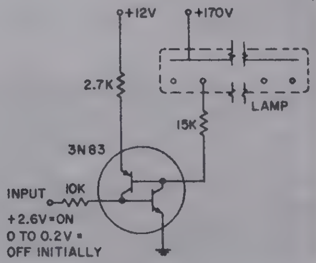
notes:

1. All individual transistor characteristics are given with the emitter of the complementary transistor open; e.g., for $V_{CB(SAT)}$ (NPN): I_C (NPN) = 25 ma, I_B (NPN) = 2.5 ma, I_E (PNP) = 0.
2. Derate current and power linearly to zero at 125°C. The absolute maximum rating at any given temperature shall be in terms of the more conservative of the two parameters, i.e., current or power.
3. The collector current of the PNP is identical to the base current of the NPN and the collector current of the NPN is identical to the base current of the PNP. (See outline drawing.)
4. ± indicates that appropriate polarity should be chosen for transistor under test.
5. $V_{CB(SAT)(NPN)}$ is modulated by the PNP emitter current.
6. Collector capacitance is measured between terminals 2 and 3. (See outline drawing.)



CIRCUIT DEFINING TEST CONDITIONS

FIG. 3



TYPICAL LATCHING LAMP DRIVER

FIG. 4

3N83

dc characteristics

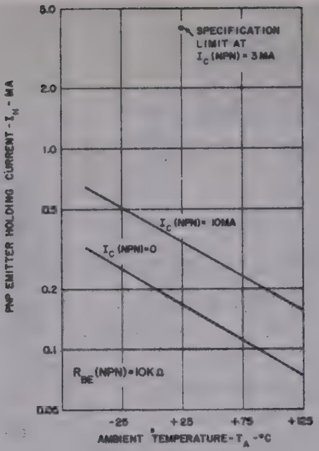


FIG. 5

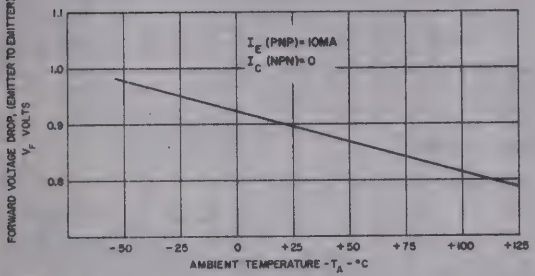


FIG. 6

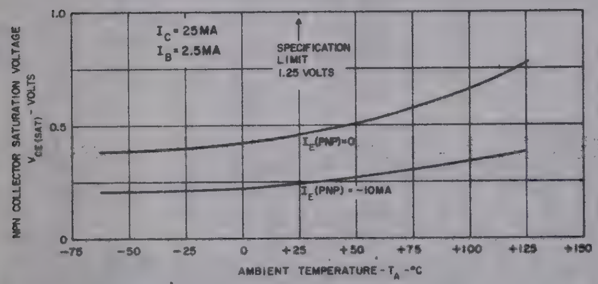


FIG. 7

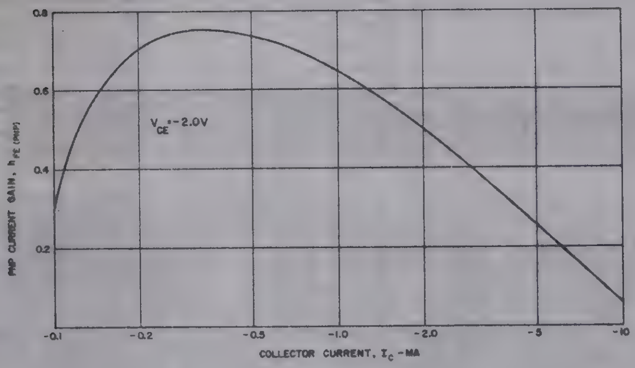


FIG. 8

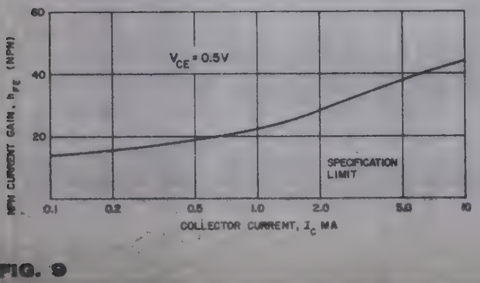


FIG. 9

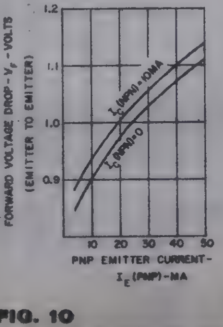


FIG. 10

dynamic characteristics

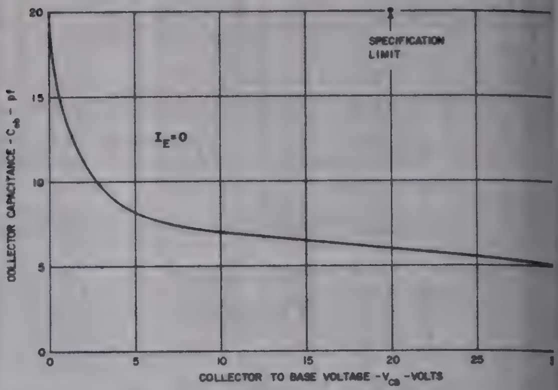


FIG. 11

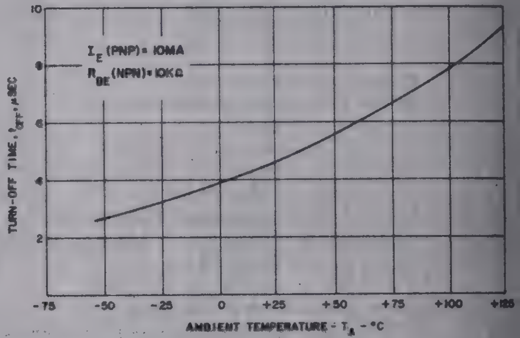


FIG. 12

triggering characteristics

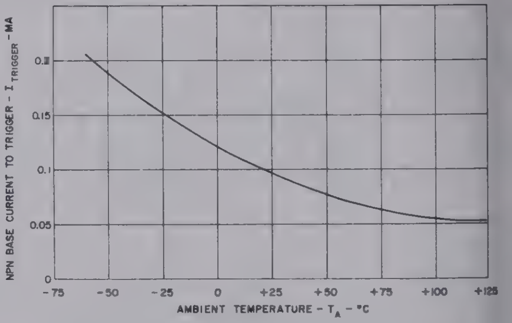


FIG. 13

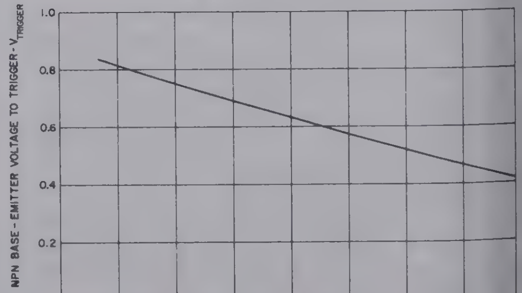
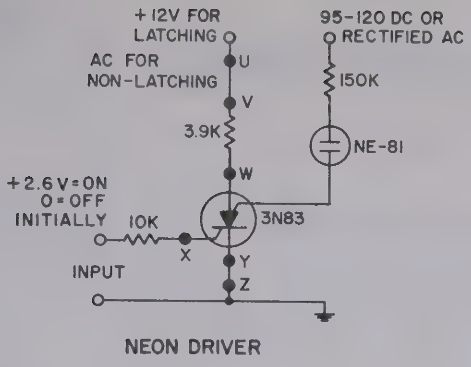
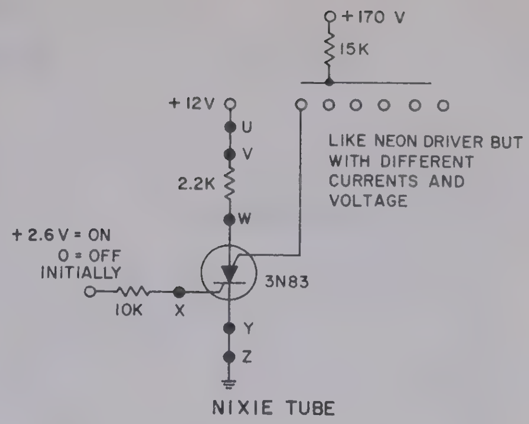


FIG. 14


+12V FOR
LATCHING
AC FOR
NON-LATCHING
95-120 DC OR
RECTIFIED AC
U
V
150K
3.9K
NE-81
W
+2.6V=ON
0=OFF
INITIALLY
10K
3N83
X
Y
INPUT
Z

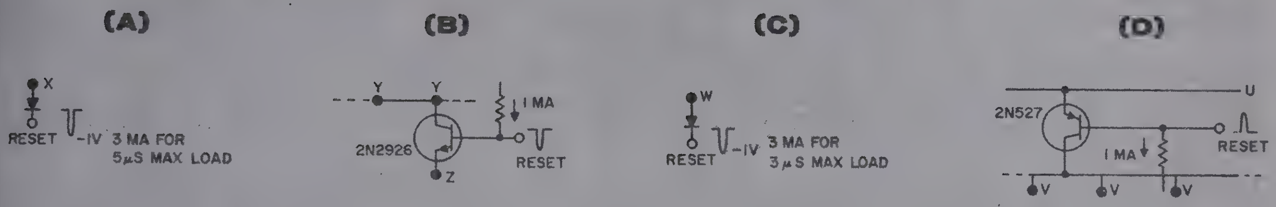
NEON DRIVER

FIG. 15


+170 V
15K
+12V
U
V
LIKE NEON DRIVER BUT
WITH DIFFERENT
CURRENTS AND
VOLTAGE
2.2K
W
+2.6V = ON
0 = OFF
INITIALLY
3N83
10K
X
Y
Z

NIXIE TUBE

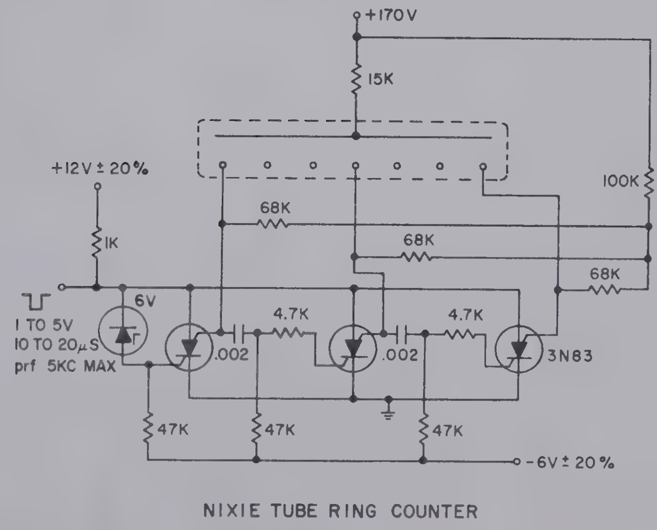
FIG. 16


(A)
(B)
(C)
(D)
X
RESET
-1V
3 MA FOR
5μS MAX LOAD
Y
Y
1 MA
2N2926
RESET
Z
W
RESET
-1V
3 MA FOR
3μS MAX LOAD
U
2N527
RESET
1 MA
V
V
V

reset methods

Four common reset methods are illustrated. The driver circuit is modified by connecting or inserting the turn-off circuitry to similarly lettered points. Method (A) reverse biases the NPN base. Method (B) illustrates that several stages can be turned off simultaneously by open circuiting the NPN emitter. Method (C) reverse biases the PNP emitter while method (D) open circuits one or more PNP emitters. In each case, rate effect problems are non-existent and no special care is required in shaping the reset waveforms.

FIG. 17


+170V
15K
+12V ± 20%
100K
68K
68K
68K
1K
6V
4.7K
4.7K
1 TO 5V
10 TO 20μS
prf 5KC MAX
.002
.002
3N83
47K
47K
47K
-6V ± 20%

NIXIE TUBE RING COUNTER

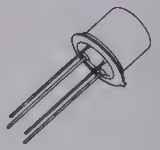
FIG. 18

Silicon
Controlled Switch

3N84,5

The General Electric Types 3N84 and 3N85 are PLANAR PNPN silicon controlled switches that feature an "extra lead" which completely eliminates rate effect (dv/dt) and voltage transient problems without compromising triggering sensitivity or transient response time. Unique fabrication processes based on planar oxide passivation have resulted in high reliability and uniformity at low cost. These devices are thoroughly characterized at temperature extremes to permit worst case circuit design.

The 3N84 and 3N85 are ideally suited for low-level SCR applications such as lamp and relay drivers, sensitive voltage-level detectors, bistable memory elements, binary counters, shift registers, ring counters, telemetry oscillators, time delay generators and pulse generators. These devices are housed in a four-leaded TO-18 size case and all junctions are completely oxide passivated. Other silicon controlled switches in this series provide characterizations suitable for a wide variety of low-level switching functions and are described in General Electric publications No. 65.16 and 65.17.

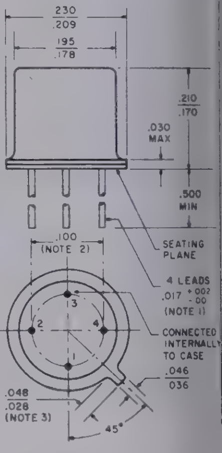


- **Fourth lead completely eliminates rate effects (dv/dt)**
- **Dynamic and static breakover voltages are equal**
- **40 and 100 volt ratings**
- **Characterized at temperature extremes**
- **Low cost**
- **TO-18 case**

absolute maximum ratings:[1] (25°C) (unless otherwise specified)

	3N84	3N85	
Voltage			
Anode to cathode forward and reverse	40	100	volts
Anode gate to anode reverse	40	100	volts
Cathode gate to cathode reverse	5	5	volts
Total Current			
Continuous DC forward[2]	175	175	ma
Peak recurrent forward ($T_A = 100°C$, 100 μsec. pulse width, 1% duty cycle)	0.5	0.5	amps
Peak non-recurrent forward (10 μsec. pulse width)	2.0	2.0	amps
Gate Current (Forward Bias)			
Continuous DC anode gate	10	10	ma
Peak anode gate ($T_A = 100°C$, 100 μsec. pulse width, 1% duty cycle)	10	10	ma
Peak cathode gate ($T_A = 100°C$, 100 μsec. pulse width, 1% duty cycle)	100	100	ma
Continuous DC cathode gate	10	10	ma
Dissipation			
Total power[2]	320	320	mw
Cathode gate power[2]	50	50	mw
Temperature			
Operating Junction	−55 to +125		°C
Storage	−65 to +200		°C

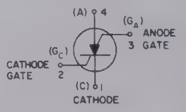
DIMENSIONS WITHIN
JEDEC OUTLINE TO-18
EXCEPT FOR
LEAD CONFIGURATION



NOTE 1: Lead diameter is controlled in the zone between .050 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held

NOTE 2: Leads having maximum diameter (.019) measured in gaging plane .054 .001 .000 below the seating plane of the device shall be within .007 of true position relative to a maximum width tab.

NOTE 3: Measured from max. diameter of the actual device



ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

electrical characteristics:[1]

	Symbol[1]	Temp.	3N84[3]	3N85[3]		Typical Curves Fig. #
CUTOFF CHARACTERISTICS						
Forward Blocking Current ($R_{GC} = 10K$, V_{AC} = Rated Voltage)	$I_{B\ max}$	@ 25°C @ 125°C	1.0 20		μa max μa max	12
Reverse Blocking Current ($R_{GC} = 10K$, V_{CA} = Rated Voltage)	$I_{R\ max}$	@ 25°C @ 125°C	1.0 20		μa max μa max	12
Cathode Gate Reverse Cutoff Current (at Rated Voltage)	I_{GC}	@ 25°C	20		μa max	
Anode Gate Reverse Cutoff Current (at Rated Voltage)	I_{GA}	@ 25°C	1.0		μa max	
CONDUCTING CHARACTERISTICS						
Forward Voltage (at 175ma Anode Current $R_{GC} = 10K$)	$V_{F\ max}$	@ 25°C @ −55°C	1.9 2.5	1.9 2.5	V max V max	6, 7
Holding Current ($R_{GC} = 10K$)	$I_{H\ max}$	@ 25°C @ −55°C	2.0 10	2.0 10	ma max ma max	8, 9, 11
TRIGGERING CHARACTERISTICS						
Cathode Gate Current to Trigger[3] (I_{GTC} from current source, $V_{AC} = 40V$, $R_A = 800\Omega$)	$I_{GTC\ max}$	@ 25°C @ −55°C	10 100	10 100	μa max μa max	13
Cathode Gate Voltage to Trigger[3] ($V_{AC} = 40V$, $R_A = 800\Omega$, $R_{GC} = 10K$, $R_{GA} = \infty$) I_{GTC} from current source)	$V_{GTC\ max}$	@ 25°C @ −55°C	.65 1.0	.65 1.0	V max V max	14
	$V_{GTC\ min}$	@ 25°C @ 125°C	0.4 0.2	0.4 0.2	V min V min	
TRANSIENT CHARACTERISTICS[3]						
Turn-On Time ($V_{AC} = 20V$, $I_A = 100ma$, $I_{GC} = 100$ μa)	$t_{on\ max}$	@ 25°C @ −55°C	1.5 2.0	1.5 2.0	μs max μs max	3, 10
Recovery Time[3] ($V_{AC} = 20V$, $I_A = 100ma$, $R_{GC} = 10K$)	$t_{rec\ max}$	@ 25°C @ 125°C	15 25	15 25	μs max μs max	4, 5, 15, 16
Rate of Rise of Forward Blocking Voltage	dv/dt max	@ 25°C	See Note 4		V/μs max	

NOTE 1: Symbols and nomenclature are defined at the top of the next page.

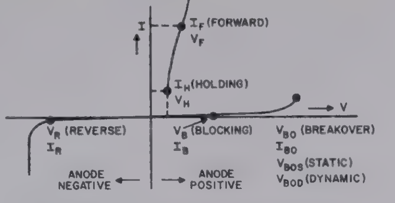
NOTE 2: Derate currents and power linearly to 125°C. The absolute maximum rating at any given temperature shall be in terms of the more conservative of the two parameters, i.e. current or power.

NOTE 3: The 3N84 and 3N85 test conditions include a 220K resistor added from the anode gate to the anode supply voltage. I_R is the only exception, the 220K resistor being deleted.

NOTE 4: The dv/dt rating is unlimited when the anode gate lead is returned to the anode voltage through a current limiting resistor. An example of this technique is shown in Figure 23.

efinition of terms used in scs specifications

PNPN devices available at present do not have a common nomenclature. In part, this is due to their different construction and varied applications. SCS nomenclature permits the reverse characteristics of all three junctions to be specified. The anode forward characteristic and gate triggering characteristics can also be specified fully. The principles used in assigning symbols are illustrated at right and with the outline drawing on previous page.

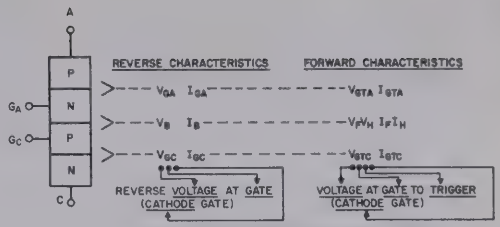


I
I_F (FORWARD)
V_F
I_H (HOLDING)
V_H
V
V_R (REVERSE)
I_R
V_B (BLOCKING)
I_B
V_{BO} (BREAKOVER)
I_{BO}
V_{BOS} (STATIC)
V_{BOD} (DYNAMIC)
ANODE NEGATIVE
ANODE POSITIVE

ANODE TO CATHODE CHARACTERISTICS

NOTE — ABSENCE OF G INDENTIFIES ANODE TO CATHODE SYMBOLS. DOT IDENTIFIES OPERATING POINT. BRACKETS INDICATE MEANING OF SUBSCRIPT LETTER.

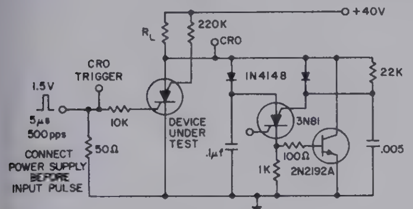
FIG. 1



A
P
N
P
N
C
G_A
G_C
REVERSE CHARACTERISTICS
FORWARD CHARACTERISTICS
V_{GA} I_{GA}
V_{GTA} I_{GTA}
V_B I_B
$V_F V_H$ $I_F I_H$
V_{GC} I_{GC}
V_{GTC} I_{GTC}
REVERSE VOLTAGE AT GATE (CATHODE GATE)
VOLTAGE AT GATE TO TRIGGER (CATHODE GATE)

NOTE: G IDENTIFIES GATE SYMBOLS. LAST LETTER (A OR C) MAY BE DROPPED IF NO AMBIGUITY RESULTS IN SPECIFIC CHARACTERIZATION. F MEANS "FORWARD" AND T MEANS "TRIGGER"

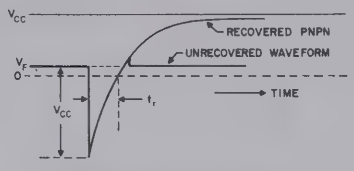
FIG. 2



+40V
R_L
220K
CRO
CRO TRIGGER
1.5V
5μs
500pps
10K
50Ω
DEVICE UNDER TEST
IN4148
22K
3N81
.1μf
100Ω
1K
2N2192A
.005
CONNECT POWER SUPPLY BEFORE INPUT PULSE

TURN ON TIME TEST SET

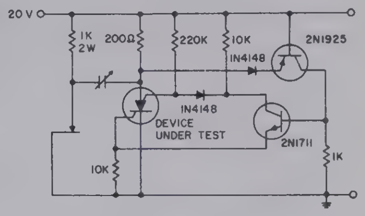
FIG. 3



V_{CC}
RECOVERED PNPN
UNRECOVERED WAVEFORM
V_F
0
V_{CC}
t_r
TIME

ANODE WAVEFORM DEFINING RECOVERY

FIG. 4

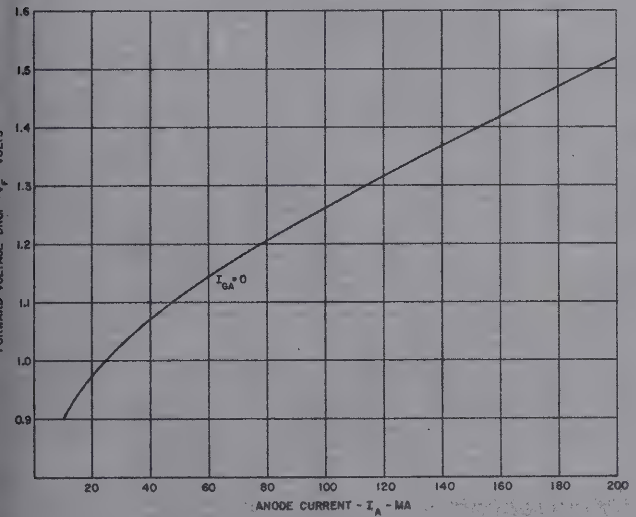


20 V
1K 2W
200Ω
220K
10K
2N1925
IN4148
IN4148
DEVICE UNDER TEST
2N1711
10K
1K

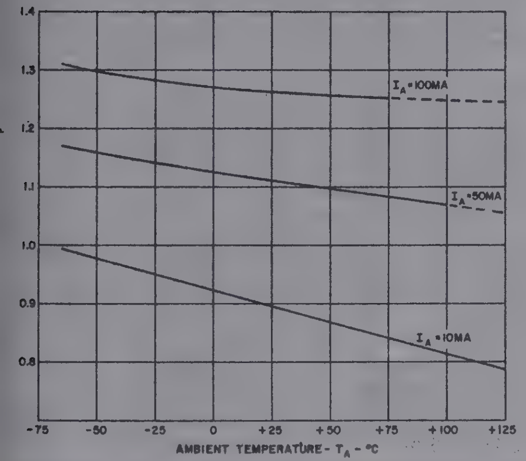
RECOVERY TEST SET

FIG. 5

orward voltage characteristics, V_f



IG. 6



IG. 7

holding current characteristics

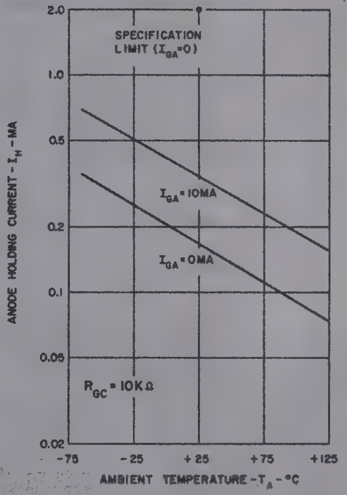


FIG. 8

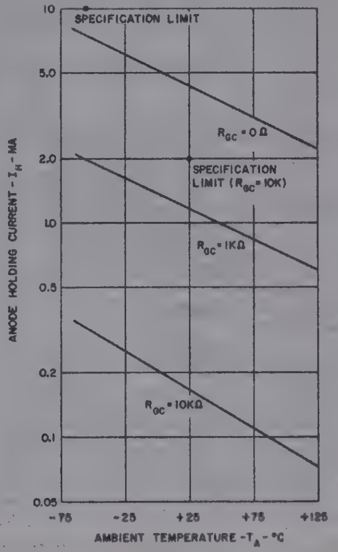


FIG. 9

turn-on time

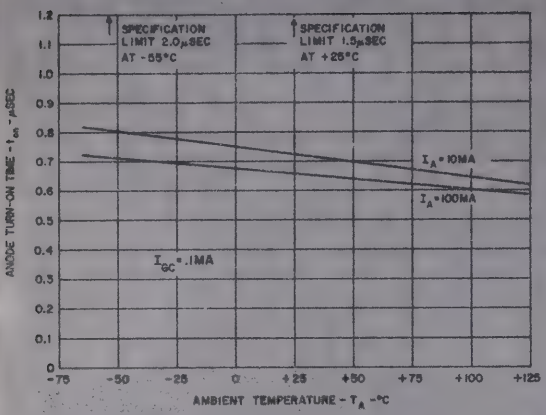


FIG. 10

valley current, i_V

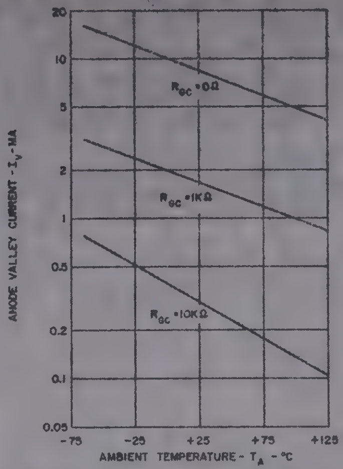


FIG. 11

forward and revers blocking current, i_B,

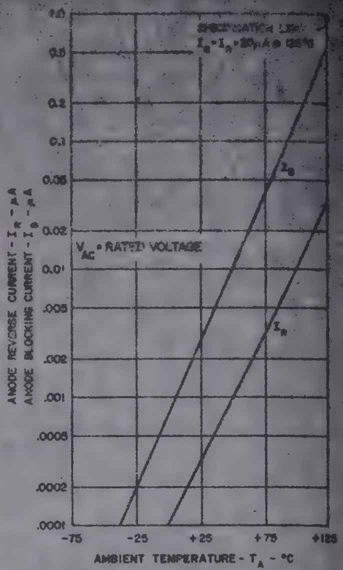


FIG. 12

triggering characteristics

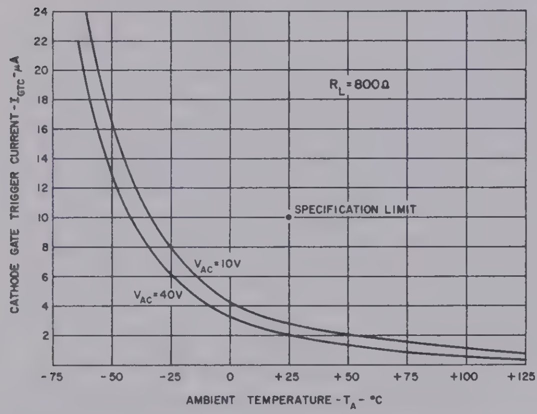


FIG. 13

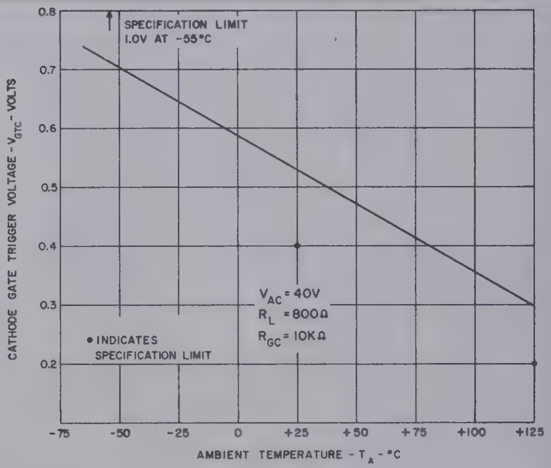


FIG. 14

recovery time

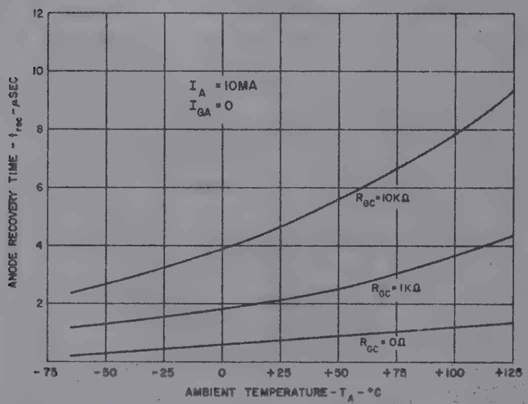


FIG. 15

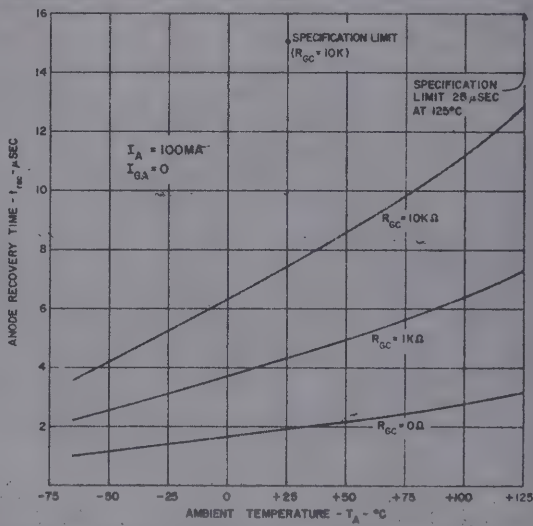
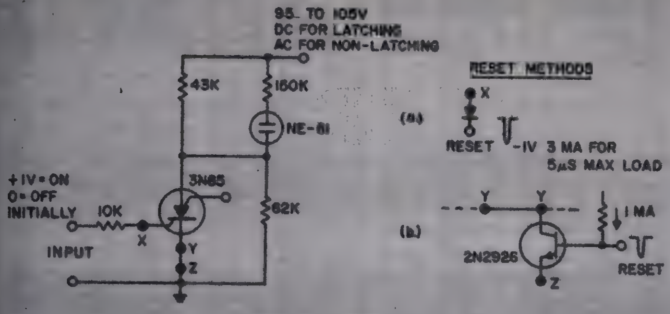


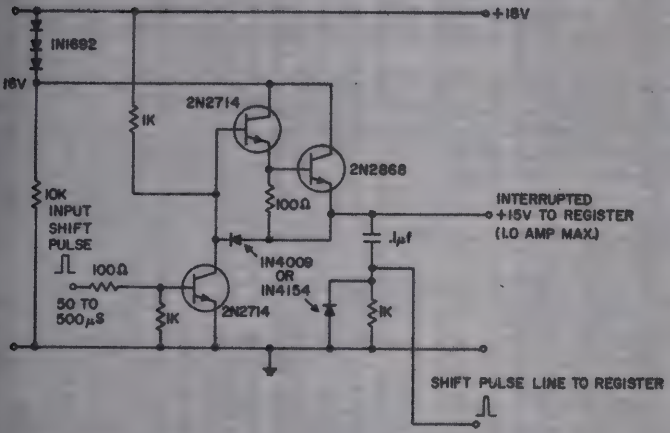
FIG. 16

APPLICATIONS


95 TO 105V
DC FOR LATCHING
AC FOR NON-LATCHING
43K
150K
NE-81
+1V = ON
0 = OFF
INITIALLY
10K
3N85
X
Y
Z
62K
INPUT
RESET METHODS
(a)
X
RESET
-1V 3 MA FOR
5μS MAX LOAD
(b)
Y
Y
1 MA
2N2926
Z
RESET

NEON LAMP DRIVER

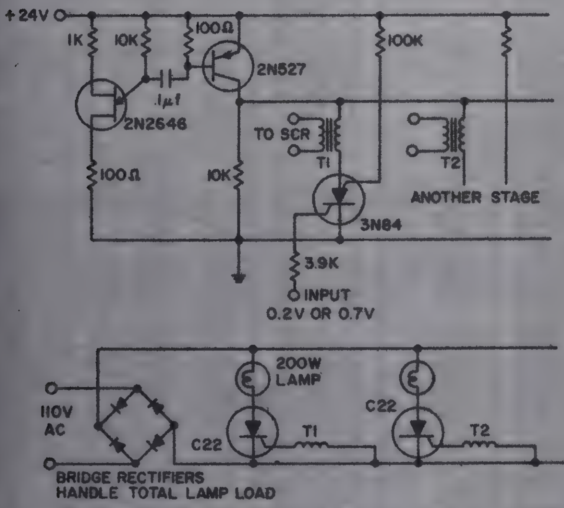
FIG. 17


IN1692
16V
+18V
2N2714
1K
2N2868
10K
INPUT
SHIFT
PULSE
100Ω
100Ω
50 TO
500μS
1K
2N2714
1N4009
OR
1N4154
.1μf
1K
INTERRUPTED
+15V TO REGISTER
(1.0 AMP MAX)
SHIFT PULSE LINE TO REGISTER

A 16 VOLT POWER SUPPLY CAN BE SYNTHESIZED AS SHOWN USING IN1692 RECTIFIERS. A SHIFT PULSE INPUT SATURATES THE 2N2714 DEPRIVING THE DARLINGTON COMBINATION (2N2714 AND 2N2868) OF BASE DRIVE. THE NEGATIVE PULSE SO GENERATED ON THE 15V LINE IS DIFFERENTIATED TO PRODUCE A POSITIVE TRIGGER PULSE AT ITS TRAILING EDGE.

SHIFT REGISTER DRIVER

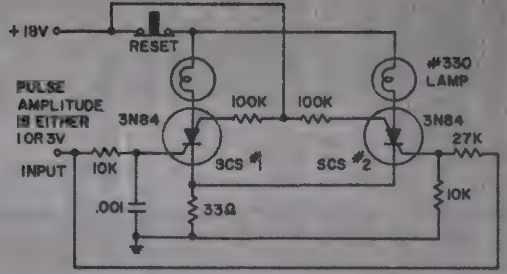
FIG. 19


+24V
1K
10K
100Ω
2N527
.1μf
2N2646
100K
TO SCR
T1
T2
100Ω
10K
ANOTHER STAGE
3N84
3.9K
INPUT
0.2V OR 0.7V
200W
LAMP
110V
AC
C22
C22
T1
T2
BRIDGE RECTIFIERS
HANDLE TOTAL LAMP LOAD

THE 2N2646 OSCILLATOR TURNS ON THE 2N527 FOR APPROX. 20μSEC AT A 1KC RATE. IF THE INPUT IS AT 0.7 VOLTS THE SCS TURNS ON GENERATING A PULSE TO TRIGGER THE SCR DRIVING THE LAMP. BY USING A BRIDGE RECTIFIER AND A 1KC PULSE RATE THE LAMPS GIVE NORMAL BRILLIANCE. A 0.2V INPUT DOES NOT TURN ON THE SCS AND THEREFORE THE LAMP.

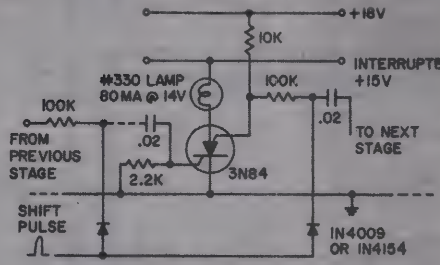
DRIVING 110V LAMPS FROM LOW LEVEL LOGIC

FIG. 22


+18V
RESET
#330
LAMP
PULSE
AMPLITUDE
IS EITHER
1 OR 3V
3N84
100K
100K
3N84
27K
INPUT
10K
SCS #1
SCS #2
10K
.001
33Ω

A ONE VOLT AMPLITUDE PULSE TRIGGERS SCS #1 BUT HAS INSUFFICIENT AMPLITUDE TO TRIGGER SCS #2. A THREE VOLT INPUT PULSE IS DELAYED IN REACHING SCS #1 BY THE 10K AND .001μf INTEGRATING NETWORK. INSTEAD, IT TRIGGERS SCS #2 THEN RAISES THE COMMON EMITTER VOLTAGE TO PREVENT SCS #1 FROM TRIGGERING. THE 100K RESISTORS SUPPRESS RATE EFFECT.

FIG. 18

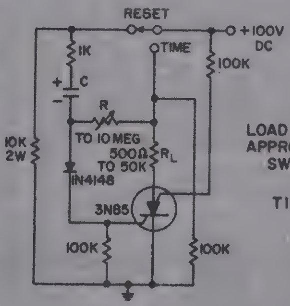

+18V
10K
INTERRUPTED
+15V
#330 LAMP
80MA @ 14V
100K
100K
.02
.02
TO NEXT
STAGE
FROM
PREVIOUS
STAGE
2.2K
3N84
SHIFT
PULSE
1N4009
OR 1N4154

BASIC SHIFT REGISTER STAGE

THE SHIFT PULSE AMPLITUDE IS LESS THAN 15 VOLTS. IF A STAGE IS OFF, THE SHIFT PULSE WILL NOT BE COUPLED TO THE NEXT STAGE. IF IT IS ON, THE DIODE WILL CONDUCT TRIGGERING THE NEXT STAGE. JUST PRIOR TO THE SHIFT PULSE THE ANODE SUPPLY IS INTERRUPTED TO TURN OFF ALL STAGES. THE STORED CAPACITOR CHARGE DETERMINES WHICH STAGES WILL BE RETRIGGERED.

SHIFT REGISTER

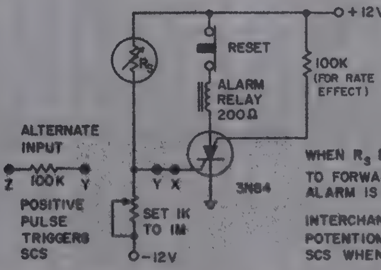
FIG. 20


RESET
+100V
DC
1K
TIME
100K
C
R
TO 10 MEG
10K
2W
500Ω
TO 50K
R_L
1N4148
3N85
100K
100K

LOAD CURRENT STARTS APPROX. 0.5 RC AFTER SWITCH IS THROWN

TIMING CIRCUIT

FIG. 21


+12V
R_3
RESET
100K
(FOR RATE
EFFECT)
ALARM
RELAY
200Ω
ALTERNATE
INPUT
Z
100K
Y
Y
X
3N84
POSITIVE
PULSE
TRIGGERS
SCS
SET 1K
TO 1M
-12V

WHEN R_3 DECREASES SUFFICIENTLY TO FORWARD BIAS THE SCS, THE ALARM IS ACTIVATED.

INTERCHANGING R_3 AND THE POTENTIOMETER TRIGGERS THE SCS WHEN R_3 INCREASES.

TEMPERATURE, LIGHT, OR RADIATION SENSITIVE RESISTORS UP TO 1 MEGOHM READILY TRIGGER ALARM WHEN THEY DROP BELOW VALUE OF PRESET POTENTIOMETER. ALTERNATELY, 0.75V AT INPUT TO 100K TRIGGERS ALARM. CONNECTING SCS BETWEEN GROUND AND -12V PERMITS TRIGGERING ON NEGATIVE INPUT TO G_A.

ALARM CIRCUIT

FIG. 23

Silicon
Controlled Switch

PNPN

3N86

The General Electric Type 3N86 is a PLANAR PNPN silicon controlled switch (SCS) offering outstanding circuit design flexibility by providing leads to all four semiconductor regions. Unique fabrication processes based on planar oxide passivation have resulted in high rehability and uniformity atlow cost. The SCS is thoroughly characterized at temperature extremes to permit worst case circuit design.
The 3N86 can be considered an integrated PNP-NPN transistor pair in a positive feedback configuration. As such it offers fewer connections, fewer parts, lower cost and better characterization than is available from two separate transistors. Its characterization permits it to be used as an extremely sensitive SCR, as a complementary SCR, or as a "transistor" with "latching" capabilities. Type 3N86 is intended for applications requiring extremely low holding current, high triggering sensitivity at either gate and high turn-off gain.

FEATURES:
- **Completely eliminates rate effect problems**
- **Dynamic and static breakover voltages are identical**
- **Extremely high triggering sensitivity at both gates**
- **Low holding current**
- **High turn-off gain**
- **Design parameters specified at worst-case temperatures**
- **Characterized for SCR and complementary SCR type applications**
- **Characterized as PNPN and also as transistor integrated pair**
- **All planar, completely oxide passivated**
- **Leads to all four semiconductor regions**

absolute maximum ratings⁽¹⁾ (25°C) (unless otherwise specified)

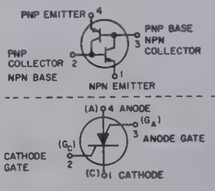
Voltage		
Anode to cathode forward and reverse	65	volts
Anode gate to anode reverse	65	volts
Cathode gate to cathode reverse	5	volts
Total Current		
Continuous DC forward⁽²⁾	200	ma
Peak recurrent forward ($T_A = 100°C$, 100 μsec. pulse width, 1% duty cycle)	1.0	amps
Peak non-recurrent forward (10 μsec. pulse width)	5.0	amps
Gate Current (Forward Bias)		
Continuous DC anode gate⁽²⁾	100	ma
Peak anode gate ($T_A = 100°C$, 100 μsec. pulse width, 1% duty cycle)	200	ma
Peak cathode gate ($T_A = 100°C$, 100 μsec. pulse width, 1% duty cycle	500	ma
Continuous DC cathode gate	20	ma
Dissipation		
Total power⁽²⁾	400	mw
Cathode gate power⁽²⁾	100	mw
Temperature		
Operating junction	−65 to +150	°C
Storage	−65 to +200	°C

DIMENSIONS WITHIN
JEDEC OUTLINE TO-18
EXCEPT FOR
LEAD CONFIGURATION

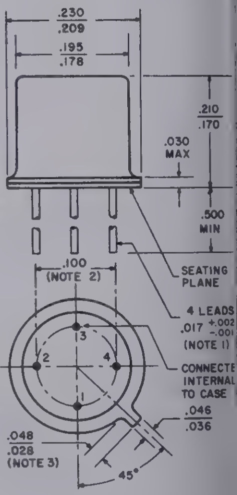
NOTE 1: Lead diameter is controlled in the zone between .050 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

NOTE 2: Leads having maximum diameter (.019) measured in gaging plane .054 + .001 − .000 below the seating plane of the device shall be within .007 of true position relative to a maximum width tab.

NOTE 3: Measured from max. diameter of the actual device.



PNP EMITTER 4
PNP BASE
NPN COLLECTOR 3
PNP COLLECTOR 2
NPN BASE
NPN EMITTER 1
(A) 4 ANODE
(G_A) 3 ANODE GATE
(G_C) CATHODE GATE 2
(C) 1 CATHODE

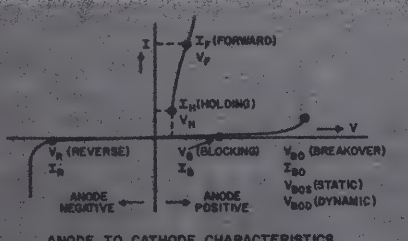


.230
.209
.195
.178
.210
.170
.030 MAX
.500 MIN
.100 (NOTE 2)
SEATING PLANE
4 LEADS .017 +.002 −.001 (NOTE 1)
CONNECTE INTERNAL TO CASE
.046
.036
.048
.028
(NOTE 3)
45°
1
2
3
4

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

NOTE 1: Symbols and nomenclature are defined below.

NOTE 2: Derate currents and power linearly to 150°C, the maximum rated temperature. The absolute maximum rating at any given temperature shall be in terms of the more conservative of the two parameters, i.e., current or power.

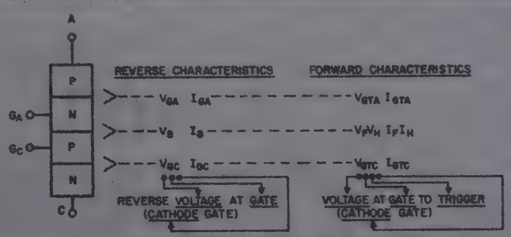


I
I_F (FORWARD)
V_F
I_H (HOLDING)
V_H
V
V_R (REVERSE)
I_R
V_B (BLOCKING)
I_B
V_{BO} (BREAKOVER)
I_{BO}
V_{BOS} (STATIC)
V_{BOD} (DYNAMIC)
ANODE NEGATIVE
ANODE POSITIVE

ANODE TO CATHODE CHARACTERISTICS

NOTE —ABSENCE OF G INDENTIFIES ANODE TO CATHODE SYMBOLS. DOT IDENTIFIES OPERATING POINT. BRACKETS INDICATE MEANING OF SUBSCRIPT LETTER.

FIG. 1



A
P
N
P
N
C
G_A
G_C
REVERSE CHARACTERISTICS
FORWARD CHARACTERISTICS
V_{GA} I_{GA}
V_{GTA} I_{GTA}
V_B I_B
$V_F V_H$ $I_F I_H$
V_{GC} I_{GC}
V_{GTC} I_{GTC}
REVERSE VOLTAGE AT GATE (CATHODE GATE)
VOLTAGE AT GATE TO TRIGGER (CATHODE GATE)

NOTE: G IDENTIFIES GATE SYMBOLS. LAST LETTER (A OR C) MAY BE DROPPED IF NO AMBIGUITY RESULTS IN SPECIFIC CHARACTERIZATION. F MEANS "FORWARD" AND T MEANS "TRIGGER"

FIG. 2

DEFINITION OF TERMS USED IN SCS SPECIFICATIONS

PNPN devices available at present do not have a common nomenclature. In part, this is due to their different construction and varied applications. SCS nomenclature permits the reverse characteristics of all three junctions to be specified. The anode forward characteristic and gate triggering characteristics can also be specified fully. The principles used in assigning symbols are illustrated below and with outline drawing above.

ectrical characteristics:(1)

	Symbol(1)	Temp.	3N86	
CUTOFF CHARACTERISTICS				
Forward Blocking Current ($R_{GC} = 10K$, $V_{AC} = 65V$)	$I_{B\ max}$	@ 25°C	1.0	μa max
		@ 150°C	20	μa max
Reverse Blocking Current ($R_{GC} = 10K$, $V_{CA} = 65V$)	$I_{R\ max}$	@ 25°C	1.0	μa max
		@ 150°C	20	μa max
Cathode Gate Reverse Cutoff Current ($V_{GC} = -5V$)	I_{GC}	@ 25°C	20	μa max
Anode Gate Reverse Cutoff Current ($V_{GA} = -65V$)	I_{GA}	@ 25°C	1.0	μa max
CONDUCTING CHARACTERISTICS				
Forward Voltage ($I_A = 200ma$, $R_{GC} = 10K$)	$V_{F\ max}$	@ 25°C	2.0	V max
		@ −65°C	2.5	V max
Forward Voltage ($I_A = 100ma$, $I_{GA} = 50ma$, $R_{GC} = 10K$)	$V_{F\ max}$	@ 25°C	1.5	V max
Holding Current ($R_{GC} = 10K$)	$I_{H\ max}$	@ 25°C	0.2	ma max
		@ −65°C	0.8	ma max
Holding Current ($R_{GC} = 10K$, $I_{GA} = 50ma$)	$I_{H\ max}$	@ 25°C	2.0	ma max
		@ −65°C	8.0	ma max
Saturation Voltage (G_A to C) ($I_{GC} = 5ma$, $I_{GA} = 50ma$, $I_A = 0$)	$V_{CEsat\ NPN}$	@ 25°C	2.0	V max
Saturation Voltage (G_A to C) ($I_{GC} = 0$, $I_{GA} = 50ma$, $I_A = 5ma$)	$V_{CEsat\ NPN}$	@ 25°C	2.0	V max
TRIGGERING CHARACTERISTICS				
Cathode Gate Current to Trigger (I_{GTC} from current source, $V_{AC} = 40V$, $R_A = 800\Omega$)	$I_{GTC\ max}$	@ 25°C	1.0	μa max
		@ −65°C	50	μa max
Cathode Gate Current to Trigger (I_{GTC} from current source, $V_{AC} = 40V$, $R_A = 800\Omega$, $I_{GA} = 50ma$)	$I_{GTC\ max}$	@ 25°C	50	μa max
Cathode Gate Voltage to Trigger ($V_{AC} = 40V$, $R_A = 800\Omega$, $R_{GC} = 10K$, $R_{GA} = \infty$, I_{GTC} from current source)	$V_{GTC\ max}$	@ 25°C	.65	V max
		@ −65°C	1.0	V max
	$V_{GTC\ min}$	@ 25°C	0.4	V min
		@ 150°C	0.15	V min
Cathode Gate Voltage to Trigger ($V_{AC} = 40V$, $R_A = 800\Omega$, $R_{GC} = 10K$, $I_{GA} = 50ma$, I_{GTC} from current source)	$V_{GTC\ max}$	@ 25°C	0.8	V max
	$V_{GTC\ min}$	@ 25°C	0.4	V min
Anode Gate Current to Trigger (I_{GTA} from current source, $V_{AC} = 40V$, $R_C = 800\Omega$, $R_{GC} = 10K$)	$I_{GTA\ max}$	@ 25°C	0.1	ma max
		@ −65°C	0.25	ma max
Anode Gate Voltage to Trigger (I_{GTA} from current source, $V_{AC} = 40V$, $R_C = 800\Omega$, $R_{GC} = 10K$, $R_{GA} = 1K$)	$V_{GTA\ max}$	@ 25°C	0.8	V max
		@ −65°C	1.0	V max
	$V_{GTA\ min}$	@ 25°C	0.4	V min
		@ 150°C	0.2	V min
TRANSIENT CHARACTERISTICS				
Turn-On Time ($V_{AC} = 20V$, $I_A = 100ma$, $I_{GC} = 100\mu a$) (See circuit, Figure 3)	$t_{on\ max}$	@ 25°C	1.5	μs max
		@ −65°C	2.0	μs max
Turn-On Time ($V_{AC} = 20V$, $I_A = 100ma$, $I_{GC} = 100\mu a$, $I_{GA} = 50ma$)	$t_{on\ max}$	@ 25°C	2.0	μsec max
Recovery Time ($V_{AC} = 20V$, $I_A = 100ma$, $R_{GC} = 10K$) (See circuit, Figure 4)	$t_{rec\ max}$	@ 25°C	15	μs max
		@ 150°C	25	μs max
Recovery Time ($V_{AC} = 20V$, $I_A = 100ma$, $R_{GC} = 10K$, $I_{GA} = 50ma$)	$t_{rec\ max}$	@ 25°C	15	μsec max
Collector Capacitance Voltage Gate to Gate = 20V	$C_{ob\ max}$	@ 25°C	15	pf
Rate of Rise of Forward Blocking Voltage	dv/dt max	@ 25°C	(see note 5)	V/μsec max

ectrical characteristics (25°C) (unless otherwise specified)

		3N86				
		PNP[1]		NPN[1]		
DC CHARACTERISTICS		Min.	Max.	Min.	Max.	
Collector to Base Breakdown Voltage ($I_C = [\pm]^{(4)}\ 1.0\mu a$, $I_E = 0$)	BV_{CBO}	−65		65		volts
Emitter to Base Breakdown Voltage ($I_C = 0$, I_E [NPN] $= 20\mu a$, I_E [PNP] $= -1\mu a$)	BV_{EBO}	−65		5		volts
Collector Saturation Voltage ($I_C = 50ma$, $I_B = 5ma$)	$V_{CE(SAT)}$				2	volts
Base Saturation Voltage ($I_C = 1ma$, $I_B = 5ma$)	$V_{BE(SAT)}$				0.9	volts
Forward Current Transfer Ratio ($V_{CE} = 0.5V$, $I_C = 3ma$)	h_{FE}			20		
Forward Current Transfer Ratio ($V_{CE} = -2.0V$, $I_C = -1ma$)	h_{FE}	0.2				
CUTOFF CHARACTERISTICS ($V_{AC} = 65$ volts)						
Collector to Emitter Leakage Current ($T_A = 150°C$)	I_{CEO}		−20			μa
($R_B = 10K\Omega$, $T_A = 150°C$)	I_{CER}				20	μa
Collector to Base Leakage Current ($I_E = 0$, $T_A = 150°C$)	I_{CBO}		−20		20	μa
Emitter to Base Leakage Current ($I_C = 0$, $T_A = 150°C$)	I_{EBO}		−20			μa
($V_{EB} = 5Vdc$, $I_C = 0$)	I_{EBO}				20	μa
TRANSIENT CHARACTERISTICS						
Collector Capacitance ($I_E = 0$, $V_{EB} = [\pm]^{(4)}\ 20V$)	C_{ob}		15		15	pf
Gain Bandwidth Product	f_T			75		mc

NOTE 3: The transistor characterization is essentially a restatement of the SCS characterization and is meant to facilitate using the SCS as a complementary PNP-NPN integrated transistor pair.

NOTE 4: The [±] sign indicates that the PNP and NPN transistors require opposite polarities as identified by the test conditions.

NOTE 5: The dv/dt rating is unlimited when the anode gate lead is returned to the anode voltage through a current limiting resistor.

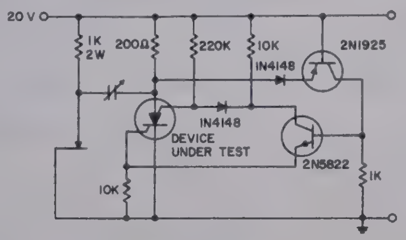


FIG. 3 RECOVERY TEST SET

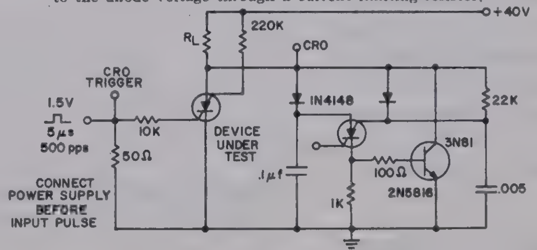


FIG. 4 TURN ON TIME TEST SET

Silicon

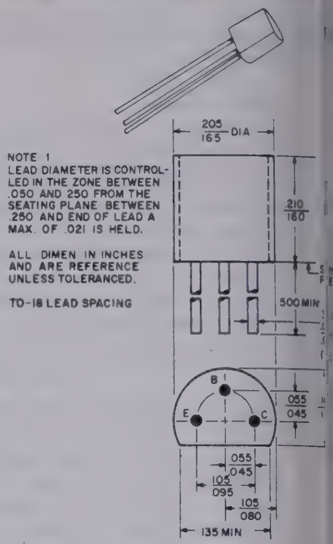
Transistors

PLANAR EPITAXIAL PASSIVATED

NPN

GBC107,8,9

This series of transistors are silicon, planar, epitaxial, passivated devices. They are designed primarily for optimum low noise performance, low-level audio amplifier applications. They feature excellent h_{FE} holdup at collector currents between 10μA and 50mA, and minimum burst ("pop-corn") noise.



NOTE 1
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND 250 FROM THE SEATING PLANE BETWEEN .250 AND END OF LEAD A MAX. OF .021 IS HELD.

ALL DIMEN IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.

TO-18 LEAD SPACING

absolute maximum ratings: (25°C unless otherwise specified)

		GBC107	GBC108 GBC109	
Voltages				
Collector-to-Emitter	V_{CEO}	45	20	Volts
Emitter-to-Base	V_{EBO}	5	5	Volts
Collector-to-Base	V_{CBO}	45	20	Volts
Current				
Collector (Steady State)	I_C		500	mA
Dissipation				
Total Power (Free Air)++	P_T		400	mW
Temperature				
Storage	T_{STG}		-65 to 150°C	
Operating	T_J		125°C	
Lead, 1/16 ± 1/32 from case for 10 seconds maximum	T_L		260°C	

++Derate 4.0mW/°C increase in ambient temperature above 25°C

electrical characteristics: (25°C unless otherwise specified)

			MIN.	TYP.	MAX.	UNITS
Collector Cutoff Current						
($V_{CB}=20V, I_E=0$)		I_{CBO}		.3	15	nA
($V_{CB}=20V, I_E=0, T_A=100°C$)		I_{CBO}			15	μA
Static Forward Current Transfer Ratio						
($V_{CE}=5V, I_C=10\mu A$)	GBC107, GBC108	h_{FE}	40			
	GBC109	h_{FE}	100			
($V_{CE}=5V, I_C=2mA$)		h_{FE}	110			
Collector-Emitter Saturation						
($I_C=10mA, I_B=1mA$)		$V_{CE(SAT)}$			0.25	V
Collector-Emitter Breakdown Voltage						
($I_C=10mA, I_B=0$)	GBC107	$V_{(BR)CEO}$	45			V
	GBC108, GBC109	$V_{(BR)CEO}$	20			V
Emitter-Base Breakdown Voltage						
($I_E=10\mu A, I_C=0$)		$V_{(BR)EBO}$	5			V
Collector-Base Breakdown Voltage						
($I_C=10\mu A, I_E=0$)	GBC107	$V_{(BR)CBO}$	45			V
	GBC108, GBC109	$V_{(BR)CEO}$	20			V
Base-Emitter Voltage						
($V_{CE}=5V, I_C=2mA$)		$V_{BE(ON)}$	0.5	0.63	0.7	V
Forward Current Transfer Ratio						
($V_{CE}=5V, I_C=2mA, f=1kHz$)	GBC107, GBC108	h_{FE}	125		500	
	GBC107A, GBC108A	h_{FE}	125		260	
	GBC107B, GBC108B	h_{FE}	240		500	
	GBC109	h_{FE}	240		900	
	GBC109B	h_{FE}	250		500	
Collector-Base Capacitance						
($V_{CB}=10V, I_E=0, f=1mHz$)		C_{CB}		4	6	pF
Gain Bandwidth Product						
($V_{CE}=2V, I_C=10mA$)		f_T	140	350	630	MHz
Narrow Band Noise Figure						
($V_{CE}=5V, I_C=100\mu A, f=1kHz$ $BW=1Hz, Rg=2k$)						
	GBC107, GBC108	N.F.		3	10	dB
	GBC109	N.F.			6	dB
Wide Band Noise Figure						
($V_{CE}=5V, I_C=200\mu A, f=10Hz$ to $10kHz, BW=15.7kHz, Rg=2k$)	GBC109	N.F.			3.0	dB

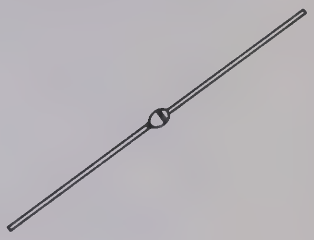
Passivated Rectifier

2.5 Amps **50-100 Volts**

A14 SERIES

A14A
A14F
A14U

THE GENERAL ELECTRIC A14 IS A 2.5 AMPERE RATED, AXIAL-LEADED GENERAL PURPOSE RECTIFIER. DUAL HEATSINK CONSTRUCTION PROVIDES RIGID MECHANICAL SUPPORT FOR THE PELLET AND EXCELLENT THERMAL CHARACTERISTICS. PASSIVATION AND PROTECTION OF THE SILICON PELLETS PN JUNCTION ARE PROVIDED BY SOLID GLASS; NO ORGANIC MATERIALS ARE PRESENT WITHIN THE HERMETICALLY SEALED PACKAGE.

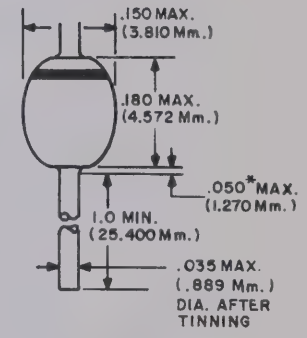


The A14 is "Transient-Voltage Protected." This device will dissipate up to 1000 watts in the reverse direction without damage. Voltage Transients generated by household or industrial power lines are dissipated.

absolute maximum ratings: (25°C unless otherwise specified)

Reverse Voltage (−65° C to + 175° C T_J)	A14U	A14F	A14A	
Working Peak, V_{RM} (rep)	25	50	100	Volts
DC, V_R	25	50	100	Volts
Average Forward Current, I_o				
100° C Ambient		← 1.0 →		Amp
25° C		← 2.5 →		Amp
Peak Surge Forward Current I_{FM} (surge), Non-repetitive .0083 sec. half sine wave				
Full Load JEDEC Method	30	50	50	Amps
No Load (25° C Case)	45	65	65	Amps
Peak Surge Forward Current, Non-repetitive, .001 sec. Half sine wave				
Full Load	70	90	90 90	Amps
No Load (25° C Case)	80	100	100 100	Amps
Junction Operating and Storage Temperature Range		← 65 to + 175 →		°C
I^2t, RMS for fusing, .001 to .01 sec.	2.0	4.0	4.0	Amps² sec.
Maximum avalanche voltage	—	← 1600 →		Volts

Mounting: Any position. Lead Temperature 290° C maximum to ⅛ inch from body for 5 seconds maximum during mounting.



ALL DIMENTIONS ARE IN INCHES AND (METRIC)
*WELD AND SOLDER FLASH NOT CONTROLLED IN THIS AREA

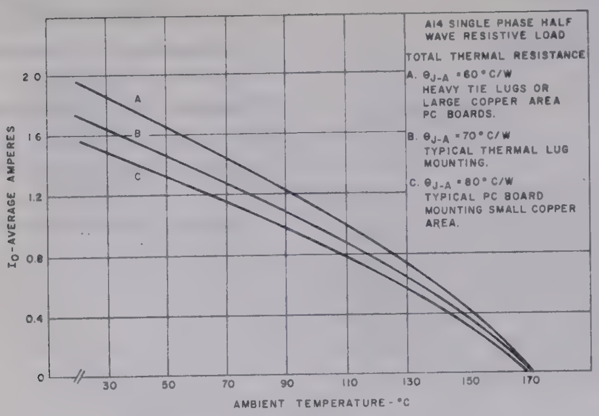
OUTLINE DRAWING

electrical characteristics: (25°C unless otherwise specified)

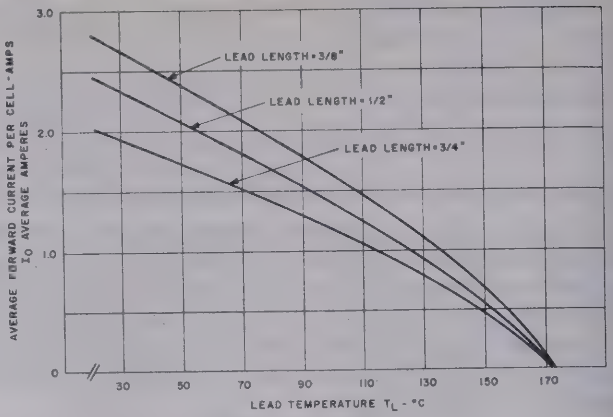
	A14U	A14F	A14A	
Maximum Forward Voltage Drop, V_F, 1A, $T_J = 25°$ C	1.2	1.0	1.0	Volt
Maximum Reverse Current, I_R, at Rated V_{RM} (rep):				
$T_J = 25°$ C	10	5.0	5.0	μA
$T_J = 175°$ C	500	300	300	μA
Typical Reverse Current				
$T_J = 25°$ C		← 0.3 →		μA
$T_J = 100°$ C		← 20 →		μA
Typical Reverse Recovery Time		← 3 →		μsec.
Maximum Reverse Recovery Time		← 6 →		μsec.

MAXIMUM ALLOWABLE DC OUTPUT CURRENT RATINGS

SINGLE PHASE
600 VOLTS & BELOW

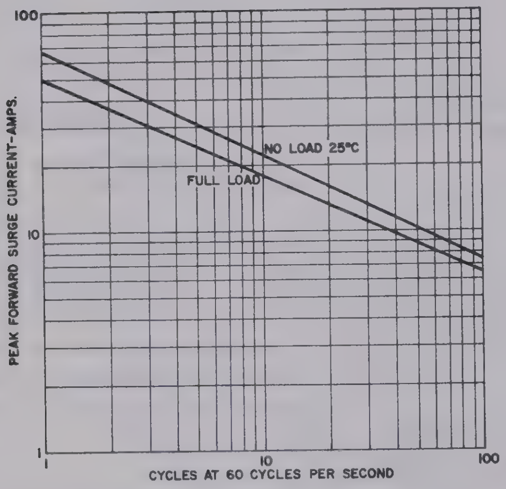


AMBIENT OPERATION
(SEE TYPICAL MOUNTING BELOW)

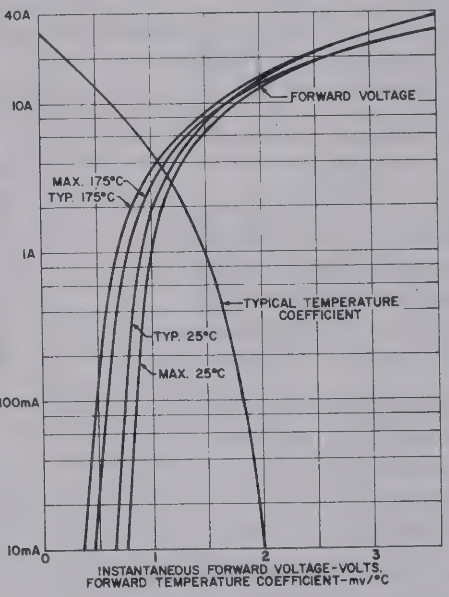


TIE POINT OPERATION

TYPICAL CHARACTERISTICS

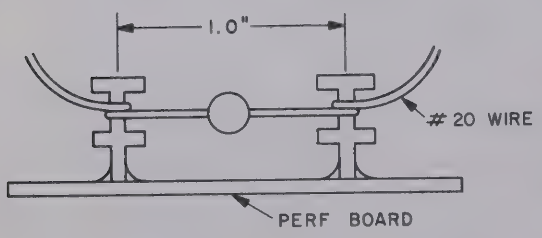


MAXIMUM NON-REPETITIVE MULTICYCLE
FORWARD SURGE CURRENT

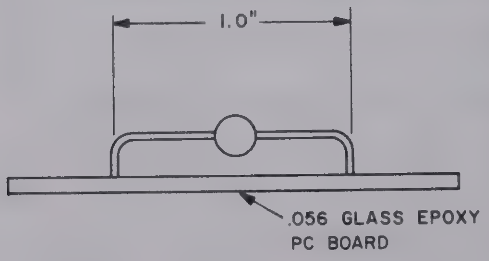


FORWARD CHARACTERISTICS

TYPICAL TIE LUG MOUNTS


1.0"
# 20 WIRE
PERF BOARD

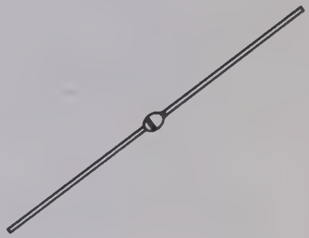
TYPICAL PC BOARD MOUNTING


1.0"
.056 GLASS EPOXY
PC BOARD

Silicon
Rectifier
1.0 Amp 1400 Volts

A14PD1

THE GENERAL ELECTRIC DAMPER DIODE IS A 1.0 AMPERE, AXIAL-LEADED, DOUBLE DIFFUSED RECTIFIER. DUAL HEATSINK CONSTRUCTION PROVIDES RIGID MECHANICAL SUPPORT FOR THE PELLET AND EXCELLENT THERMAL CHARACTERISTICS. PASSIVATION AND PROTECTION OF THE PN JUNCTION OF THE SILICON PELLET ARE PROVIDED BY SOLID GLASS; NO ORGANIC MATERIALS ARE PRESENT WITHIN THE HERMETICALLY-SEALED PACKAGE.



The normal and fast switching devices below are designed for special applications in TV receivers as damper, boost or clamp diodes in the horizontal sweep circuitry. These may also be used for conventional power supply rectification where higher than normal PRV is required.

absolute maximum ratings: (25°C unless otherwise specified)

	A14PD1	
Reverse Voltage (–65°C to +150°C T_J)		
Working Peak, V_{RM} (WKG)	1400	Volts
Repetitive Peak, V_{RM} (REP)	1400	Volts
DC, V_R	1400	Volts
Average Forward Current, I_o		
75°C T_A (see Rating Curve)	1.0	Amps
Peak Forward Surge Current		
I_{FM} (SURGE) Non-repetitive .0083 sec., half sine wave, Full load JEDEC method	40	Amps
Peak Forward Surge Current		
Non-repetitive .001 sec., half sine wave, full load 150°C T_J	85	Amps
Junction Temperature Range		
Operating	–65°C to +150°C	
Storage	–65°C to +175°C	
I^2t, RMS, for fusing – .001 to .01 sec.	3.5*	Amp² sec.

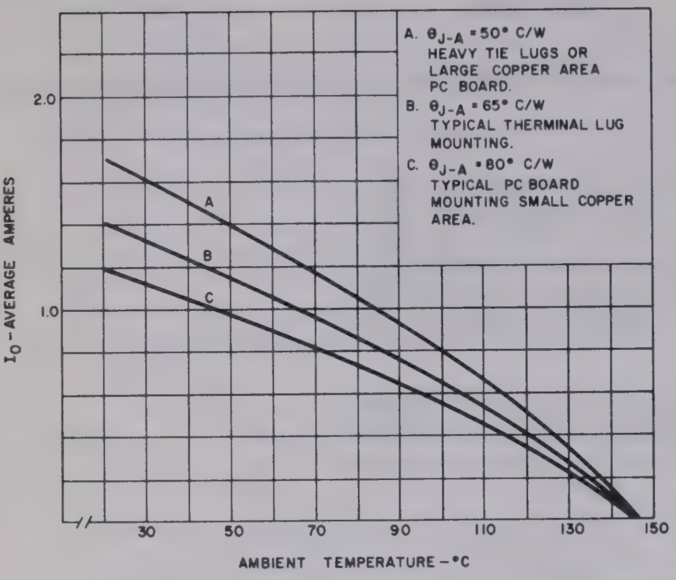
Mounting: Any position. Lead temperature 290°C maximum to 1/8" from body for 5 seconds maximum during mounting.

electrical characteristics·

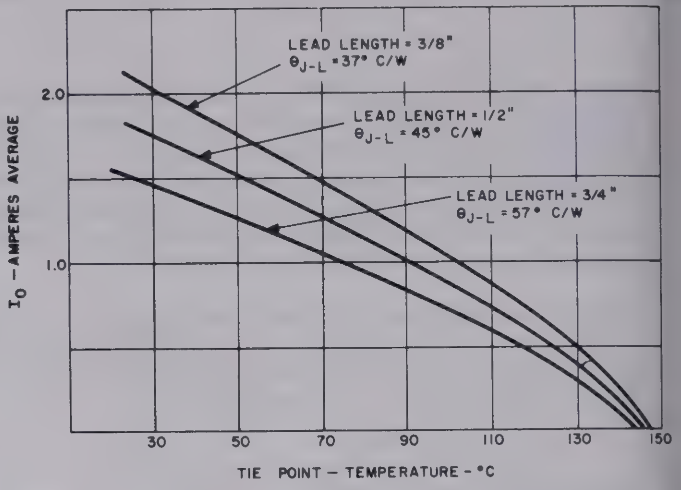
Maximum Forward Voltage Drop V_F		
I_F = 1.0A, T_A = 25°C	1.1	Volts
Maximum Reverse Current, I_R		
AT V_R = 1400V + 25°C	10	μA
AT V_R = 1400V +150°C	200	μA
Maximum Reverse Recovery Time, t_{rr} measured in Tektronix Type S Plug-in		μs
I_F = 20 mA, I_R = 2 mA		
I_F = 500 mA, See circuit A		μs
Maximum Forward Recovery Time		
T_{FR}, I_F = 500 mA measured at point where V_F recovers to 1.5 volts	.5	μs

MAXIMUM ALLOWABLE DC OUTPUT CURRENT RATINGS

SINGLE PHASE RESISTIVE LOAD

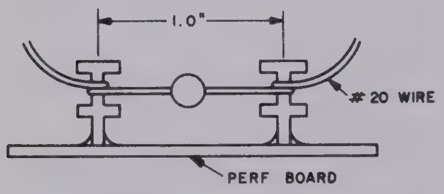


AMBIENT OPERATION

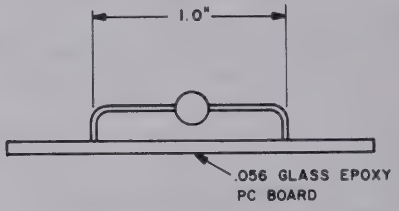


TIE POINT OPERATION

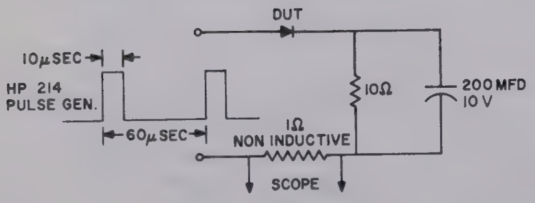
TYPICAL TIE LUG MOUNTINGS

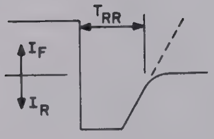

1.0"
# 20 WIRE
PERF BOARD

TYPICAL PC BOARD MOUNTING

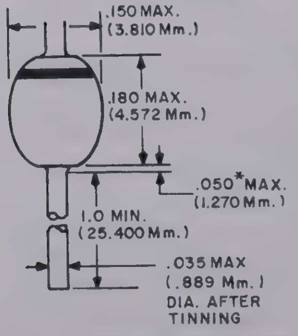

1.0"
.056 GLASS EPOXY
PC BOARD

CIRCUIT A


DUT
10μSEC
HP 214
PULSE GEN.
60μSEC
10Ω
200 MFD
10 V
1Ω
NON INDUCTIVE
SCOPE



OUTLINE DRAWING


.150 MAX.
(3.810 Mm.)
.180 MAX.
(4.572 Mm.)
.050* MAX.
(1.270 Mm.)
1.0 MIN.
(25.400 Mm.)
.035 MAX
(.889 Mm.)
DIA. AFTER
TINNING

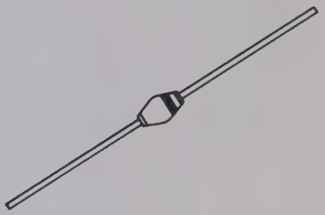
ALL DIMENSIONS ARE IN INCHES
AND (METRIC)
*WELD AND SOLDER FLASH NOT
CONTROLLED IN THIS AREA

Passivated
Rectifier

5.0 Amps **50-100 Volts**

A15 SERIES
A15A
A15F
A15U

THE GENERAL ELECTRIC A15 IS A 5.0 AMPERE RATED, AXIAL-LEADED GENERAL PURPOSE RECTIFIER. ITS DUAL HEATSINK CONSTRUCTION PROVIDES RIGID MECHANICAL SUPPORT FOR THE PELLET AND EXCELLENT THERMAL CHARACTERISTICS. PASSIVATION AND PROTECTION OF THE SILICON PELLETS PN JUNCTION ARE PROVIDED BY SOLID GLASS; NO ORGANIC MATERIALS ARE PRESENT WITHIN THE HERMETICALLY SEALED PACKAGE.

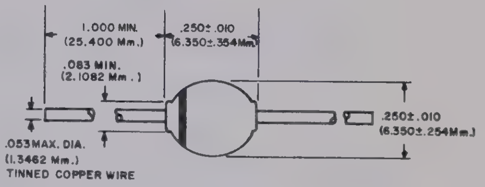


absolute maximum ratings: (25°C unless otherwise specified)

	A15U	A15F	A15A	
Reverse Voltage (−65 to +175°C T_J)				
Working Peak, V_{RM} (WKG)	25	50	100	Volts
Repetitive Peak, V_{RM} (REP)	25	50	100	Volts
DC, VR	25	50	100	Volts
Average Forward Current, I_O				
70°C ambient, see rating curves	3.0	3.0	3.0	Amps
25°C ambient, see rating curves	5.0	5.0	5.0	Amps
Peak Surge Forward Current I_{FM} (surge) non-repetitive .0083 sec half sine wave Full load JEDEC method	75	125	125	Amps
Peak Surge Forward Current Non-repetitive .001 sec Half sine wave Full load 175°C T_J	—	225	225	Amps
Junction Operating and Storage Temperature Range		−65 to +175°C		
I^2T, RMS for fusing .001 to .01 sec	—	25	25	Amp^2sec

Mounting: Any position. Lead temperature 290°C maximum to ⅛″ from body for 5 seconds maximum during mounting.

OUTLINE DRAWING



ALL DIMENSIONS ARE IN INCHES AND (METRIC)

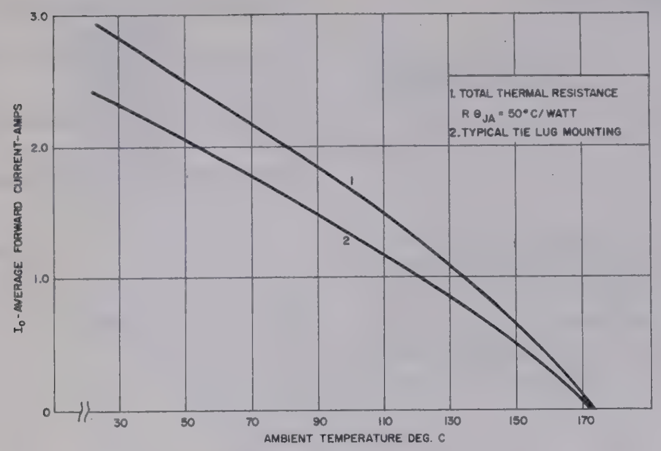
electrical characteristics: (25°C unless otherwise specified)

	A15U	A15F	A15A	
Maximum Forward Voltage Drop $I_F = 3.0A$, $T_A = 25°C$	1.2	1.0	1.0	Volts
Maximum Reverse Current, I_R at rated VR				
$T_J = 25°C$	10.0	5.0	5.0	μA
$T_J = 175°C$	500	300	300	μA
Typical I_R at 25°C	—	1.0	1.0	μA
Typical Reverse Recovery Time, T_{RR}		2.5	2.5	μsec
Maximum Reverse Recovery Time, T_{RR} Recovery Circuit Per MIL-S-19500/286C		5.0	5.0	μsec

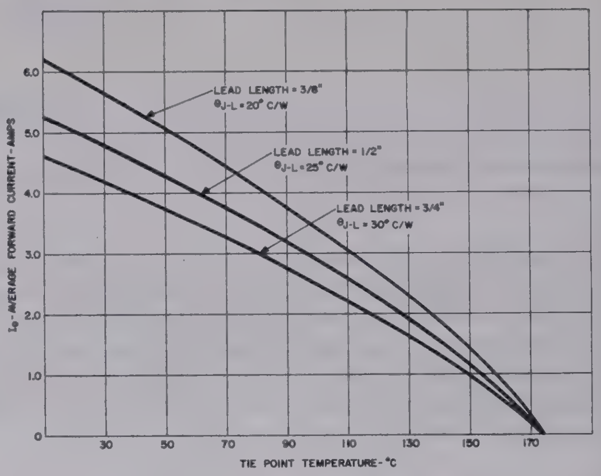
CIRCUIT DESIGN INFORMATION

MAXIMUM ALLOWABLE DC OUTPUT CURRENT RATINGS

SINGLE PHASE, RESISTIVE AND INDUCTIVE LOADS

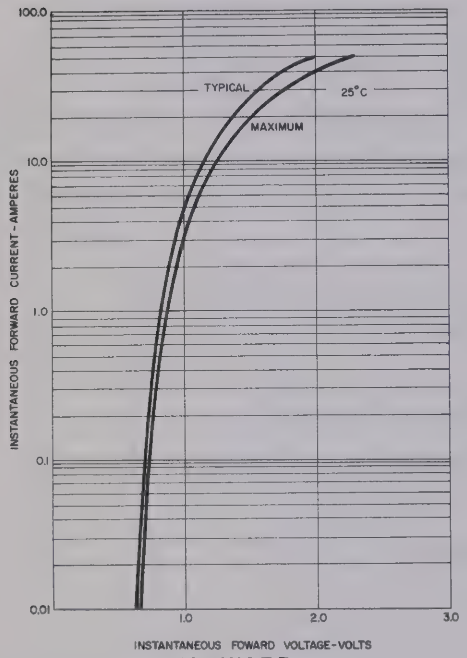


AMBIENT OPERATION
(See Tie Point Mounting Below)

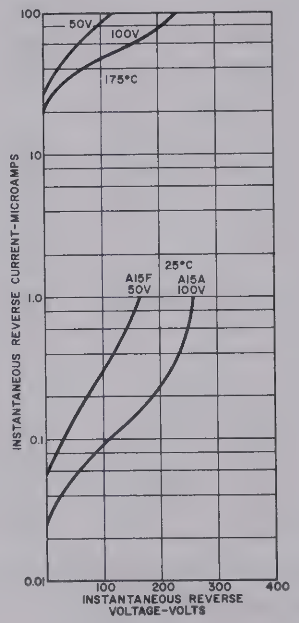


TIE POINT OPERATION

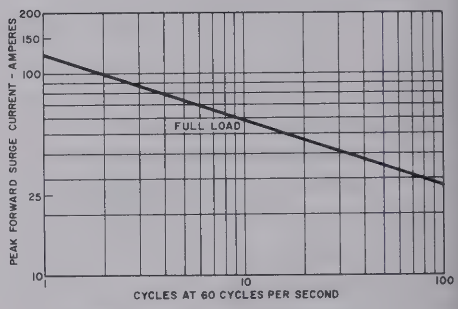
TYPICAL CHARACTERISTICS



FORWARD CHARACTERISTICS

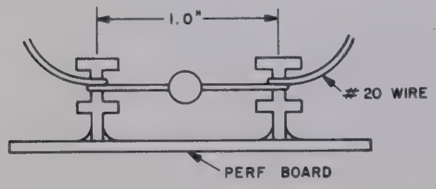


REVERSE CHARACTERISTICS



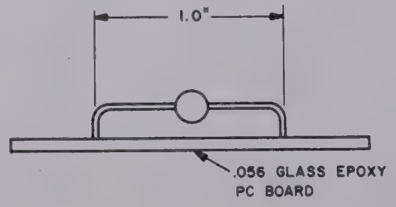
MAXIMUM NON-REPETITIVE MULTICYCLE FORWARD SURGE CURRENT

TYPICAL TIE LUG MOUNTS

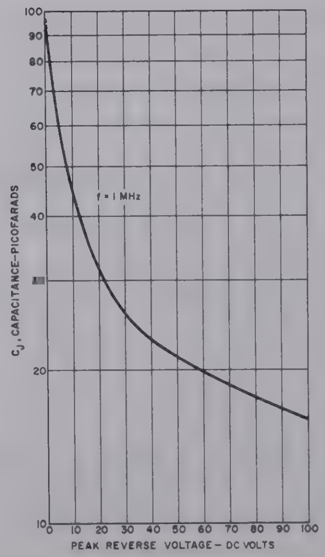


1.0"
# 20 WIRE
PERF BOARD

TYPICAL PC BOARD MOUNTING



1.0"
.056 GLASS EPOXY
PC BOARD



JUNCTION CAPACITANCE

Rectifier

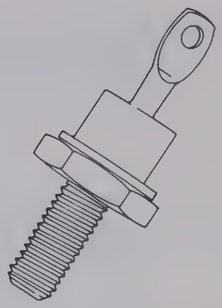
A28,9*

*Reverse polarity type

12A AVG. V_{RRM} Up to 400V

Features:

- Fast Recovery Time . . . 100 Nanoseconds Maximum
- Recovered Charge Characteristics Shown on Charts 1, 2, and 3
- The Fast Recovery Characteristics of the A28/A29 Match the High Frequency Capability of the New General Electric High Speed SCR's, such as the C140 and C141.
- For Use in:
  - — Inverters
  - — Sonar Power Supplies
  - — Choppers
  - — Ultrasonic Systems
  - — Low RF Interference Applications
  - — Free Wheeling Rectifier Applications
  - — DC To DC Power Supplies



maximum allowable ratings (Resistive or Inductive Load)

	A28F A29F	A28A A29A	A28B A29B	A28C A29C	A28D A29D	
Maximum Repetitive and Working Peak Reverse Voltage*, V_{RRM} and V_{RWM}, T_J = —65°C to +175°C	50	100	200	300	400	Volts
Maximum RMS Voltage*, T_J = —65°C to +175°C, V_r	35	70	140	210	280	Volts
Maximum DC Blocking Voltage**, T_J = —65°C to +125°C, V_R	50	100	200	300	400	Volts
Maximum Average Forward Current (Single Phase, T_C = +135°C), I_O	← 12 Amperes →					
Maximum Peak One Cycle Surge Current, 60 Cycle Non-Recurrent, T_J = —65°C to +175°C, I_{FSM}	← 240 Amperes →					
²t Rating (.001 <t<.008 second), T_J = —65°C to +175°C	← 67 Ampere² second Min. Rating →					
Maximum Full Load Forward Voltage Drop, Single Phase Full Cycle Average, I_O = 12 Amp. at T_C = +135°C, $V_{F(AV)}$	← 0.7 Volts →					
Maximum Reverse Current at Full Load, Single Phase Full Cycle Average, I_O = 12 Amp. at T_C = +135°C, $I_{R(AV)}$	← 8.0 mA →					
Maximum Effective Thermal Resistance (Junction to Case) $R_{\theta JC}$	← 2.0°C/W →					
Junction Operating and Storage Temperature Range, T_J & T_{STG}	← —65°C to +175°C →					
Reverse Recovery Time (see reverse side)***, t_{rr}	← 100 Nanosec. Max. →					
Stud Torque	← Min. 15 in-lbs.; Max. 20 in-lbs. → (Min. 17 Kg-cm; Max. 23 Kg-cm)					

Rating assumes rectifier heatsink ≤ 3°C/W at max. T_J. If max. operating T_J ≤ 150°C, rectifier heatsink can be ≤ 6°C/W.

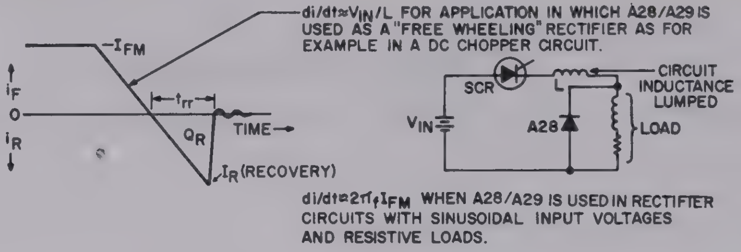
*Rating assumes rectifier heatsink ≤ 6°C/W at max. T_J.

**Recovery characteristic factory test point:
I_{FM} = 5.0 Amp.; di/dt = 50 Amp./μsec; T_C = +25°C; t_{rr} = 100 nanoseconds max.; I_R (recovery) = 4.0 Amperes max.

NOTE: Case Temperature, T_C, is measured at the center of any flat on the hex base.

RECOVERY SPECIFICATIONS AND INFORMATION

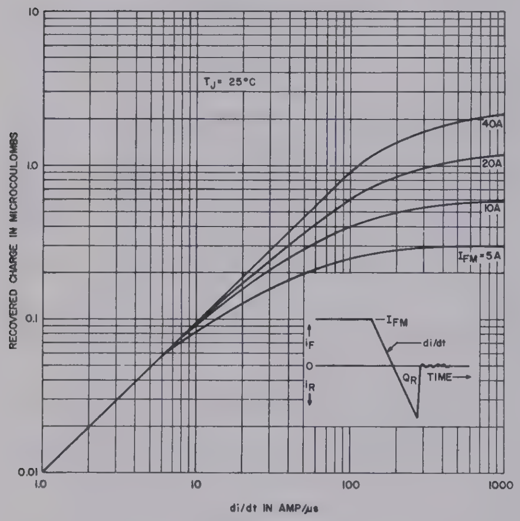
In most power circuits where the rectifier reverse loop L/R is large, the A28/A29 recovery characteristics are essentially as shown below:


di/dt≈V_{IN}/L FOR APPLICATION IN WHICH A28/A29 IS USED AS A "FREE WHEELING" RECTIFIER AS FOR EXAMPLE IN A DC CHOPPER CIRCUIT.
$-I_{FM}$
i_F
0
i_R
t_{rr}
Q_R
TIME→
I_R (RECOVERY)
SCR
L
CIRCUIT INDUCTANCE LUMPED
V_{IN}
A28
LOAD
di/dt≈2πfI_{FM} WHEN A28/A29 IS USED IN RECTIFIER CIRCUITS WITH SINUSOIDAL INPUT VOLTAGES AND RESISTIVE LOADS.

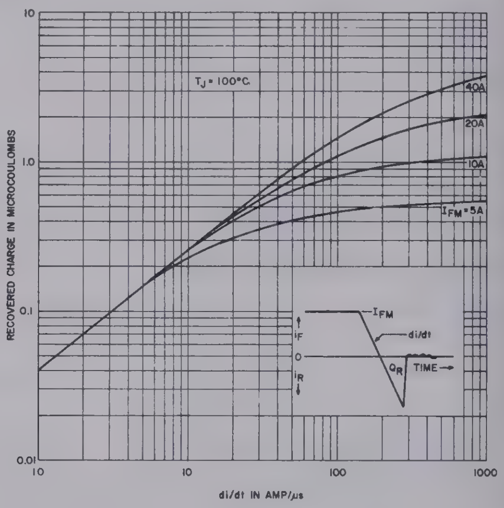
From the curves of recovered charge, Q_R (Charts 1, 2, 3), recovery time and peak recovery current (as defined above) may be very closely approximated using the following formulas if the application, I_R (recovery), di/dt, and A28/A29 operating junction temperatures are known.

$$I_R\ (\text{recovery}) = \sqrt{2\,Q_R\,di/dt} \qquad t_{rr} = \sqrt{\frac{2\,Q_R}{di/dt}}$$

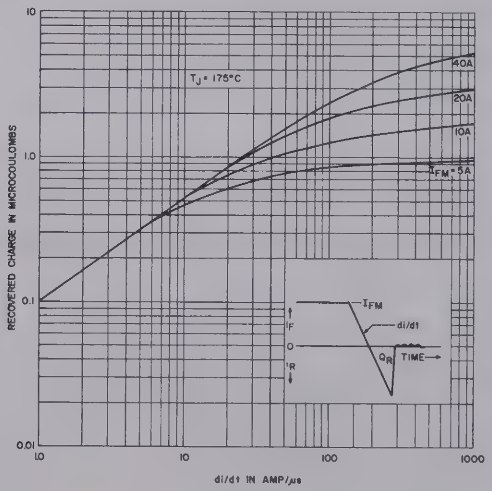
NOTE: At high values of di/dt, reverse voltage transients may be generated that will destroy the A28/A29 especially with high values of I_{FM} and T_J. In these cases R-C suppression should be connected across the A28/A29.



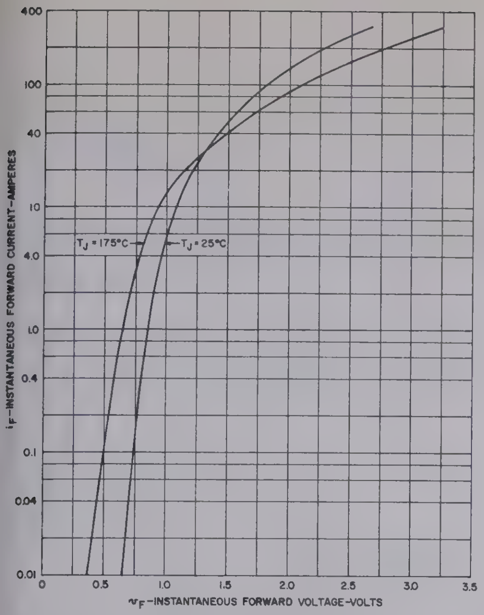
1. Recovered Charge Curves (T_J = +25°C)



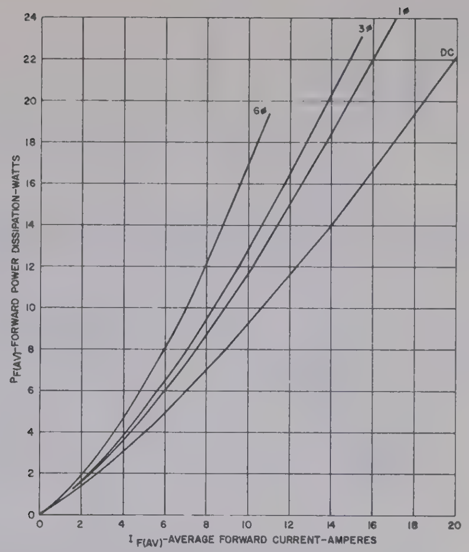
2. Recovered Charge Curves (T_J = +100°C)



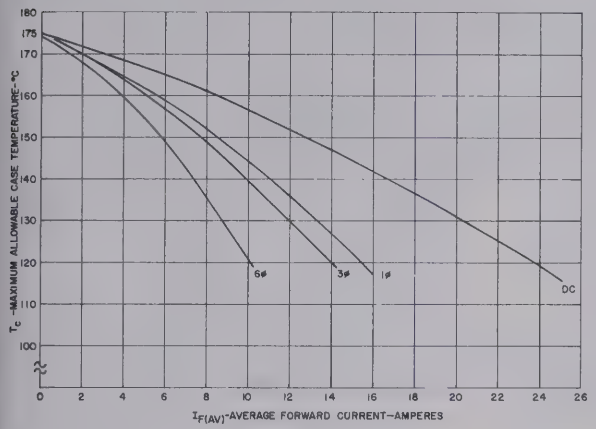
3. Recovered Charge Curves (T_J = +175°C)



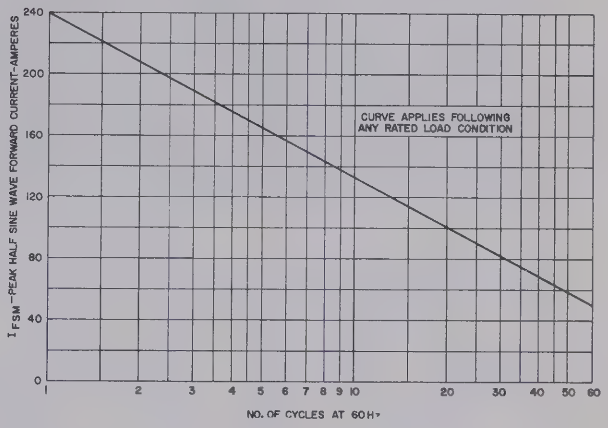
4. Maximum Forward Characteristics



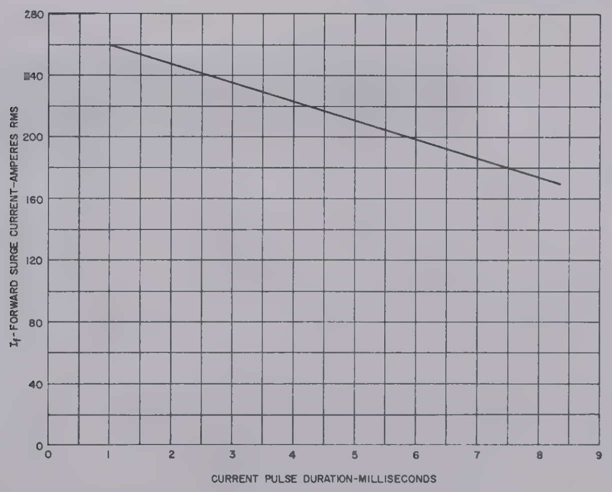
5. Average Forward Power as a Function of Average Forward Current ($T_J = +175°C$)



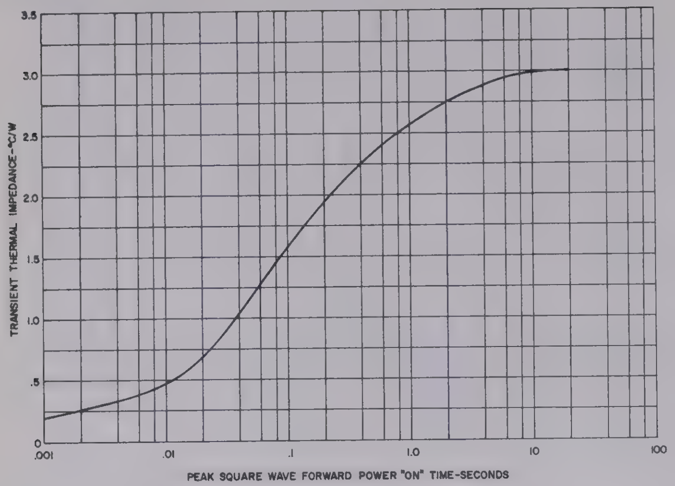
6. Current Rating vs. Case Temperature Curves



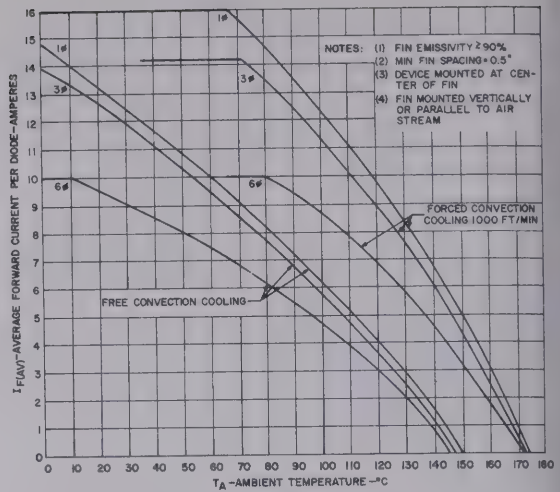
7. Non-Recurrent Multi-Cycle Surge Forward Current



8. Non-Recurrent Sub-Cycle Surge Forward Current



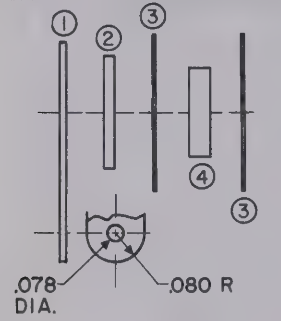
9. DC Transient Thermal Impedance, Junction to Heatsink



10. Current Rating as a Function of Ambient Air Temperature for Device Mounted on 5" x 5" x .050" Copper Fin

OUTLINE DRAWING

INSULATING HARDWARE KIT*


①
②
③
④
③
.078 DIA.
.080 R

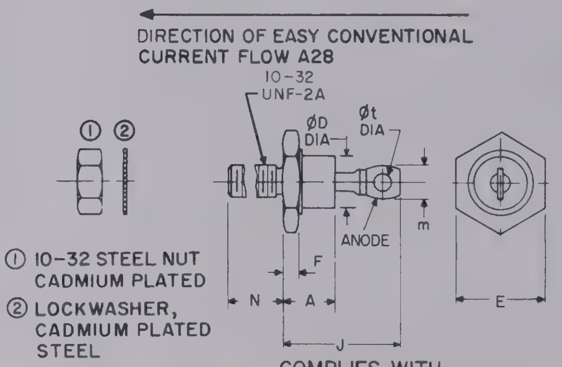
① COPPER TERMINAL, .016 THICK, TIN PLATED

② BRASS WASHER, .035 THICK NICKEL PLATED

③ MICA WASHERS, TWO, .625 O.D., .204 I.D., .005 THICK

④ TEFLON WASHER, .270 O.D. .204 I.D., .050 THICK

* AVAILABLE UPON REQUEST


DIRECTION OF EASY CONVENTIONAL CURRENT FLOW A28
10-32 UNF-2A
ØD DIA
Øt DIA
① ②
ANODE
m
F
N
A
J
E

① 10-32 STEEL NUT CADMIUM PLATED

② LOCKWASHER, CADMIUM PLATED STEEL

COMPLIES WITH
EIA REGISTERED OUTLINE DO-4

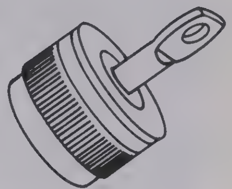
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A		.405		10.29	
ϕD		.424		10.77	
E	.424	.437	10.77	11.10	
F	.075	.175	1.91	4.45	
J		.800		20.32	
m		.250		6.35	1
N	.422	.453	10.72	11.51	
ϕt	.060		1.52		
W					2

NOTES:
1. Angular orientation of this terminal is undefined.
2. 10-32 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter (.1697", 4.29 MM) Ref. (Screw thread standards for Federal Services 1957) Handbook H28 1957 P1.

Silicon Rectifiers

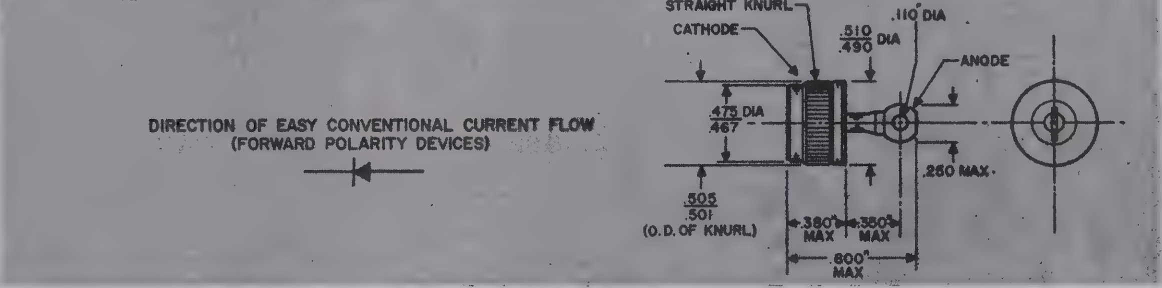
A44F,M
A45F,M

General Electric has designed this 20 Ampere rectifier specifically for the light industrial and consumer low ambient temperature applications. The design utilizes the smallest practical size for the rating with particular attention to rigidity and rugged construction. The solid one-piece terminal provides good mechanical strength, and minimizes breakage problems.



- **High Surge Current Capabilities (Up to 300 Amperes)**
- **One-Piece Terminal**
- **Reverse Polarity Devices Available**
- **Small Size**

OUTLINE DRAWING



RATINGS AND CHARACTERISTICS (Single Phase Resistive Load)

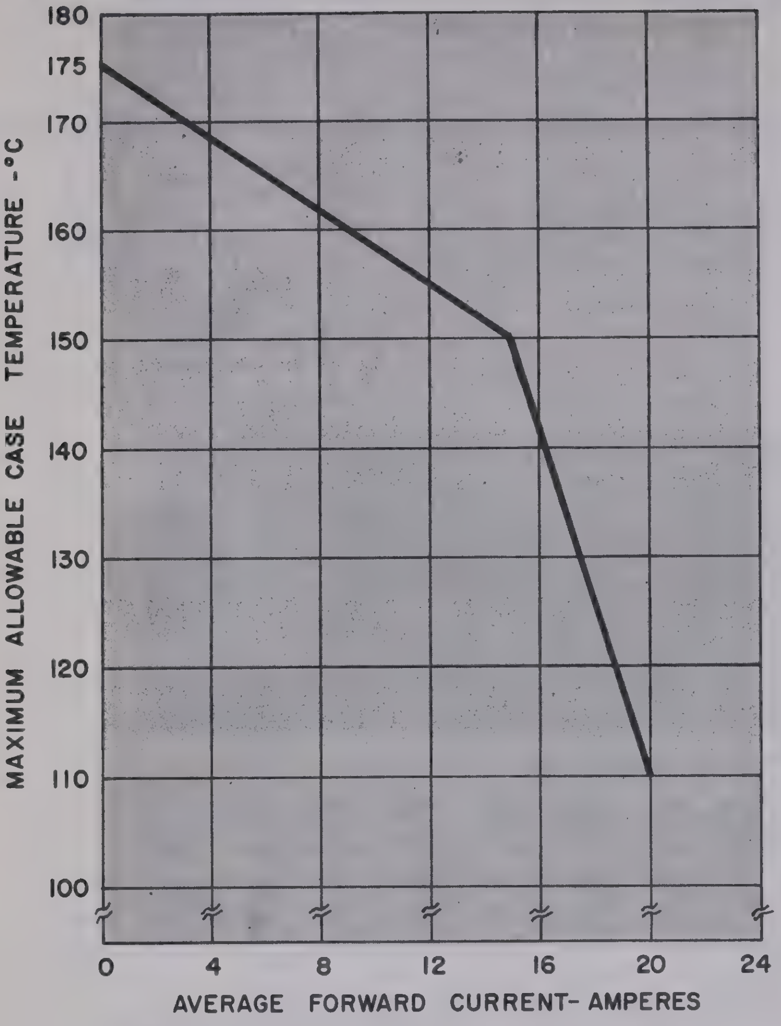
Forward Polarity	A44F	A44A	A44B	A44C	A44D	A44E	A44M	
Reverse Polarity	A45F	A45A	A45B	A45C	A45D	A45E	A45M	
Max. Peak Reverse Voltage	50	100	200	300	400	500	600	volts
Max. Continuous D-C Reverse Voltage	50	100	200	300	400	500	600	volts
Max. Sine Wave RMS Voltage	35	70	140	210	280	350	420	volts
Max. Avg. D-C Forward Current								
At 110°C Case	← 20 amps →							
At 150°C Case	← 15 amps →							
Peak One-cycle Forward Surge Current (60 cps, $T_J = 25°C$)	← 300 amps →							
I^2t Rating for Fusing or Capacitor Inrush	← 100 amp^2 sec →							
Max. Forward Voltage at 20 Amps D-C Forward Current ($T_J = 25°C$)	← 1.2 volts →							
Max. Avg. Forward Voltage Drop (15 amps d-c single phase, $T_J = 150°C$)	← 0.75 volts →							
Max. Reverse Current at Rated D-C Reverse Voltage ($T_J = 25°C$)	← 1.0 ma →							
Max. Full Load Reverse Current (full cycle avg., single phase, $T_J = 150°C$)	10	9	8	6	5	4.5	4.0	ma
Typical Thermal Resistance (junction to case)	← 1.5°C/watt →							
Operating Junction Temperature Range	← −65°C to +175°C →							
Storage Temperature Range	← −65°C to +175°C →							

RECOMMENDED MOUNTING PROCEDURE FOR PRESS-FITTING IN A HEATSINK

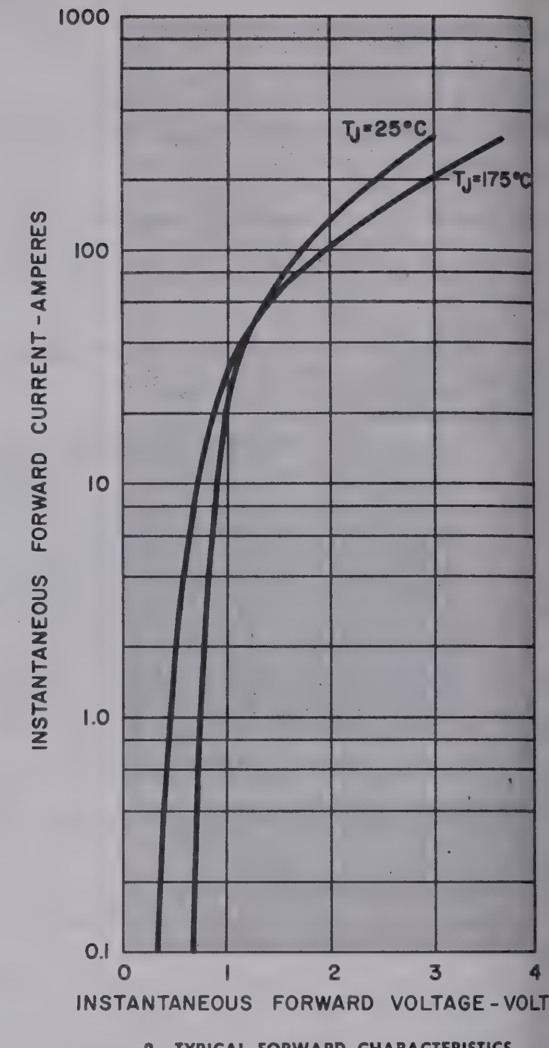
When press-fitting these diodes into a heatsink, the following specifications and recommendations apply.

1. The heatsink thickness should be at least ⅛".
2. The hole diameter into which the diode is pressed should be 0.4975 ± .001 inches. A slight chamfer of the hole should be used.
3. The entire knurled section of the diode should be in contact with the heatsink to insure maximum heat removal.
4. The diode insertion force should not exceed 800 pounds. This force should be uniformly applied to the top face of the diode within an annular ring of diameter .44 ± .05 inches.
5. The thermal resistance between the diode case and the heatsink will not exceed 0.5°C/W if the diode is installed in the manner described above.

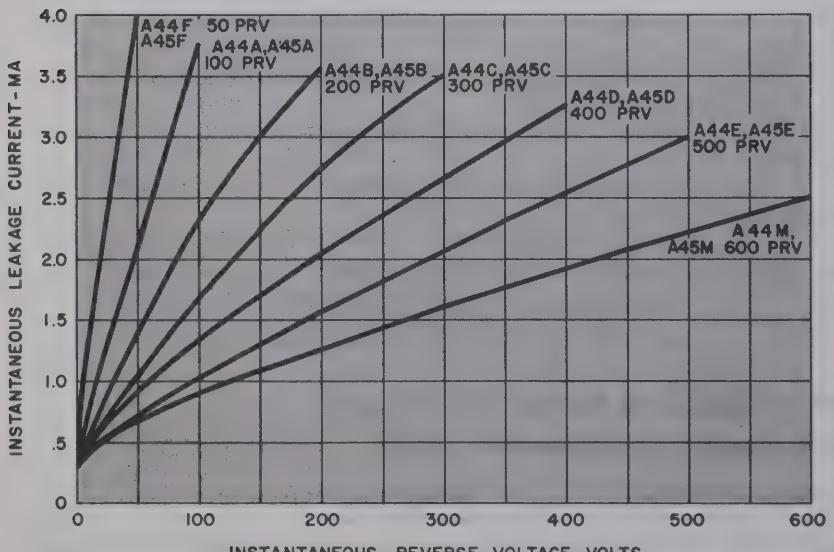
A44F,M
A45F,M



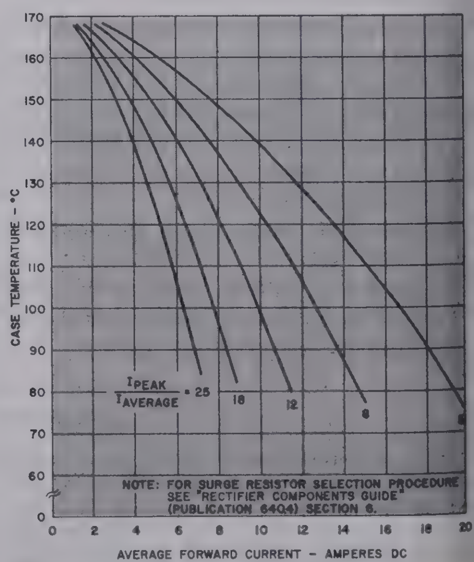
1. SINGLE PHASE AND THREE PHASE CURRENT RATING AS A FUNCTION OF STUD TEMPERATURE



2. TYPICAL FORWARD CHARACTERISTICS



3. TYPICAL REVERSE CHARACTERISTICS ($T_J = 175°C$)



NOTE: FOR SURGE RESISTOR SELECTION PROCEDURE SEE "RECTIFIER COMPONENTS GUIDE" (PUBLICATION 6404) SECTION 6.

4. HALFWAVE CAPACITIVE LOAD RATING

Fast Recovery Rectifier

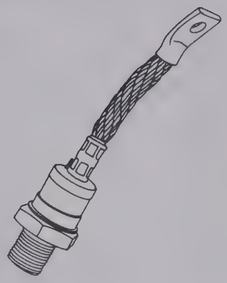
A96,7

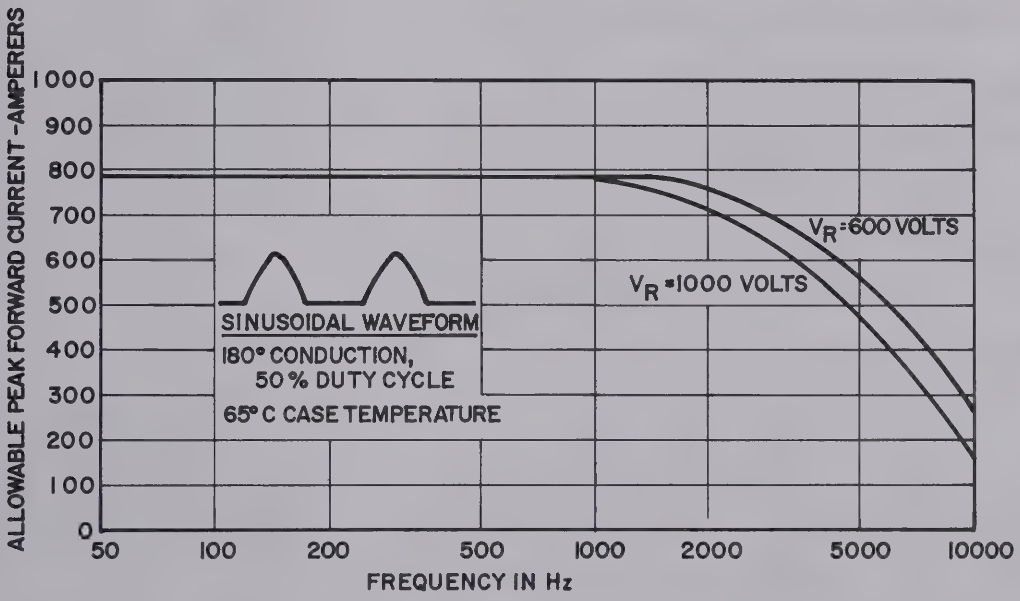
1000 Volts 250 A AVG.

The General Electric Type A96/97 Series of power rectifier diodes is designed for use in high-frequency applications, or where a fast recovery rectifier diode is a necessity. The A96/97 Series is rated up to 10k Hz.

The Type A96/97 features the following characteristics:

- Reverse blocking voltage to 1000 volts
- Fast recovery (low recovered charge)
- Diffused construction
- Forward and reverse polarity
- Fully characterized to 10k Hz





The fast recovery, A96/97, high-current rectifier diode provides a superior combination of speed and blocking voltage capability. This high performance rectifier diode has been designed specifically for such demanding applications as:

- Inverter Feedback Diode
- Free-Wheeling Diode
- High Frequency Rectification

MAXIMUM ALLOWABLE RATINGS

Types	Repetitive Peak Reverse Voltage (PRV) (1)	Transient Peak Reverse Voltage (non-recurrent 5 msec max) (2)	DC Blocking Voltage (3)	Full Load Reverse Current (full - cycle avg., 70°C case temperature, single-phase)
A96A, A97A	100 Volts	200 Volts	100 Volts	16.0 mA
A96B, A97B	200	300	200	16.0
A96C, A97C	300	400	300	16.0
A96D, A97D	400	500	400	16.0
A96E, A97E	500	600	500	15.0
A96M, A97M	600	720	600	12.5
A96S, A97S	700	840	700	12.5
A96N, A97N	800	950	800	10.0
A96T, A97T	900	1075	900	10.0
A96P, A97P	1000	1200	1000	10.0

Average Forward Current (half sine wave, 60 Hz waveform, $T_C = 70^oC$) . . . . 250 Amperes

Peak One-Cycle Surge Current (2) (half sine wave, 60 Hz waveform) . . . . 3300 Amperes

Minimum I^2t Rating (2) (for times ≥ 1.0 msec.) . . . . 28,000 Ampere^2 seconds
(for times ≥ 8.3 msec.) . . . . 43,000 Ampere^2 seconds

Maximum Thermal Resistance, $\Theta_{J\text{-}C}$ . . . . DC . . . . 0.18°C/Watt
1ϕ and 3ϕ (50 to 400 Hz) . . . . 0.22°C/Watt
6ϕ (50 to 400 Hz) . . . . 0.30°C/Watt

Storage and Operating Junction Temperature, T_J . . . . -40°C to +125°C

Stud Torque(4) . . . . 325 Lb-in (Max), 275 Lb-in (Min)
380 Kg-cm(Max, 320 Kg-cm (Min)

Recovered Charge ($T_J = 125^oC$) . . . . 70μ C (Max), 24μ C (Typical), 5μ C (Min)
($T_J = 25^oC$) . . . . 19μ C (Max), 6.6μ C (Typical), 1.8μC (Min)
(Conditions: I_{FM} = 200 amps; di/dt = 50 amps/μ sec)

NOTES:

(1) Assumes a heatsink thermal resistance of less than 2.0°C/watt.

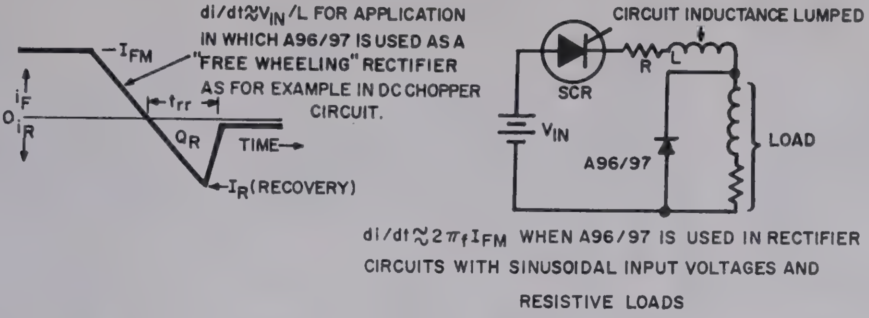
(2) Non-recurrent voltage and current ratings, as contrasted to repetitive ratings, apply for occasional or unpredictable overloads. For example, the forward surge current ratings are non-recurrent ratings that are used in fault coordination work.

(3) Assumes a heatsink thermal resistance of less than 1.0°C/watt.

(4) Use of Burndy's Penetrox "A" between the rectifier base and the heatsink is recommended.

RECOVERY SPECIFICATIONS AND INFORMATION

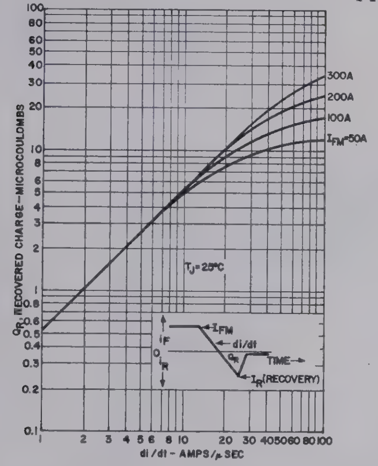
In most power circuits where the rectifier reverse loop, L/R, is large, the A96/97 recovery characteristics are essentially as shown below:


di/dt≈VIN/L FOR APPLICATION IN WHICH A96/97 IS USED AS A "FREE WHEELING" RECTIFIER AS FOR EXAMPLE IN DC CHOPPER CIRCUIT.
−IFM
iF
O
iR
trr
QR
TIME→
←IR(RECOVERY)
CIRCUIT INDUCTANCE LUMPED
R
L
SCR
VIN
A96/97
LOAD
di/dt≈2πfIFM WHEN A96/97 IS USED IN RECTIFIER CIRCUITS WITH SINUSOIDAL INPUT VOLTAGES AND RESISTIVE LOADS

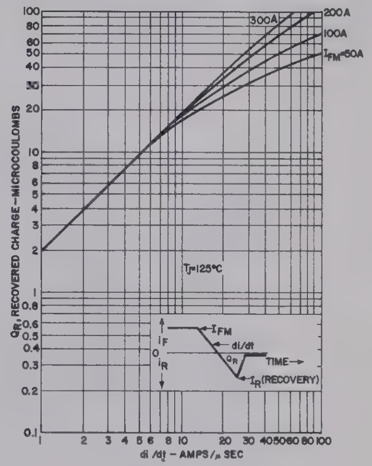
From the curves (Figures 1 and 2) of maximum recovered charge, Q_R, the recovery time, t_{rr}, and peak recovery current (as defined above), I_R (recovery), may be very closely approximated by using the following formulas if I_{FM}, di/dt, and the A96/97 operating junction temperature are known.

$$I_R\ \text{(recovery)} = \sqrt{2\, Q_R\, di/dt} \qquad t_{rr} = \sqrt{\frac{2\, Q_R}{di/dt}}$$

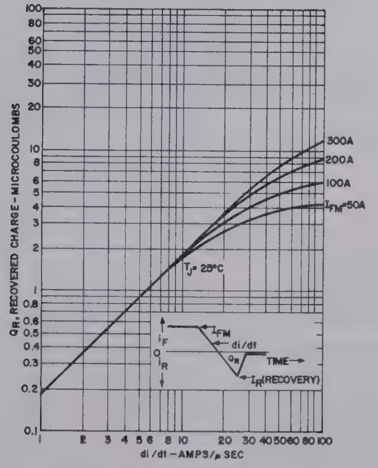
NOTE: At high values of di/dt, reverse voltage transients may be generated that will destroy the A96/97; especially with high values of I_{FM} and T_J. In these cases, R-C suppression should be connected across the A96/97. Refer to Figure 9 for further information on the R-C Suppression circuit.



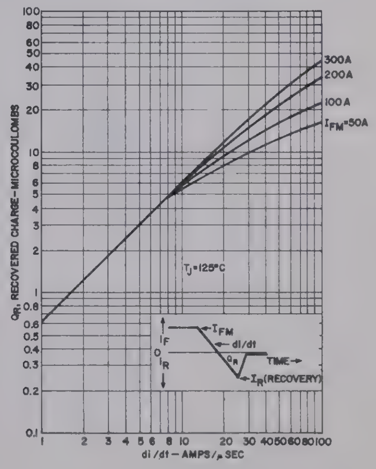
1. Maximum Recovered Charge (T_J = 25°C)



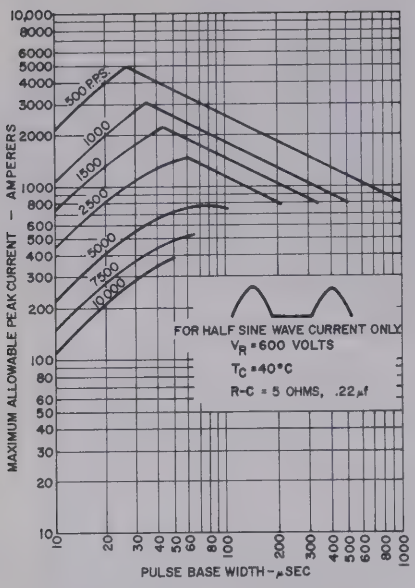
2. Maximum Recovered Charge (T_J = 125°C)



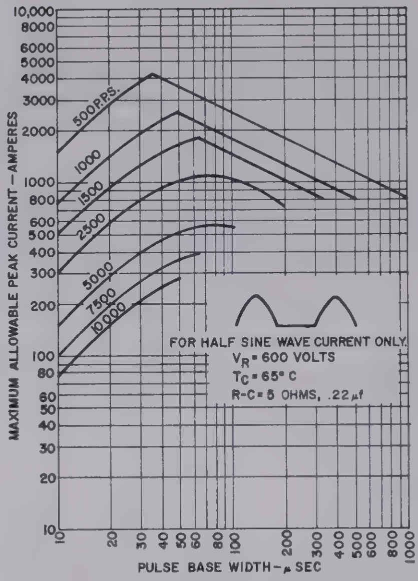
3. Typical Recovered Charge (T_J = 25°C)



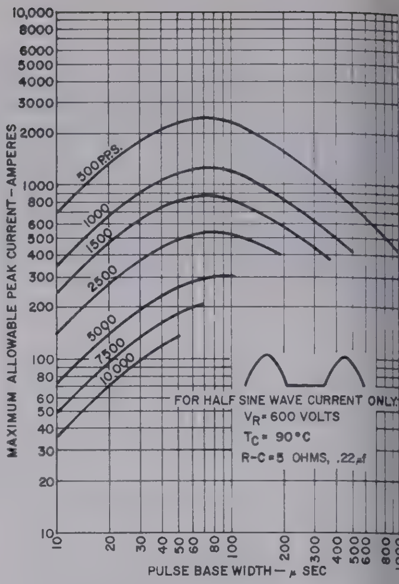
4. Typical Recovered Charge (T_J = 125°C)



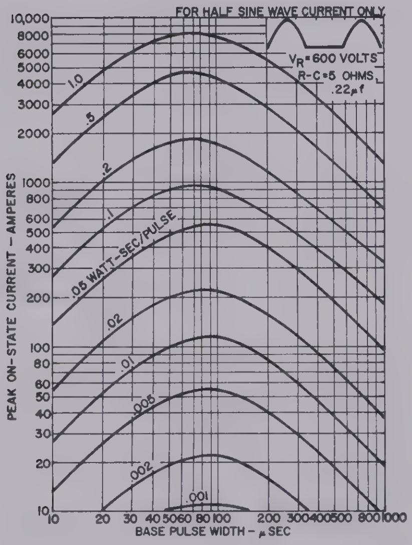
5. Maximum Allowable Peak Current Vs. Pulse Base Width (T_C = 40°C)



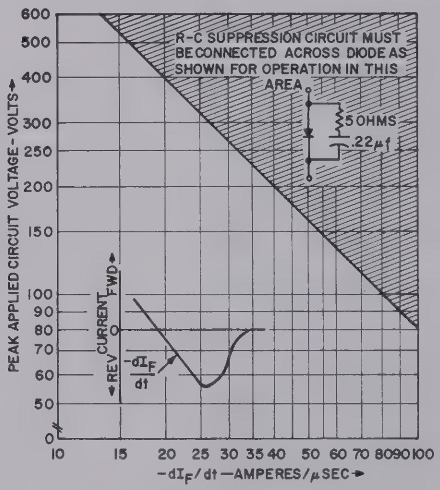
6. Maximum Allowable Peak Current Vs. Pulse Base Width (T_C = 65°C)



7. Maximum Allowable Peak Current Vs. Pulse Base Width (T_C = 90°C)

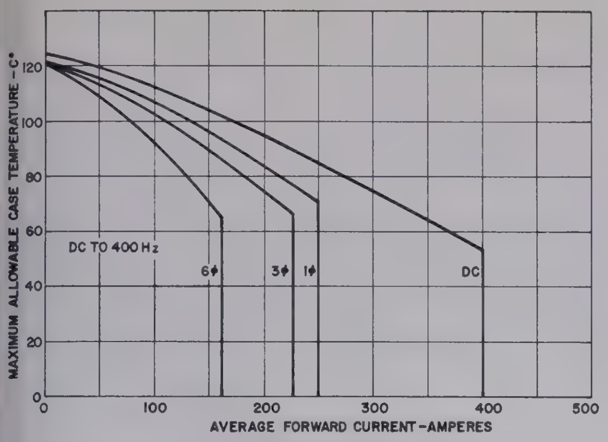


8. Energy per Pulse for Sinusoidal Pulses

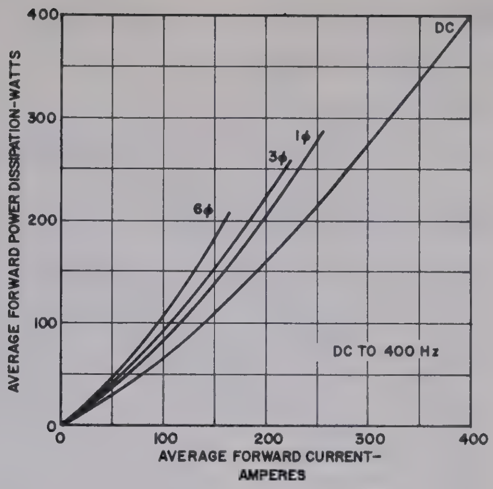


9. Reverse Voltage Vs. di/dt

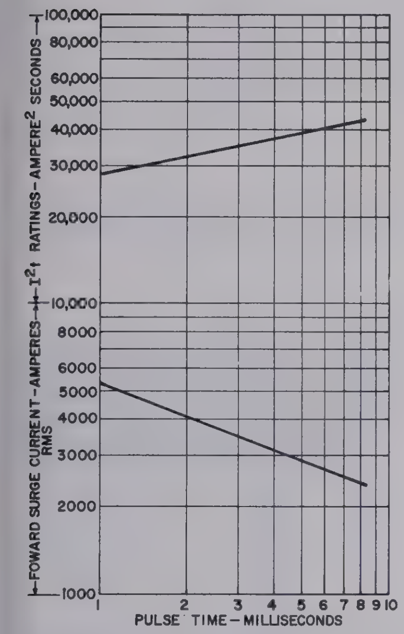
NOTE: It is possible to damage the Type A96/97 rectifier diode by its own commutation transient when commutating conditions fall within the cross-hatched area. The use of the R-C Suppression circuit shown in Figure 9 provides adequate protection.



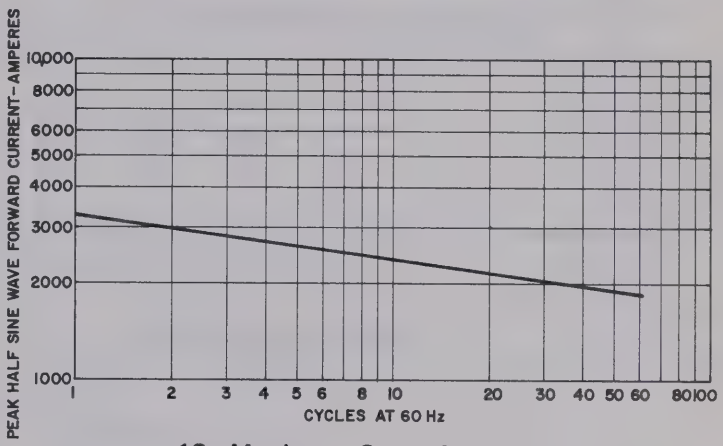
10. Maximum Case Temperature Vs. Average Forward Current



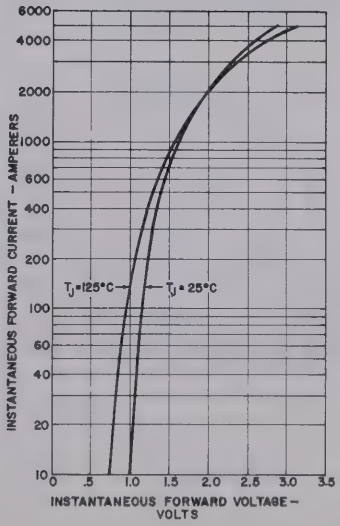
11. Average Forward Power Dissipation Vs. Average Forward Current



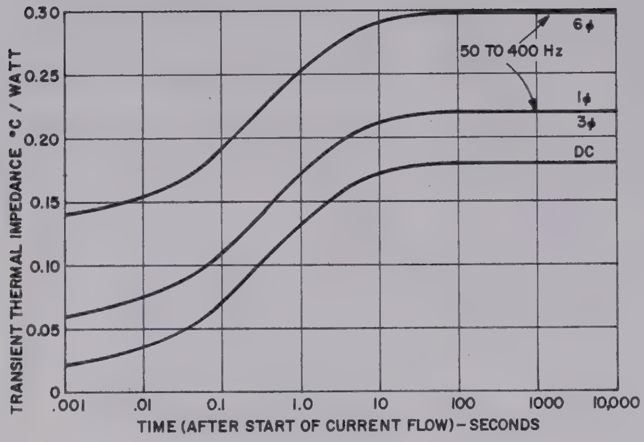
12. Subcycle Surge Forward Current and I²t Rating Following Rated Load Conditions



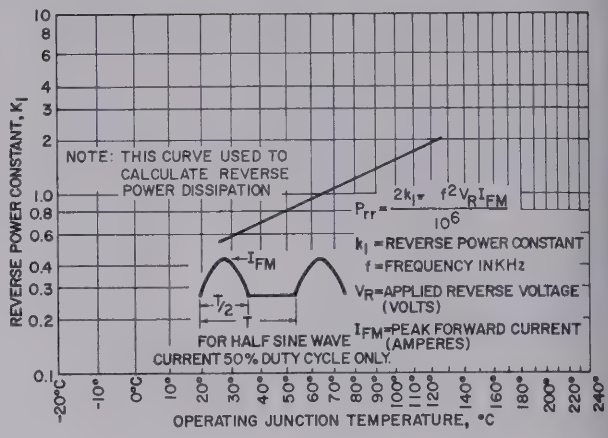
13. Maximum Surge Current Following Rated Load Conditions



14. Maximum Forward Characteristics

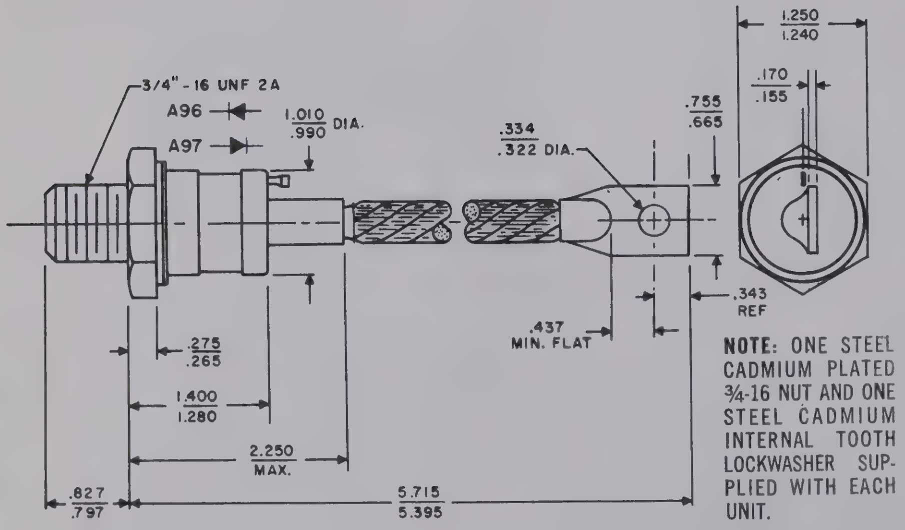


15. Transient Thermal Impedance -- Junction to Case



16. Variation of Reverse Constant as a Function of Operating Junction Temperature

OUTLINE DRAWING


3/4" - 16 UNF 2A
A96
A97
1.010 / .990 DIA.
.334 / .322 DIA.
.755 / .665
1.250 / 1.240
.170 / .155
.343 REF
.437 MIN. FLAT
.275 / .265
1.400 / 1.280
2.250 MAX.
.827 / .797
5.715 / 5.395

NOTE: ONE STEEL CADMIUM PLATED ¾-16 NUT AND ONE STEEL CADMIUM INTERNAL TOOTH LOCKWASHER SUPPLIED WITH EACH UNIT.

Device Configuration complies with EIA Registered Outline DO-9

CONVERSION TABLE	
Inches	Millimeters
.155	3.936
.170	4.318
.265	6.730
.275	6.985
.322	8.178
.334	8.483
.343	8.712
.437	11.099
.665	16.890
.755	19.177
.797	20.243
.827	21.006
.990	25.145
1.010	25.654
1.240	31.495
1.250	31.750
1.280	32.511
1.400	35.560
2.250	57.149
5.395	137.031
5.715	145.160

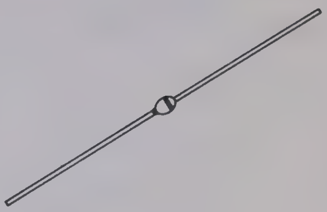
Fast Recovery Rectifier

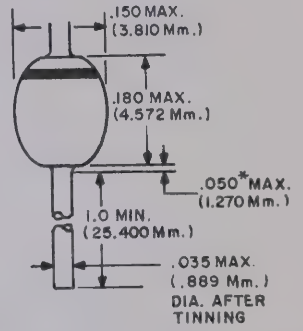
A114A
A114F

2.0 Amps **50-100 Volts**

THE GENERAL ELECTRIC A114 IS A 2.0 AMPERE, AXIAL LEADED, FAST RECOVERY RECTIFIER. DUAL HEATSINK CONSTRUCTION PROVIDES RIGID MECHANICAL SUPPORT FOR THE PELLET AND EXCELLENT THERMAL CHARACTERISTICS. PASSIVATION AND PROTECTION OF THE PN JUNCTION OF THE SILICON PELLET ARE PROVIDED BY SOLID GLASS; NO ORGANIC MATERIALS ARE PRESENT WITHIN THE HERMETICALLY-SEALED PACKAGE.

The A114 design provides protection against voltage transients generated by household or industrial power lines. These transients may be safely dissipated when this rectifier is utilized within the ratings described in this specification.





ALL DIMENTIONS ARE IN INCHES AND (METRIC)
*WELD AND SOLDER FLASH NOT CONTROLLED IN THIS AREA

OUTLINE DRAWING

absolute maximum ratings: (25°C unless otherwise specified)

	A114F	A114A	
Reverse Voltage (−65°C to +150°C, T_J)			
Working Peak, V_{RWM}	50	100	Volts
Repetitive Peak, V_{RRM}	50	100	Volts
DC, V_R	50	100	Volts
Average Forward Current, I_O			
55°C ambient (see Rating Curves)	← 1.0 →		Amperes
25°C	← 2.0 →		Amperes
Peak Surge Forward Current, I_{FSM}			
Non-rep., .0083 sec., half sine wave, Full load JEDEC method	← 40 →		Amperes
Non-rep., .001 sec., half sine wave, Full load @ +125°C, T_J	← 85 →		Amperes
I^2t (for fusing), RMS			
.001 to .01 seconds	← 3.5 →		$Amp^2secs.$
Junction Temperature Range			
Operating, T_J	−65°C to +150°C		
Storage, T_{STG}	−65°C to +175°C		

Mounting: Any position. Lead temperature 290°C max. to ⅛″ from body for 5 seconds max. during mounting.

electrical characteristics: (25°C unless otherwise specified)

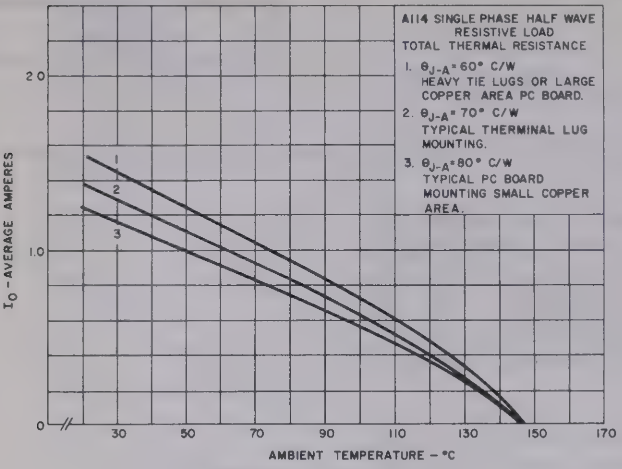
	A114F	A114A	
Maximum Forward Voltage Drop, V_{FM}			
$I_{FM} = 1.0A$, $T_J = +25°C$	← 1.1 →		Volts
Maximum Reverse Current, I_{RM} @ rated V_{RM}			
$T_J = +25°C$	5	5	Microamps.
$T_J = +125°C$	500	500	Microamps.
Typical Reverse Recovery Time, t_{rr}	← 140 →		Nanosecs.
Maximum Reverse Recovery Time, t_{rr}	← 200 →		Nanosecs.

Recovery circuit per MIL-S-19500/286C.

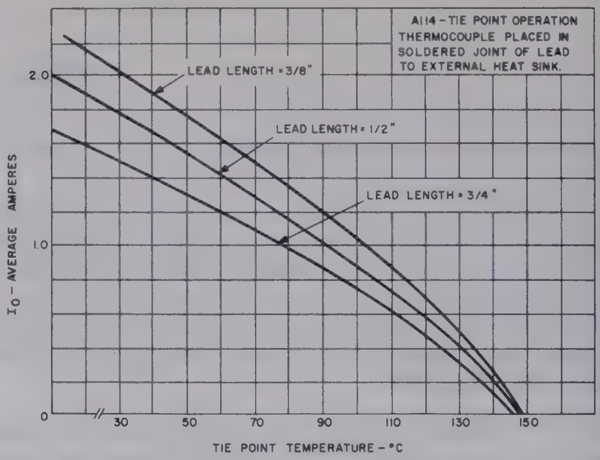
CIRCUIT DESIGN INFORMATION

MAXIMUM ALLOWABLE DC OUTPUT CURRENT RATINGS

SINGLE PHASE, RESISTIVE AND INDUCTIVE LOADS

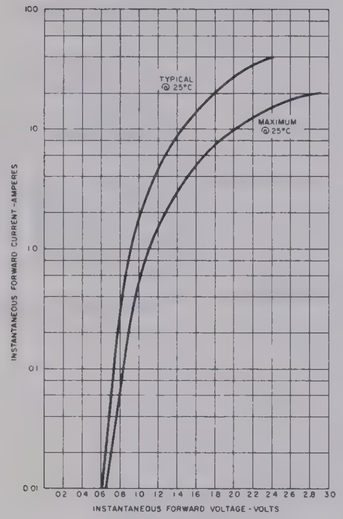


AMBIENT OPERATION

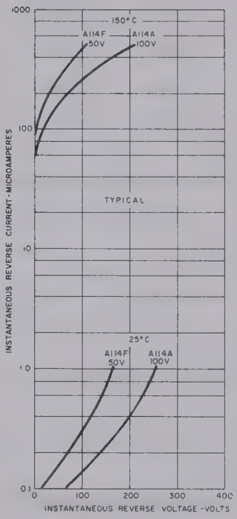


TIE POINT OPERATION

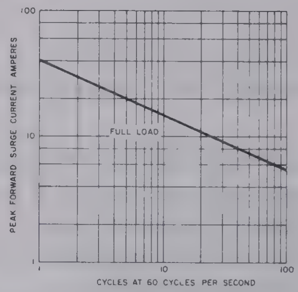
TYPICAL CHARACTERISTICS



FORWARD CHARACTERISTICS

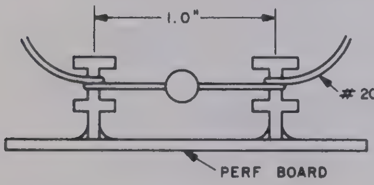


REVERSE CHARACTERISTICS

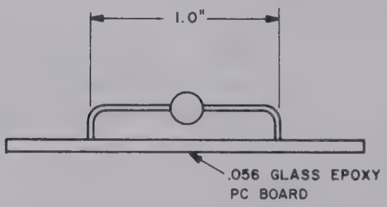


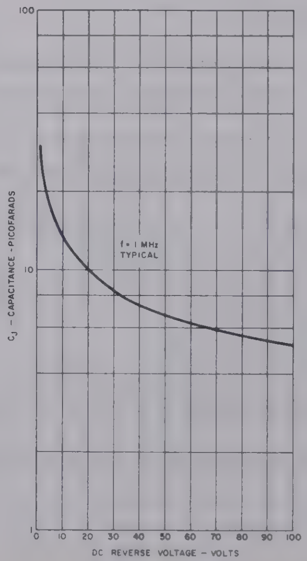
MAXIMUM NON-REPETITIVE MULTICYCLE FORWARD SURGE CURRENT

TYPICAL TIE LUG MOUNTS


1.0"
# 20 WIRE
PERF BOARD

TYPICAL PC BOARD MOUNTING


1.0"
.056 GLASS EPOXY
PC BOARD



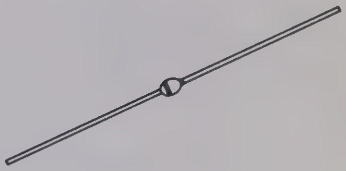
JUNCTION CAPACITANCE

Fast Recovery Rectifier

2.0 Amps **200-600 Volts**

A114B
A114C
A114D
A114E
A114M

THE GENERAL ELECTRIC A114 IS A 2.0 AMPERE, AXIAL-LEADED, FAST RECOVERY RECTIFIER. DUAL HEATSINK CONSTRUCTION PROVIDES RIGID MECHANICAL SUPPORT FOR THE PELLET AND EXCELLENT THERMAL CHARACTERISTICS. PASSIVATION AND PROTECTION OF THE PN JUNCTION OF THE SILICON PELLET ARE PROVIDED BY SOLID GLASS; NO ORGANIC MATERIALS ARE PRESENT WITHIN THE HERMETICALLY-SEALED PACKAGE.



The A114 design provides protection against voltage transients generated by household or industrial power lines. These transients may be safely dissipated when this rectifier is utilized within the ratings described in this specification.

absolute maximum ratings: (25°C unless otherwise specified)

	A114B	A114C	A114D	A114E	A114M	
Reverse Voltage (−65°C to +150°C, T_J)						
Working Peak, V_{RWM}	200	300	400	500	600	Volts
Repetitive Peak, V_{RRM}	200	300	400	500	600	Volts
DC, V_R	200	300	400	500	600	Volts
Average Forward Current, I_O						
75°C ambient (see Rating Curves)	← 1.0 →					Amperes
25°C " "	← 2.0 →					Amperes
Peak Surge Forward Current, I_{FSM}						
Non-rep., .0083 sec., half sine wave, Full load JEDEC method	← 40 →					Amperes
Non-rep., .001 sec., half sine wave, Full load @ +150°C, T_J	← 85 →					Amperes
I^2t (for fusing), RMS						
.001 to .01 seconds	← 3.5 →					$Amp^2secs.$
Junction Temperature Range						
Operating, T_J	← −65°C to +150°C →					
Storage, T_{STG}	← −65°C to +175°C →					

Mounting: Any position. Lead temperature 290°C max. to ⅛″ from body for 5 seconds max. during mounting.

electrical characteristics: (25°C unless otherwise specified)

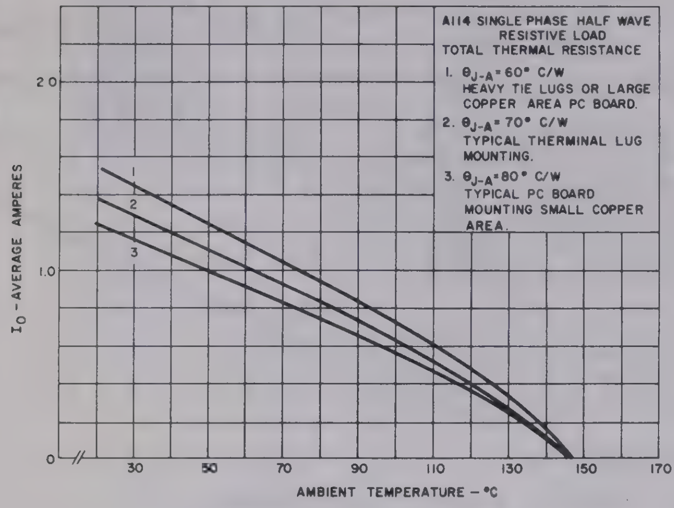
	A114B	A114C	A114D	A114E	A114M	
Maximum Forward Voltage Drop, V_{FM}						
$I_{FM} = 1.0A$, $T_A = +25°C$	← 1.1 →					Volts
Maximum Reverse Current, I_{RM} @ rated V_{RM}						
$T_J = +25°C$	5	5	5	5	5	Microamps.
$T_J = +150°C$	300	300	500	500	500	Microamps.
Typical I_{RM} @ 25°C	1	1	1	1	1	Microamps.
Typical Reverse Recovery Time, t_{rr}	← 140 →					Nanosecs.
Maximum Reverse Recovery Time, t_{rr}	← 200 →					Nanosecs.

Recovery circuit per MIL-S-19500/286C.

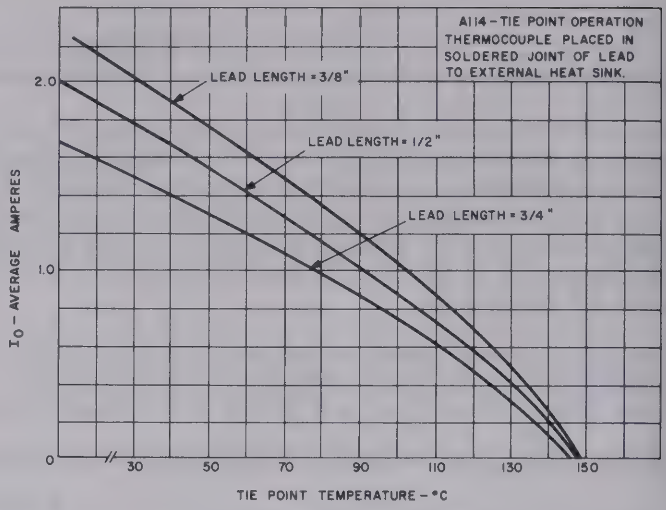
CIRCUIT DESIGN INFORMATION

MAXIMUM ALLOWABLE DC OUTPUT CURRENT RATINGS

SINGLE PHASE, RESISTIVE AND INDUCTIVE LOADS



AMBIENT OPERATION



TIE POINT OPERATION

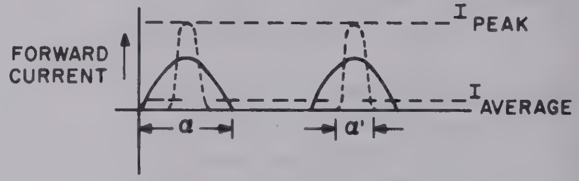
CAPACITIVE LOADS

Current Derating (capacitive load)

Average forward current as specified under maximum ratings, page 1, and derating curves for high temperature operation, above, must be corrected for applications with capacitive loads. As the current conduction angle, α', is decreased, the peak current required to maintain the *same average current* increases, i.e., the peak-to-average current ratio increases from 3.14. Figure 3 gives the derating required based on this increase in peak to average current ratio for sine wave operation. For more complete information consult Application Note 200.30.

METHOD:
1. Determine conduction angle α' in degrees for *particular circuit as designed.*
2. Enter Figure 3 for the particular conduction angle and read corresponding percent of forward current per cell.
3. Multiply this value times average forward current for resistive load from figures 1 and 2 as given for the actual ambient or tie point temperature required.

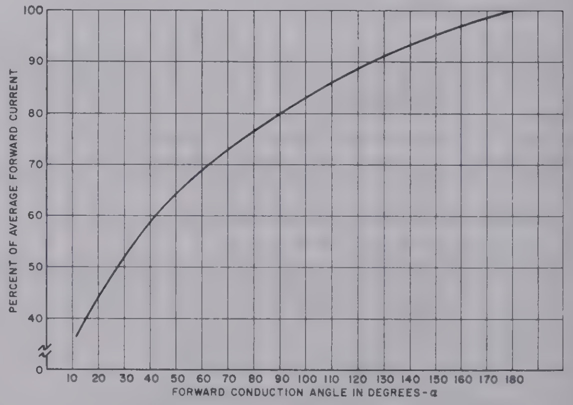
See Typical Examples Below



α = CONDUCTION ANGLE (180°)
α' = SHORTENED CONDUCTION ANGLE

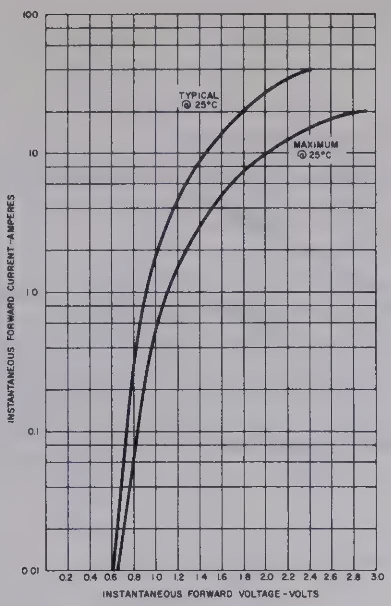
OSCILLOSCOPE PRESENTATION

TYPICAL EXAMPLES (25°C Ambient Temperature)	Example No. 1	Example No. 2	Example No. 3	Example No. 4	Units
Conduction Angle (α)	170	110	130	70	Degrees
Rated Average Current (Resistive Load)	1	1	1	1	Amp.
% of Average Current	0.98	0.86	0.92	0.73	%
Rated Average Current (Capacitive Load)	0.98	0.86	0.92	0.73	Amps.

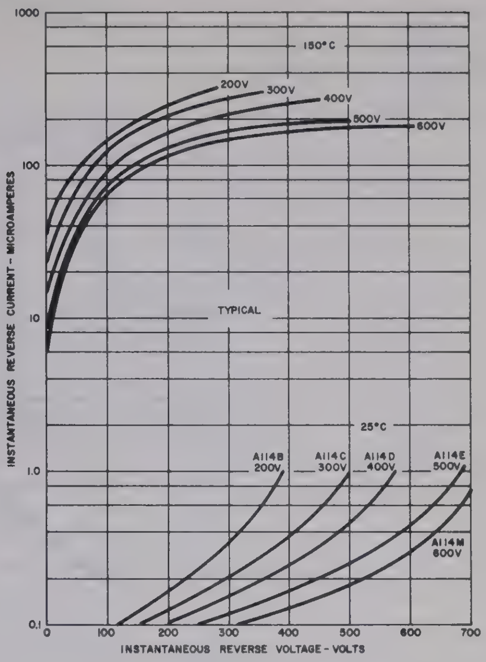


DERATING FOR SHORTENED CONDUCTION ANGLE

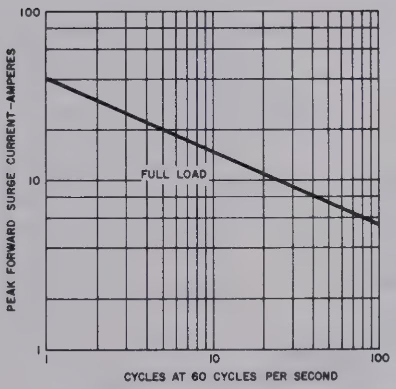
TYPICAL CHARACTERISTICS



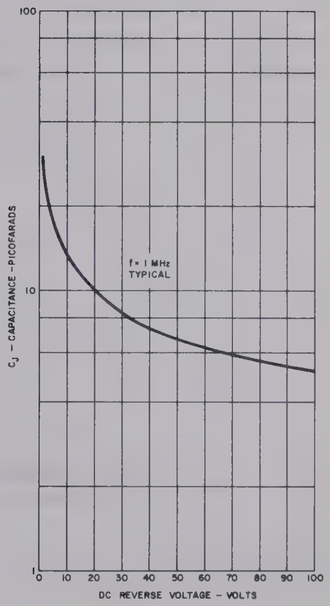
FORWARD CHARACTERISTICS



REVERSE CHARACTERISTICS

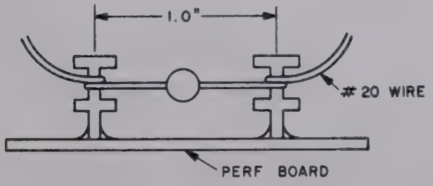


MAXIMUM NON-REPETITIVE MULTICYCLE FORWARD SURGE CURRENT

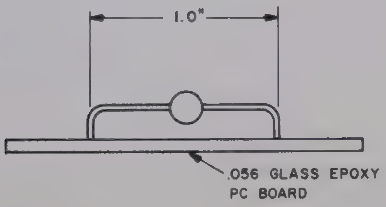


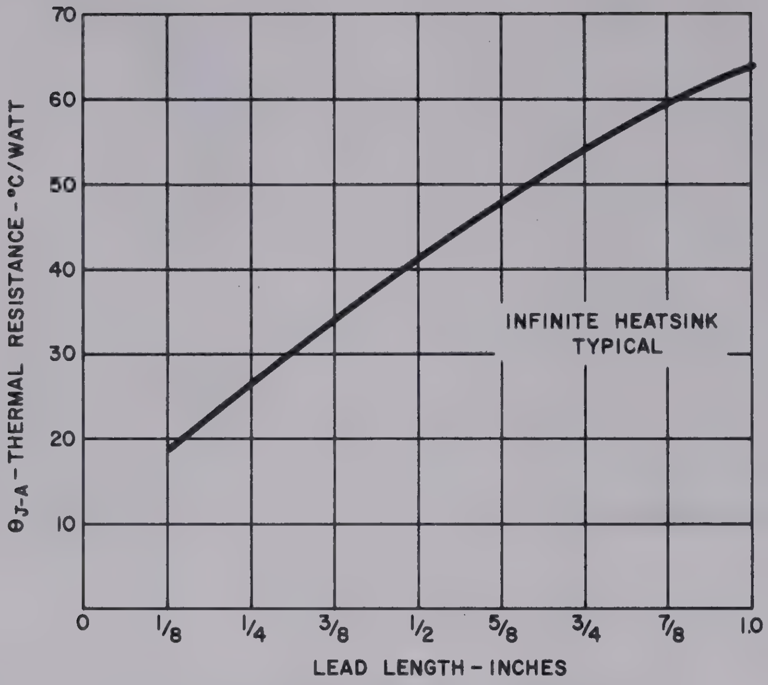
JUNCTION CAPACITANCE

TYPICAL TIE LUG MOUNTS


1.0"
# 20 WIRE
PERF BOARD

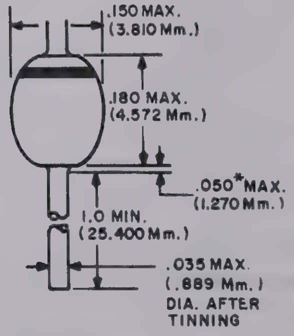
TYPICAL PC BOARD MOUNTING


1.0"
.056 GLASS EPOXY
PC BOARD



STEADY STATE THERMAL RESISTANCE

Marking band to appear on cathode end.


.150 MAX.
(3.810 Mm.)
.180 MAX.
(4.572 Mm.)
.050* MAX.
(1.270 Mm.)
1.0 MIN.
(25.400 Mm.)
.035 MAX.
(.889 Mm.)
DIA. AFTER
TINNING

ALL DIMENTIONS ARE IN INCHES
AND (METRIC)
*WELD AND SOLDER FLASH NOT
CONTROLLED IN THIS AREA

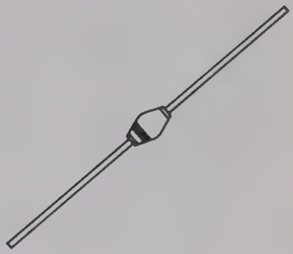
OUTLINE DRAWING

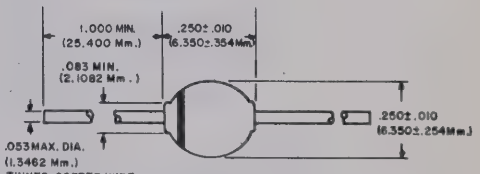
Fast Recovery Rectifier

A115A
A115F

5.0 Amps 50-100 Volts

THE GENERAL ELECTRIC A115 IS A 5.0 AMPERE, AXIAL-LEADED, FAST RECOVERY RECTIFIER. DUAL HEATSINK CONSTRUCTION PROVIDES RIGID MECHANICAL SUPPORT FOR THE PELLET AND EXCELLENT THERMAL CHARACTERISTICS. PASSIVATION AND PROTECTION OF THE PN JUNCTION OF THE SILICON PELLET ARE PROVIDED BY SOLID GLASS; NO ORGANIC MATERIALS ARE PRESENT WITHIN THE HERMETICALLY-SEALED PACKAGE.





ALL DIMENSIONS ARE IN INCHES AND (METRIC)

absolute maximum ratings: (25°C unless otherwise specified)

	A115F	A115A	
Reverse Voltage (–65°C to +150°C, T_J)			
Working Peak, $V_{R'VM}$	50	100	Volts
Repetitive,Peak, V_{RRM}	50	100	Volts
DC, V_R	50	100	Volts
Average Forward Current, I_o			
55°C ambient (see Rating Curves)	← 3.0 →		Amperes
25°C ambient (see Rating Curves)	← 5.0 →		Amperes
Peak Surge Forward Current, I_{FSM}			
Non-rep., .0083 sec., half sine wave, Full load JEDEC method	← 110 →		Amperes
Non-rep., .001 sec., half sine wave, Full load @ +150°C, T_J	← 200 →		Amperes
I^2t (for fusing), RMS			
.001 to .01 seconds	← 20.0 →		Amp^2 secs.
Junction Temperature Range			
Operating, T_J	–65°C to +150°C		
Storage, T_{STG}	–65°C to +175°C		

Mounting: Any position. Lead temperature 290°C max.. to 1/8" from body for 5 seconds max. during mounting.

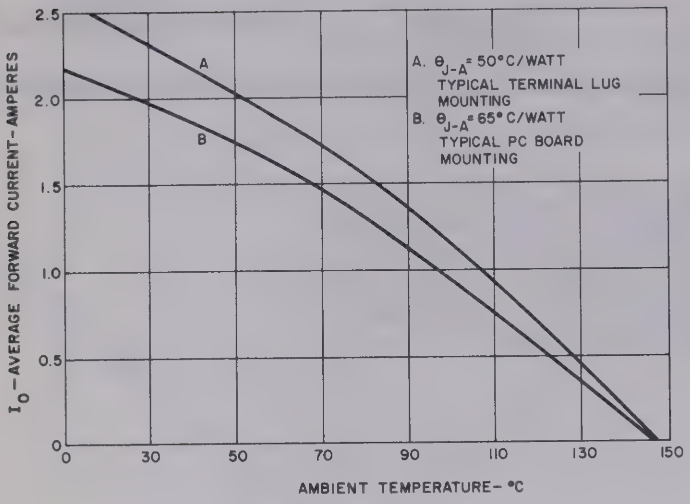
electrical characteristics:

Maximum Forward Voltage Drop, V_{FM}			
I_{FM} = 3.0A, T_J = +25°C	← 1.0 →		Volts
Maximum Reverse Current, I_{RM} @ rated V_{RM}			
T_J = +25°C	5	5	Microamps.
T_J = +150°C	500	500	Microamps.
Typical Reverse Recovery Time, t_{rr}	← 140 →		Nanosecs.
Maximum Reverse Recovery Time, t_{rr}	← 200 →		Nanosecs.

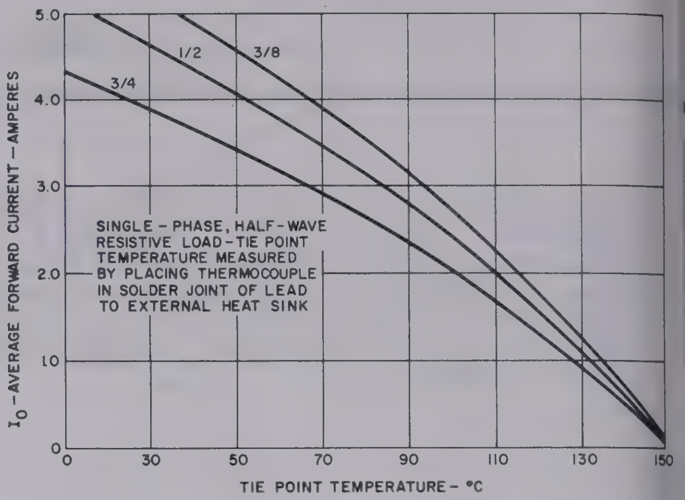
Recovery circuit per MIL-S-19500/286C.

CIRCUIT DESIGN INFORMATION

MAXIMUM ALLOWABLE DC OUTPUT CURRENT RATINGS
SINGLE PHASE, RESISTIVE AND INDUCTIVE LOADS

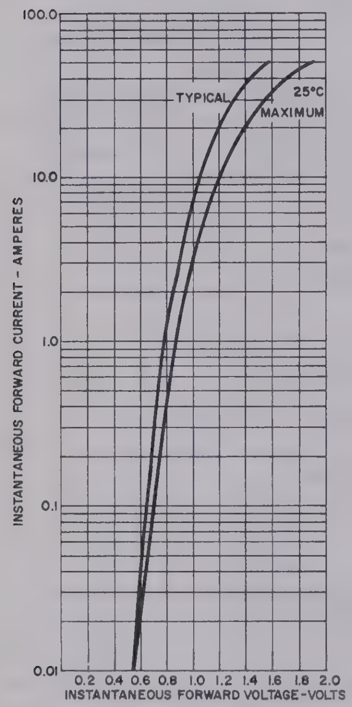


1. AMBIENT OPERATION

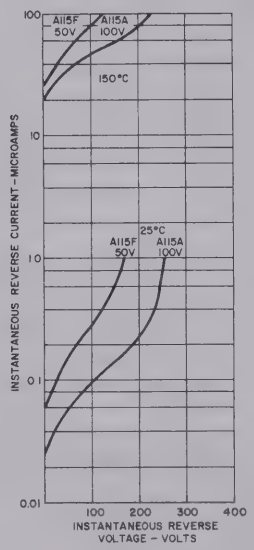


2. TIE POINT OPERATION

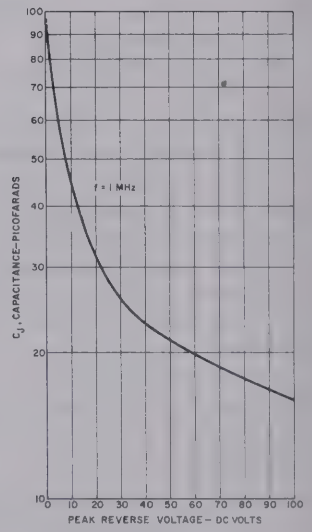
TYPICAL CHARACTERISTICS



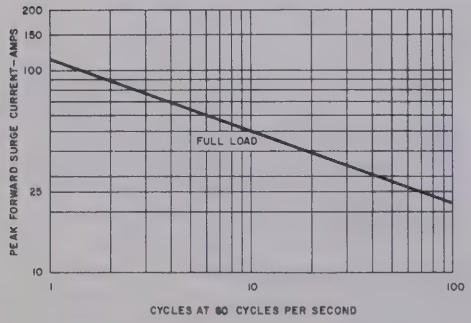
FORWARD CHARACTERISTICS



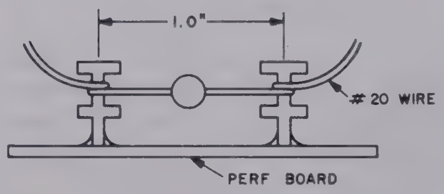
REVERSE CHARACTERISTICS



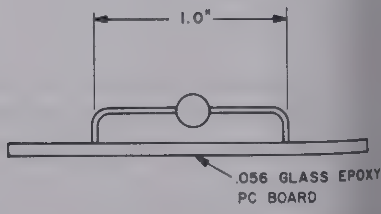
JUNCTION CAPACITANCE



MAXIMUM NON-REPETITIVE MULTICYCLE FORWARD SURGE CURRENT


1.0"
# 20 WIRE
PERF BOARD

TYPICAL TIE LUG MOUNTS


1.0"
.056 GLASS EPOXY
PC BOARD

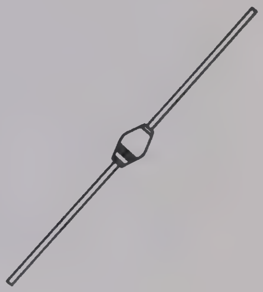
TYPICAL PC BOARD MOUNTING

Fast Recovery Rectifier

A115B
A115C
A115D
A115E
A115M

5.0 Amps **200-600 Volts**

THE GENERAL ELECTRIC A115 IS A 5.0 AMPERE, AXIAL-LEADED, FAST RECOVERY RECTIFIER. DUAL HEATSINK CONSTRUCTION PROVIDES RIGID MECHANICAL SUPPORT FOR THE PELLET AND EXCELLENT THERMAL CHARACTERISTICS. PASSIVATION AND PROTECTION OF THE PN JUNCTION OF THE SILICON PELLET ARE PROVIDED BY SOLID GLASS; NO ORGANIC MATERIALS ARE PRESENT WITHIN THE HERMETICALLY-SEALED PACKAGE.



The A115 design provides protection against voltage transients generated by household or industrial power lines. These transients may be safely dissipated when this rectifier is utilized within the ratings described in this specification.

absolute maximum ratings: (25°C unless otherwise specified)

	A115B	A115C	A115D	A115E	A115M	
Reverse Voltage (−65°C to +150°C, T_J)						
Working Peak, V_{RWM}	200	300	400	500	600	Volts
Repetitive Peak, V_{RRM}	200	300	400	500	600	Volts
DC, V_R	200	300	400	500	600	Volts
Average Forward Current, I_o						
55°C ambient (see Rating Curves)	←		3.0		→	Amperes
25°C ambient (see Rating Curves)	←		5.0		→	Amperes
Peak Surge Forward Current, I_{FSM}						
Non-rep., .0083 sec., half sine wave, Full load JEDEC method	←		110		→	Amperes
Non-rep., .001 sec. half sine wave, Full load @ +150°C, T_J	←		200		→	Amperes
I^2t (for fusing), RMS .001 to .01 seconds	←		20.0		→	Amp² secs.
Junction Temperature Range						
Operating, T_J	←		−65°C to +150°C		→	
Storage, T_{STG}	←		−65°C to +175°C		→	

Mounting: Any position. Lead temperature 290°C max. to 1/8" from body for 5 seconds max. during mounting.

electrical characteristics: (25°C unless otherwise specified)

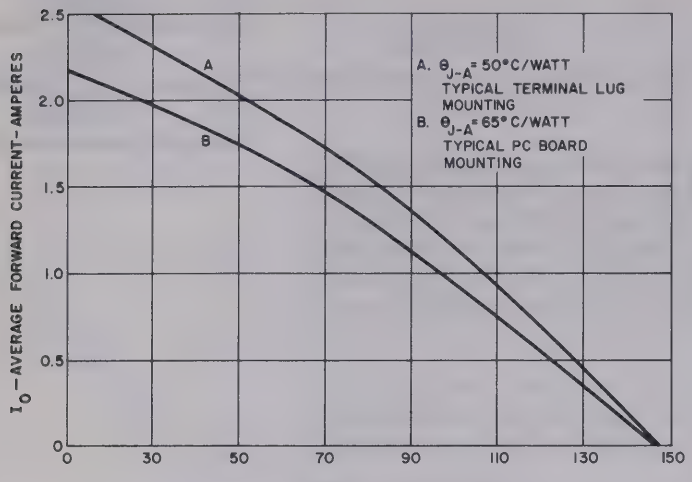
	A115B	A115C	A115D	A115E	A115M	
Maximum Forward Voltage Drop, V_{FM}						
I_{FM} = 3.0A, T_A = +25°C	←		1.0		→	Volts
Maximum Reverse Current, I_{RM} @ rated V_{RM}						
T_J = +25°C	5	5	5	5	5	Microamps.
T_J = +150°C	300	300	300	200	200	Microamps.
Typical Reverse Recovery Time, t_{rr}	←		140		→	Nanosecs.
Maximum Reverse Recovery Time, t_{rr}	←		200		→	Nanosecs.

Recovery circuit per MIL-S-19500/286°C

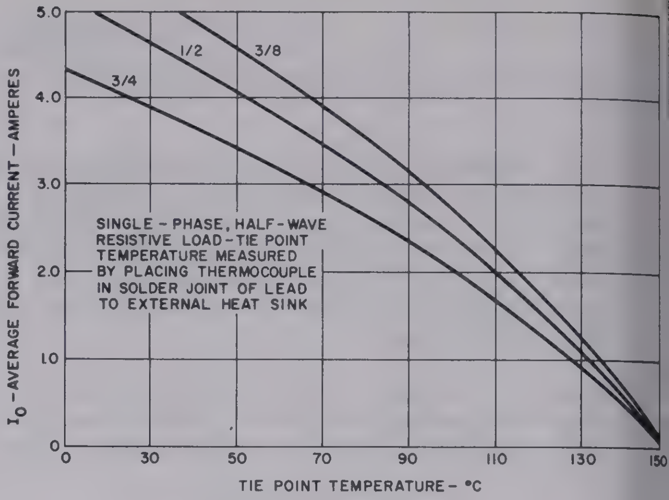
CIRCUIT DESIGN INFORMATION

MAXIMUM ALLOWABLE DC OUTPUT CURRENT RATINGS

SINGLE PHASE, RESISTIVE AND INDUCTIVE LOADS



AMBIENT OPERATION



TIE POINT OPERATION

CAPACITIVE LOADS

Current Derating (capacitive load)

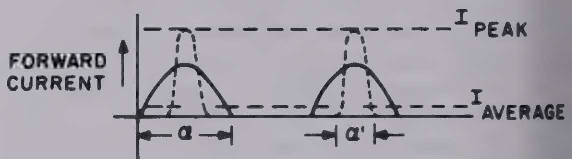
Average forward current as specified under maximum ratings, page 1, and derating curves for high temperature operation, above, must be corrected for applications with capacitive loads. As the current conduction angle, α′, is decreased, the peak current required to maintain the *same average current* increases, i.e., the peak-to-average current ratio increases from 3.14. Figure 3 gives the derating required based on this increase in peak to average current ratio for sine wave operation. For more complete information consult Application Note 200.30.

METHOD: 1. Determine conduction angle α′ in degrees for *particular circuit as designed.*

2. Enter Figure 3 for the particular conduction angle and read corresponding percent of forward current per cell.

3. Multiply this value times average forward current for resistive load from figures 1 and 2 as given for the actual ambient or tiepoint temperature required.

See Typical Examples Below

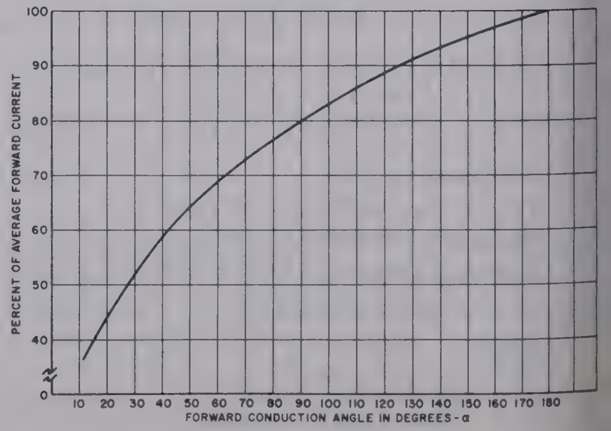


α = CONDUCTION ANGLE (180°)

α' = SHORTENED CONDUCTION ANGLE

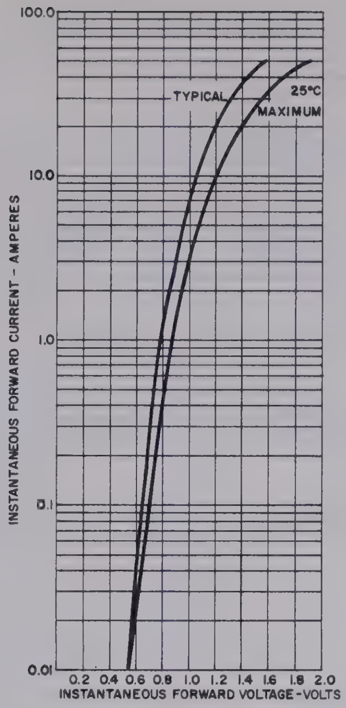
OSCILLOSCOPE PRESENTATION

TYPICAL EXAMPLES (25°C Ambient Temperature)					
	Example No. 1	Example No. 2	Example No. 3	Example No. 4	Units
Conduction Angle (α)	170	110	130	70	Degrees
Rated Average Current (Resistive Load)	3	3	3	3	Amp.
% of Average Current	0.98	0.86	0.92	0.73	%
Rated Average Current (Capacitive Load)	2.9	2.6	2.8	2.2	Amps.

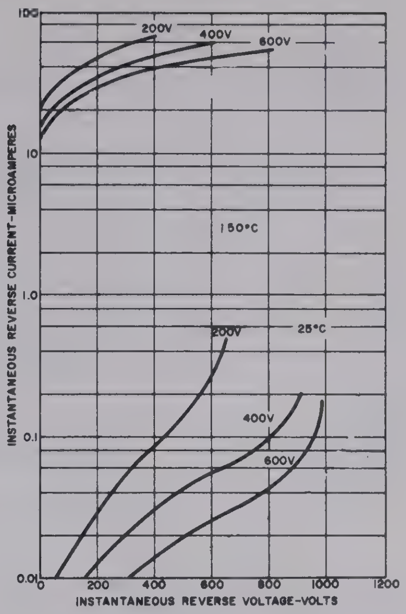


DERATING FOR SHORTENED CONDUCTION ANGLE

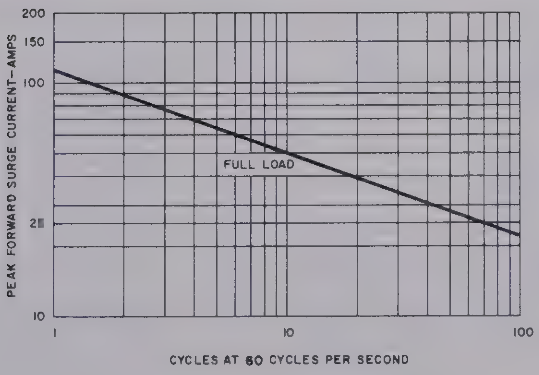
TYPICAL CHARACTERISTICS



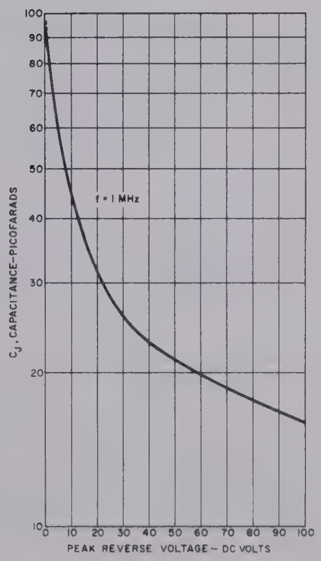
FORWARD CHARACTERISTICS



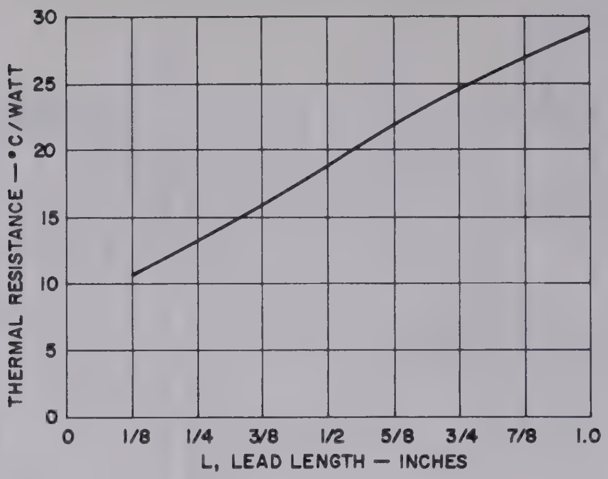
REVERSE CHARACTERISTICS



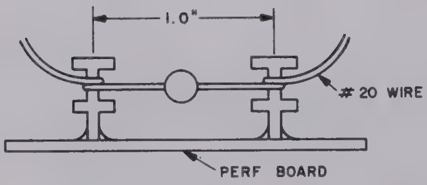
MAXIMUM NON-REPETITIVE
MULTICYCLE FORWARD SURGE CURRENT



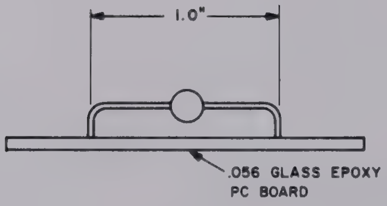
JUNCTION CAPACITANCE



STEADY STATE THERMAL RESISTANCE

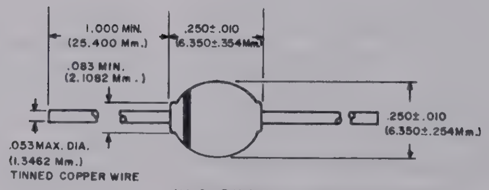

1.0"
# 20 WIRE
PERF BOARD

TYPICAL TIE LUG MOUNTS


1.0"
.056 GLASS EPOXY
PC BOARD

TYPICAL PC BOARD MOUNTING

OUTLINE DRAWING

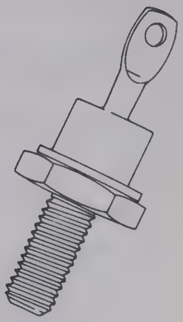

1.000 MIN.
(25.400 Mm.)
.250± .010
(6.350±.354Mm.)
.083 MIN.
(2.1082 Mm.)
.250± .010
(6.350±.254Mm.)
.053MAX. DIA.
(1.3462 Mm.)
TINNED COPPER WIRE

ALL DIMENSIONS ARE IN INCHES AND (METRIC)

Silicon
Rectifier

A129

The General Electric Type A129 Series of power rectifier diodes is designed for use in applications where a fast recovery rectifier diode is a necessity. The A129 is rated up to 10,000 Hertz. It is available in both forward and reverse polarity versions.



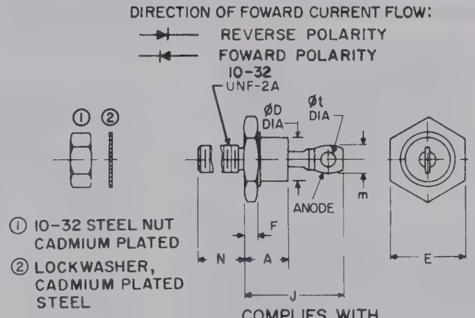
FEATURES:

- High Voltage – up to 1200 V
- Fast Recovery Time – 500 Nanoseconds Maximum
- The Fast Recovery Characteristics of the A129 Match the High Frequency Capability of General Electric High-Speed SCR's such as the C140, C141, C138, C139, and C144.
- For Use in:
  - Inverters
  - Choppers
  - Low RFI Applications
  - Sonar Power Supplies
  - Ultrasonic Systems
  - DC-DC Power Supplies
  - Free-Wheeling Rectifier Applications

OUTLINE DRAWING

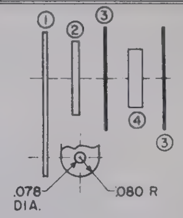
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A		.405		10.29	
ϕD		.424		10.77	
E	.424	.437	10.77	11.10	
F	.075	.175	1.91	4.45	
J		.800		20.32	
m		.250		6.35	1
N	.422	.453	10.72	11.51	
ϕt	.060		1.52		
W					2

NOTES:
1. Angular orientation of this terminal is undefined.
2. 10-32 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter (.1697", 4.29 MM). Ref: (Screw thread standards for Federal Services 1957) Handbook H28, P1


DIRECTION OF FOWARD CURRENT FLOW:
REVERSE POLARITY
FOWARD POLARITY
10-32
UNF-2A
ØD
DIA
Øt
DIA
ANODE
m
F
N
A
J
E
① ②
① 10-32 STEEL NUT CADMIUM PLATED
② LOCKWASHER, CADMIUM PLATED STEEL

COMPLIES WITH
EIA REGISTERED OUTLINE DO-4

INSULATING HARDWARE KIT*



① COPPER TERMINAL, .016 THICK, TIN PLATED
② BRASS WASHER, .035 THICK NICKEL PLATED
③ MICA WASHERS, TWO, .625 O.D., .204 I.D., .005 THICK
④ TEFLON WASHER, .270 O.D. .204 I.D., .050 THICK
* AVAILABLE UPON REQUEST

The fast recovery, A129, medium-current rectifier diode provides a superior combination of speed and blocking voltage capability. This high performance rectifier diode has been designed specifically for demanding, medium-current, high voltage applications.

ratings and specifications (Resistive or Inductive Load)

Forward Polarity: Reverse Polarity:	A129E A129ER	A129M A129MR	A129N A129NR	A129P A129PR	A129PB A129PB-R	
Maximum Allowable Repetitive and Working Peak Reverse. Voltage, V_{RM} (rep) & V_{RM} (wkg.) (1)	500	600	800	1000	1200	Volts
Maximum Allowable R_{MS} Voltage, V_r	355	424	565	710	850	Volts
Maximum Allowable DC Blocking Voltage, V_R (1)	500	500	600	700	700	Volts
Maximum Allowable Non-Repetitive Reverse Voltage, V_{RSM}	600	720	960	1200	1400	Volts
Maximum Allowable Average Forward Current (180° conduction angle, 60 cps, half sine wave current at T_C = 64°C), I_o	←		12 Amperes		→	
Maximum Allowable Peak One Cycle Surge Current (non-recurrent), I_{FM}(surge)	←		150 Amperes		→	

A129

ratings and specifications (cont'd)

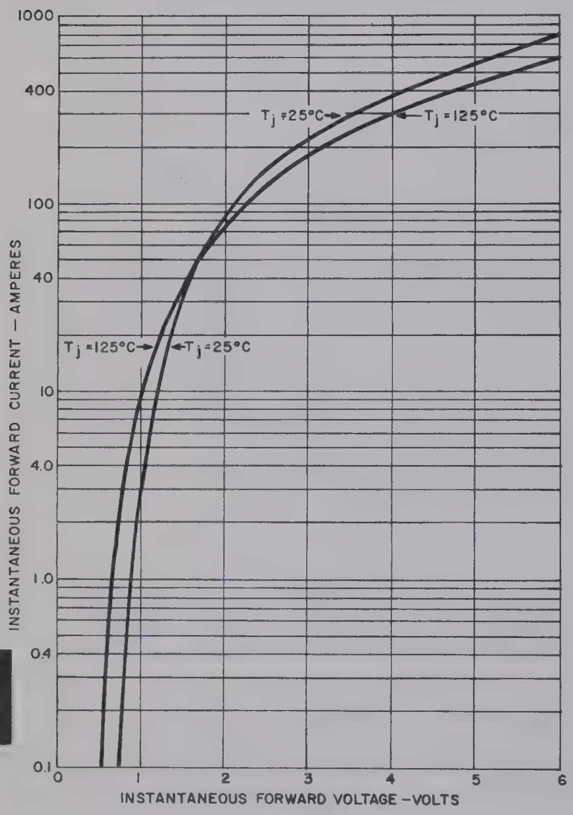
	A129E	A129M	A129N	A129P	A129PB
Forward Polarity:	A129E	A129M	A129N	A129P	A129PB
Reverse Polarity:	A129ER	A129MR	A129NR	A129PR	A129PB-R
I^2t Rating (for t greater than .001 sec. and less than .0083 sec., non-recurrent)	60 Ampere²seconds				
Maximum Peak Forward Voltage Drop (I_o = 12 Adc at T_C = 64°C), $V_{F(AV)}$	1.55 Volts Peak				
Maximum Average Reverse Current (I_o = 12 Adc at T_C = 64° C), $I_{R(AV)}$	3.0 mA				
Maximum Reverse Recovery Time t_{rr}(2)	500 Nanoseconds				
Maximum Effective Thermal Resistance Junction to Case, $R\theta_{JC}$	3.25 deg. C per watt				
Junction Operating Temperature Range, T_J	−40°C to +125°C				
Storage Temperature Range, T_{stg}	−40°C to +200°C				
Stud Torque	20 Lb-in (23.3 Kg-cm.)				

(1) Maximum thermal resistance, case to ambient, for which maximum voltage and temperature ratings apply is:

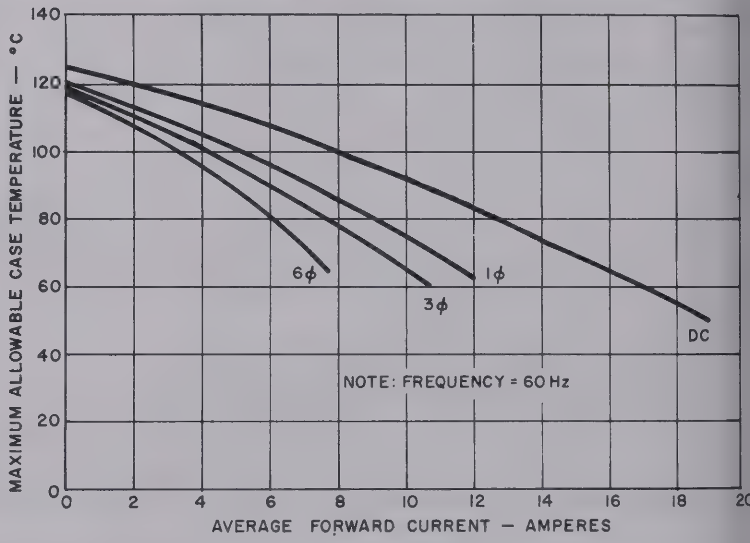
Voltage Type :	500	600	800	1000	1200	Volts
Sinusoidal Voltage:	12.5	10.0	6.6	4.7	3.3	°C/watt
DC Voltage :	1.0	1.0	1.0	1.0	1.0	°C/watt

(2) Reverse recovery time measured at T_C = 25°C with I_{FM} = 5.0 Amp., commutating di/dt = 50 Amp/μsec, max reverse current = 10 Amp. pea

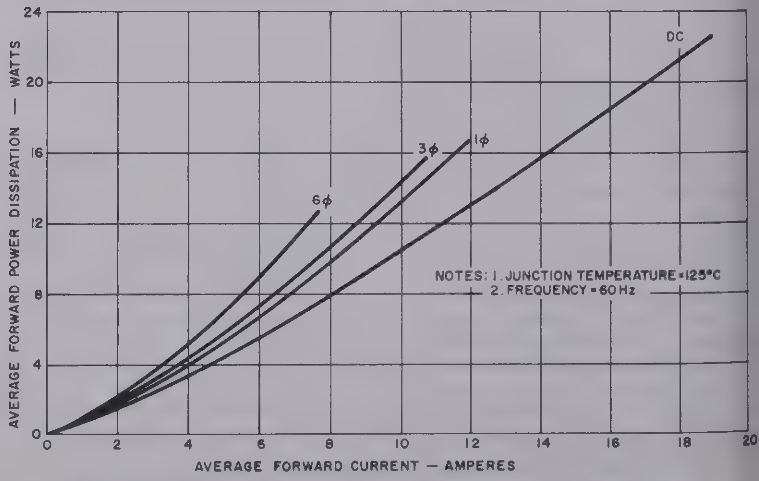
(3) To prevent possible device damage during reverse recovery, it is recommended that the rate of rise of reverse voltage be limited to 1200 volts microsecond maximum. An RC Snubber connected across the rectifier diode may be used to limit the rate of rise of reverse voltage.



MAXIMUM FORWARD CHARACTERISTICS



AVERAGE CURRENT RATING VS. CASE TEMPERATURE



MAXIMUM AVERAGE FORWARD POWER DISSIPATION

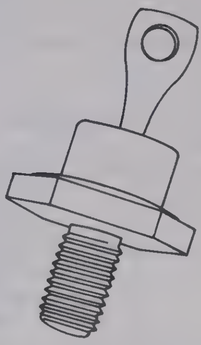
Fast Recovery Rectifier

A139

he General Electric Type A139 Series of power rectifier diodes is designed for use in applications here a fast recovery rectifier diode is a necessity. The A139 is rated up to 10,000 Hertz. It is vailable in both forward and reverse polarity versions.

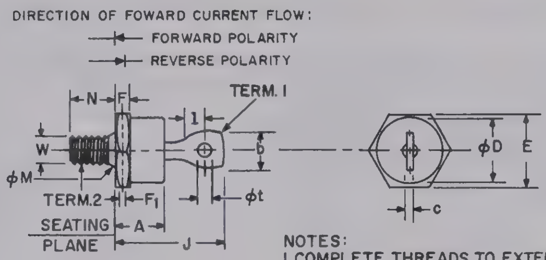
EATURES:

- High Voltage – up to 1200 V
- Fast Recovery Time – 500 Nanoseconds Maximum
- The Fast Recovery Characteristics of the A139 Match the High Frequency Capability of General Electric High-Speed SCR's such as the C140, C141, C138, C139, and C144.
- For Use in:
  - Inverters
  - Choppers
  - Low RFI Applications
  - Sonar Power Supplies
  - Ultrasonic Systems
  - DC-DC Power Supplies
  - Free-Wheeling Rectifier Applications



OUTLINE DRAWING

SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A		.450		11.43	
b		.375		9.53	2
c		.080		2.03	
ϕD		.667		16.94	
E	.667	.687	16.94	17.45	
F	.115	.200	2.92	5.08	
F_1	.060		1.52		
J		1.000		25.40	
l	.156		3.96		4
ϕM	.220	.249	5.59	6.32	1
N	.422	.453	10.72	11.51	
ϕt	.140	.175	3.56	4.45	
W					1,3



NOTES:
1. COMPLETE THREADS TO EXTEND TO WITHIN 2-1/2 THREADS OF SEATING PLANE.
2. ANGULAR ORIENTATION OF TERMINAL IS UNDEFINED.
3. 1/4-28 UNF-2A. MAXIMUM PITCH DIAMETER OF PLATED THREADS SHALL BE BASIC PITCH DIAMETER (.2268", 5.74 MM) REF. (SCREW THREAD STANDARDS FOR FEDERAL SERVICES 1957) HANDBOOK H28 1957 P1.
4. MINIMUM FLAT.

EIA-NEMA STANDARD OUTLINE, NEMA SK-51-EIA RS-241.
INSULATING HARDWARE IS AVAILABLE UPON REQUEST.

COMPLIES WITH EIA REGISTERED OUTLINE DO-5

he fast recovery, A139, medium-current rectifier diode provides a superior combination of speed and blocking voltage capability. This high erformance rectifier diode has been designed specifically for demanding, medium-current, high voltage applications.

ratings and specifications (Resistive or Inductive Load)

Forward Polarity: Reverse Polarity:	A139E A139ER	A139M A139MR	A139N A139NR	A139P A139PR	A139PB A139PB-R	
Maximum Allowable Repetitive and Working Peak Reverse Voltage, V_{RM} (rep) & V_{RM} (wkg.)(1)	500	600	800	1000	1200	Volts
Maximum Allowable RMS Voltage, V_r	355	424	565	710	850	Volts
Maximum Allowable DC Blocking Voltage, V_R (1)	500	600	800	1000	1200	Volts
Maximum Allowable Non-Repetitive Reverse Voltage, V_{RSM}	600	720	960	1200	1400	Volts
Maximum Allowable Average Forward Current (180° conduction angle, 60 cps, half sine wave current at T_C = 75°C), I_o	← 25 Amperes →					
Maximum Allowable Peak One Cycle Surge Current (non-recurrent), I_{FM}(surge)	← 400 Amperes →					

General Electric Co., 1968

A139 ratings and specifications (cont'd)

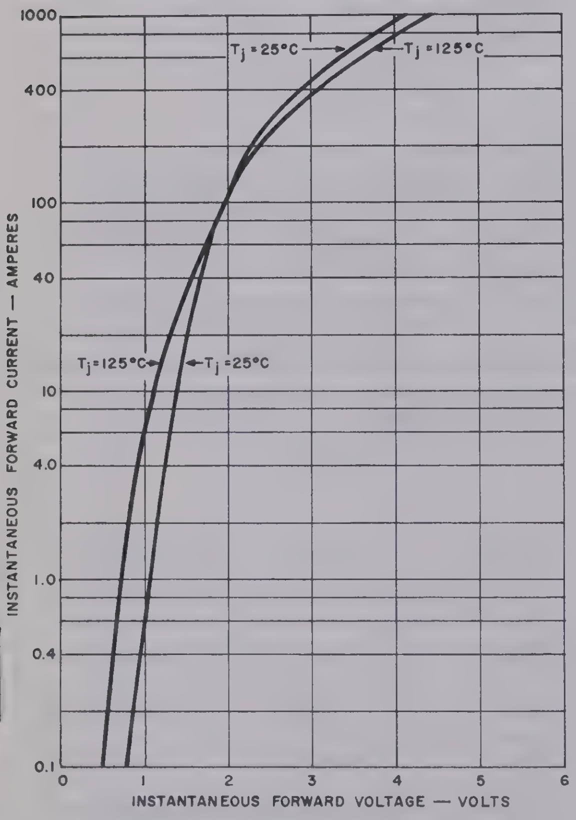
Forward Polarity:	A139E	A139M	A139N	A139P	A139PB
Reverse Polarity:	A139ER	A139MR	A139NR	A139PR	A139PB-R
I^2t Rating (for t greater than .001 sec. and less than .0083 sec., non-recurrent)	←		500 Ampere²seconds		→
Maximum Peak Forward Voltage Drop (I_o = 25 Adc at T_C = 75°C), V_{FM}	←		1.85 Volts Peak		→
Maximum Average Reverse Current (I_o = 35 Adc at T_C = 75° C), $I_{R(AV)}$	←		3.0 mA		→
Maximum Reverse Recovery Time t_{rr} (2)	←		500 Nanoseconds		→
Maximum Effective Thermal Resistance Junction to Case, $R\theta_{JC}$	←		1.0 deg. C per watt		→
Junction Operating Temperature Range, T_J	←		−40°C to +125°C		→
Storage Temperature Range, T_{stg}	←		−40°C to +200°C		→
Stud Torque	←		30 Lb-in (35 Kg-cm)		→

(1) Maximum thermal resistance, case to ambient, for which maximum voltage and temperature ratings apply is:

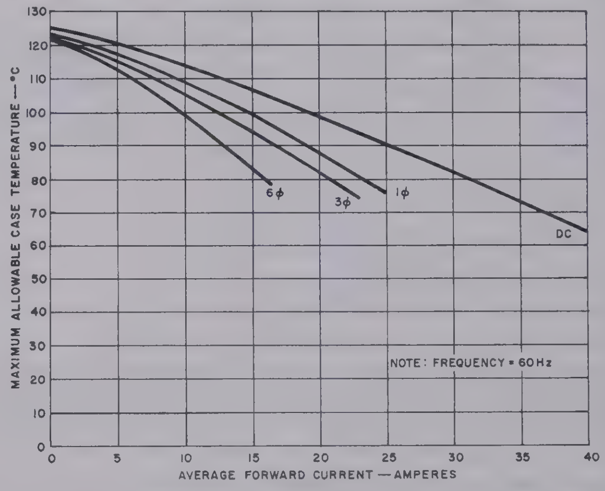
Voltage Type :	500	600	800	1000	1200	Volts
Sinusoidal Voltage:	14.0	12.0	9.0	7.0	5.5	°C per watt
DC Voltage :	3.7	3.0	2.0	1.4	1.0	°C per watt

(2) Reverse recovery time measured at T_C = 25°C with I_{FM} = 5.0 Amp., commutating di/dt = 50 Amp/μsec, max. reverse recovery current = 15 A peak.

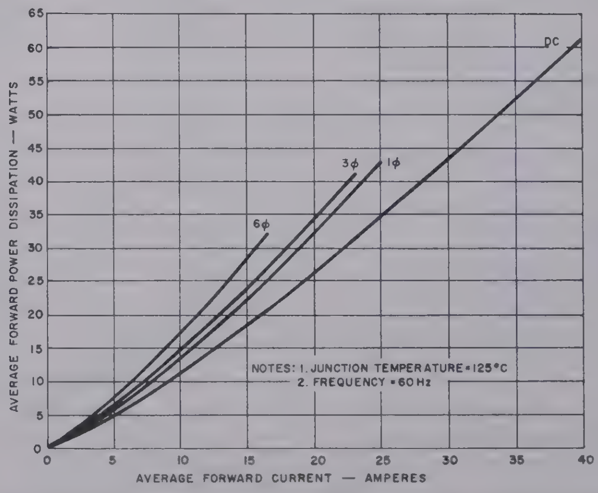
(3) To prevent possible device damage during reverse recovery, it is recommended that the rate of rise of reverse voltage be limited to 1200 volts p micro second maximum. An RC Snubber connected across the rectifier diode may be used to limit the rate of rise of reverse voltage.



MAXIMUM FORWARD CHARACTERISTICS



AVERAGE CURRENT RATING VS. CASE TEMPERATURE

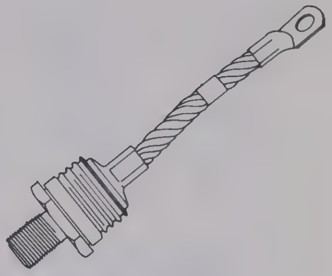


MAXIMUM AVERAGE FORWARD POWER DISSIPATION

Silicon
Rectifier

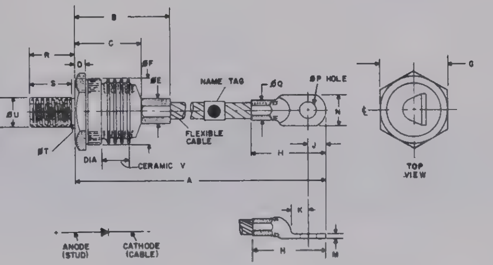
A291

The A291 is a power silicon rectifier diode for use in applications requiring blocking voltages up to 2000 volts and forward current ratings up to 250 amperes average in single phase applications. This device was formerly known as 6RW51, and is a reverse polarity device. The stud is the anode.



	INCHES		MILLIMETERS		
SYMBOL	MIN.	MAX.	MIN.	MAX.	NOTES
A	7.500	8.000	190.50	203.20	
B		2.375		60.32	
C		1.625		41.28	
D	.235	.265	5.97	6.73	
ØE		.750		19.05	
ØF		1.625		41.28	
G	1.605	1.640	40.77	41.66	
H	2.000	2.375	50.80	60.32	
J	.469	.531	11.91	13.49	
K	.375		9.52		
L	.312	.375	7.92	9.52	
M	.094	.125	2.39	3.18	
N		.938		23.82	
ØP	.391	.422	9.93	10.72	
ØQ		.678		17.22	
R	1.037	1.087	26.34	27.61	
S	.912	1.009	23.16	25.63	
ØT	.660	.670	16.76	17.02	
ØU					2
V					1

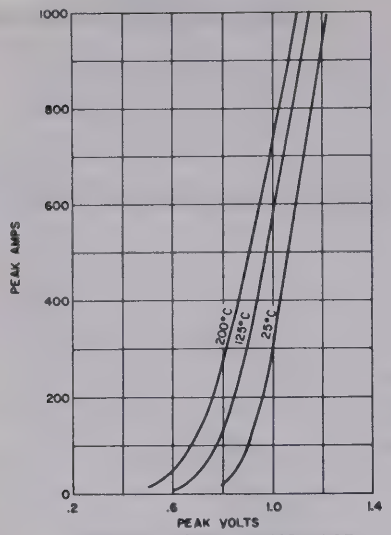
NOTES:
1 1.000" (25.40 mm.) min. insulation surface creep.
2 ¾"-16 UNF-2A.
Pitch Dia. -0.7029" (17.85 mm.) min.
0.7094" (18.02 mm.) max



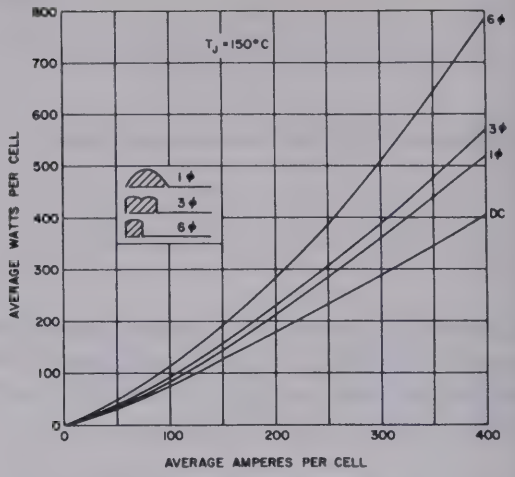
RATINGS AND CHARACTERISTICS

	A291PC	A291PD	A291PE	A291PM	A291PS	A291PN	Units
Maximum Allowable Repetitive Peak Reverse Voltage, V_{RM}(rep) (1)	1300	1400	1500	1600	1700	1800	volts
Maximum Allowable DC Blocking Voltage, V_R (2)	1300	1400	1500	1600	1700	1800	volts
Maximum Allowable V_{RM}(rep) and DC Blocking Voltage (0°C to +150°C)	1500	1600	1700	1800	1900	2000	volts
Average Forward Current, 1 φ, 180° Conduction	← 250 amperes at case temperature →						
Maximum Allowable Peak One-Cycle Surge Current (60 cps single-phase basis, non-repetitive)	← 4500 amperes →						
Minimum I^2t Rating (non-repetitive)	← 84,000 ampere² seconds →						
Maximum Peak Reverse Current	← 20 mA at V_{RM} (rep) →						
Maximum Average Reverse Current (full cycle average, +130°C case temperature, single phase)	← 10 mA →						
Maximum Thermal Resistance (junction to case)	← DC=0.15°C/watt → ← 1 φ=0.16°C/watt, 3 φ=0.17°C/watt, 6 φ=0.185°C/watt →						
Storage and Junction Operating Temperature	← 40°C to +200°C →						
Stud Torque (3)	← 300-inch-lb. maximum for nut and washer → (346KG-CM)						

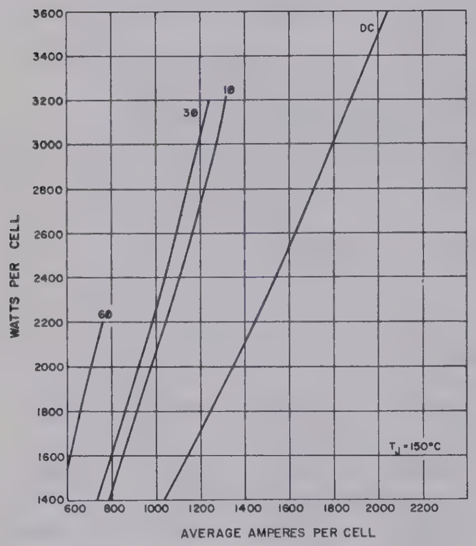
NOTES: (1)Assumes a heat sink dissipation of 2°C/W, or less.
(2)Assumes a heat sink dissipation of 1°C/W, or less.
(3)Use of a silicone grease (G-E #G623) between rectifier base and heatsink is recommended.



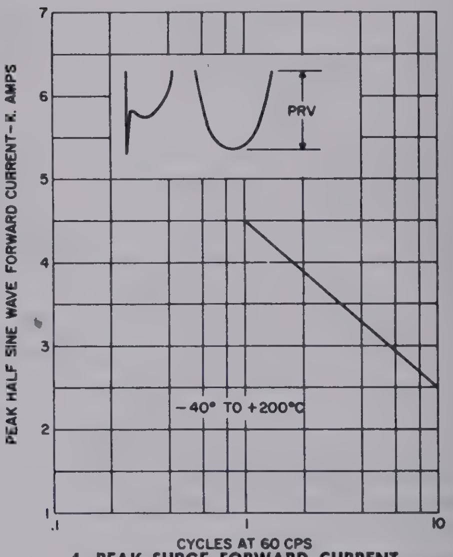
1. MAXIMUM FORWARD VOLTAGE DROP VS. TEMPERATURE



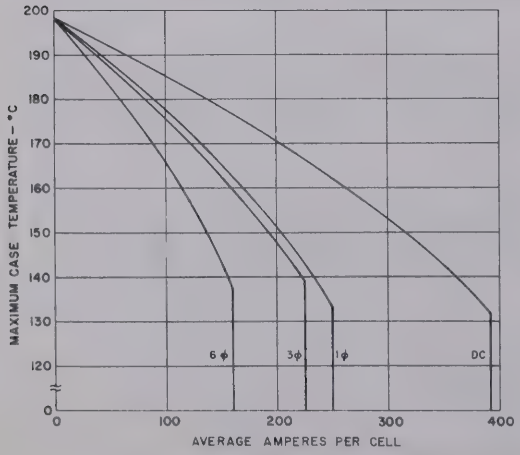
2. FORWARD POWER DISSIPATION



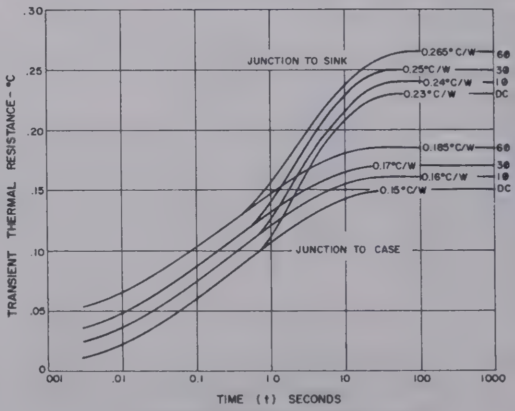
3. EXTENDED FORWARD POWER DISSIPATION



4. PEAK SURGE FORWARD CURRENT (WITH VRM[rep] REAPPLIED, NON-RECURRENT)



5. MAXIMUM CASE TEMPERATURE VS. AVERAGE FORWARD CURRENT



6. TRANSIENT THERMAL RESISTANCE

Silicon
RECTIFIERS

A295,A296

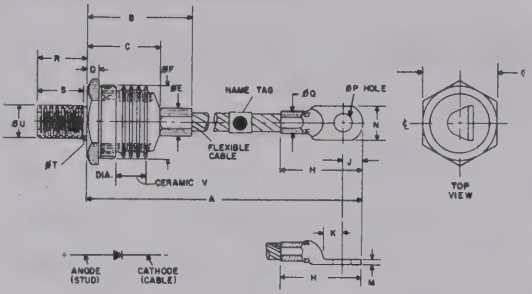
The A295/A296 is a power silicon rectifier diode for use in applications requiring blocking voltages up to 2000 volts (0° to 150°C) and forward current ratings up to 500 amperes average in singls phase applications. This series was formerly the 6RW62 and 6RW65 series. These are reverse polarity devices. The stud or base is the anode.

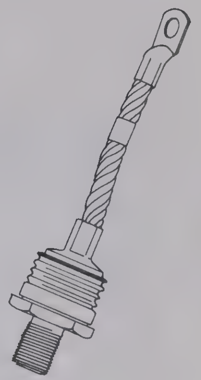
OUTLINE DRAWING A295

	INCHES		MILLIMETERS		
SYMBOL	MIN.	MAX.	MIN.	MAX.	NOTES
A	7.500	8.000	190.50	203.20	
B		2.375		60.32	
C		1.625		41.28	
D	.235	.265	5.97	6.73	
ϕE		.750		19.05	
ϕF		1.625		41.28	
G	1.605	1.640	40.77	41.66	
H	2.000	2.375	50.80	60.32	
J	.469	.531	11.91	13.49	
K	.375		9.52		
L	.312	.375	7.92	9.52	
M	.094	.125	2.39	3.18	
N		.938		23.82	
ϕP	.391	.422	9.93	10.72	
ϕQ		.678		17.22	
R	1.037	1.087	26.34	27.61	
S	.912	1.009	23.16	25.63	
ϕT	.660	.670	16.76	17.02	
ϕU					2
V					1

NOTES:

1. 1.000" (25.40 mm.) min. insulation surface creep.
2. ¾"-16 UNF-2A.
   Pitch Dia.—0.7029" (17.85 mm.) min.
   0.7094" (18.02 mm.) max.





RATINGS AND CHARACTERISTICS (Resistive or Inductive Load, 50 to 400 cps)

Type		Maximum Allowable Repetitive Peak Reverse Voltage, V_{RM} (rep)[1] and DC Blocking Voltage, V_R[2].	
		−40°C to +200°C	0°C to +150°C
A295B,	A296B	200 volts	—
A295C,	A296C	300 volts	—
A295D,	A296D	400 volts	—
A295E,	A296E	500 volts	—
A295M,	A296M	600 volts	—
A295S,	A296S	700 volts	—
A295N,	A296N	800 volts	—
A295T,	A296T	900 volts	—
A295P,	A296P	1000 volts	1200 volts
A295PA,	A296PA	1100 volts	1300 volts
A295PB,	A296PB	1200 volts	1400 volts
A295PC,	A296PC	1300 volts	1500 volts
A295PD,	A296PD	1400 volts	1600 volts
A295PE,	A296PE	1500 volts	1700 volts
A295PM,	A296PM	1600 volts	1800 volts
A295PS,	A296PS	1700 volts	1900 volts
A295PN,	A296PN	1800 volts	2000 volts

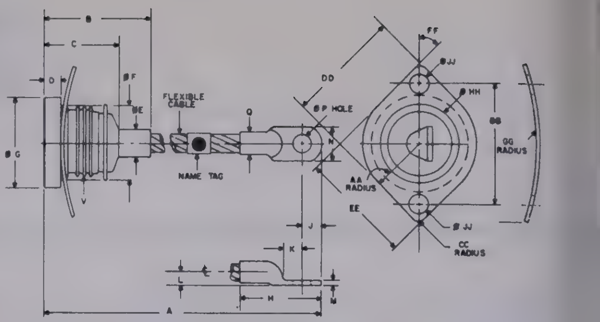
	A295, A296
Maximum Full Load Reverse Current (full-cycle average, 130°C case temperature, single phase)	← 15mA →
Maximum Allowable Average Forward Current (single phase, 130°C case temperature)	← 500 amperes →
Maximum Allowable Peak One-Cycle Surge Current (60 cps single-phase basis, non-repetitive)	← 7000 amperes →
Minimum I^2t Rating (non-repetitive)	← 200,000 amperes² seconds →
Maximum Thermal Resistance (junction to case)	← D.C. = .12°C/watt → ←1 ϕ = .13°C/watt, 3 ϕ = .14°C/watt, 6 ϕ = .16°C/watt→
Storage and Junction Operating Temperature	← 40°C to +200°C →
Stud Torque[3] Maximum	← 300 inch-pounds → (346KG-CM)

(1) Assumes a heatsink dissipation of 2°C/W, or less. (2) Assumes a heatsink dissipation of 1°C/W, or less.
(3) Use of a silicone grease (G-E #G623) between rectifier base and heat sink is recommended.

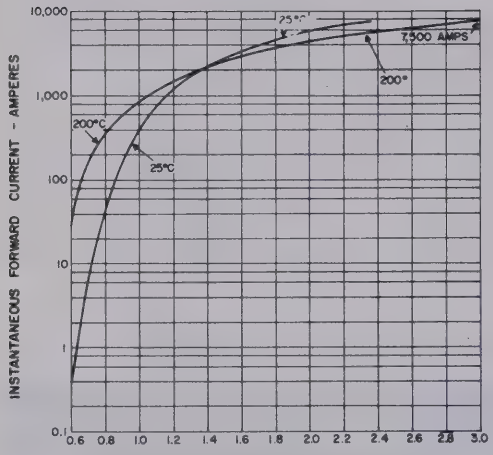
OUTLINE DRAWING
A296

	INCHES		MILLIMETERS		
SYMBOL	MIN.	MAX.	MIN.	MAX.	NOTES
A	7.625	8.125	193.68	206.38	
B		2.500		63.50	
C		1.750		44.45	
D	.325	.355	8.25	9.01	
φE		.750		19.05	
φF		1.625		41.28	
G	1.865	1.885	47.37	47.88	
H	2.000	2.375	50.80	60.32	
J	.469	.531	11.91	13.49	
K	.375		9.52		
L	.312	.375	7.92	9.52	
M	.094	.125	2.39	3.18	
N		.938		23.82	
φP	.391	.422	9.93	10.72	
φQ		.678		17.22	
V					1
AA	1.178	1.198	29.92	30.43	3
BB	2.484	2.516	63.09	63.91	3
CC	.172	.203	4.37	5.16	3
DD	2.356	2.395	59.82	60.83	3
EE	2.355	2.395	59.82	60.83	3
FF					2, 3
GG	5.500	6.500	139.70	165.10	3
φHH	1.610	1.630	40.89	41.40	3
φJJ	.370	.380	9.40	9.65	3

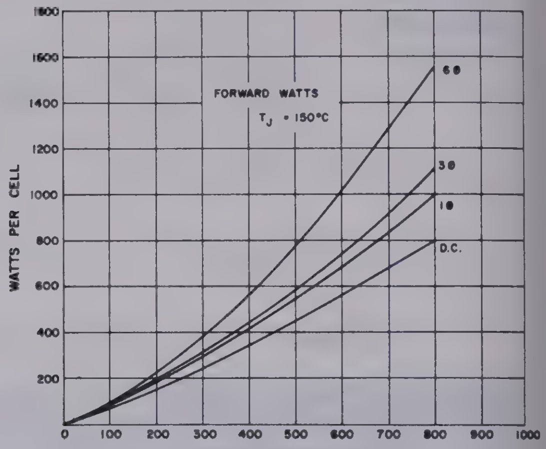
NOTES:
1. 1.000" (25.40 mm.) min. insulation surface creep.
2. 44° min., 46° max.
3. Dimensions of clamp before forming to 6.000" (212.40 mm.) radius.



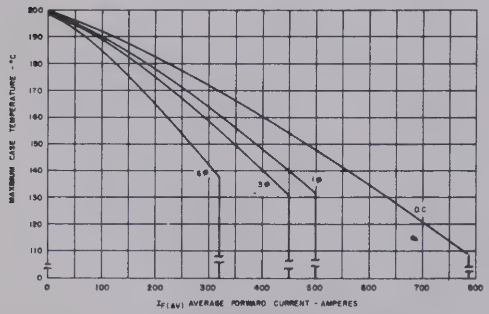
FOR MOUNTING PROCEDURE, SEE SPECIFICATION NO. 170.60, DATED 6/65.



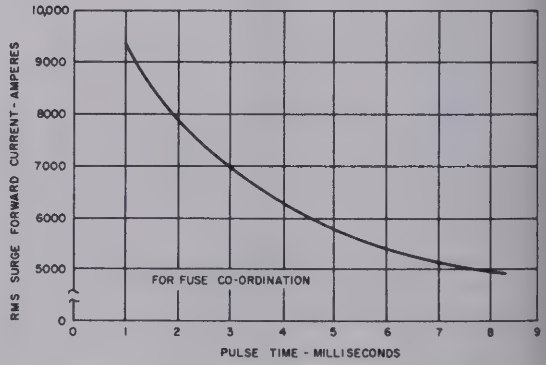
1. MAXIMUM FORWARD CHARACTERISTICS



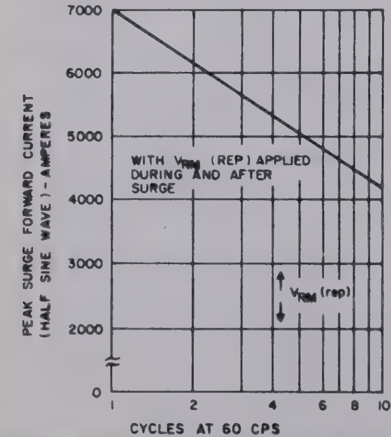
2. AVERAGE FORWARD POWER LOSS VS. AVERAGE FORWARD CURRENT



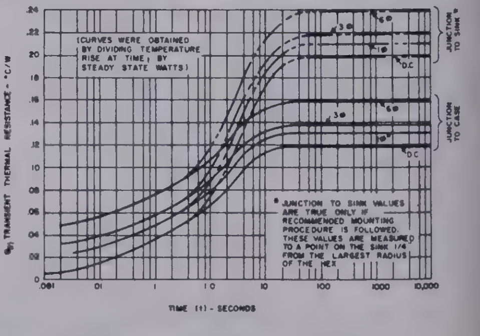
3. MAXIMUM CASE TEMPERATURE VS. AVERAGE FORWARD CURRENT



4. MAXIMUM SURGE CURRENT FOR SUB-CYCLE PULSES AT RATED LOAD CONDITIONS (Non-Repetitive) T_J = −40°C to +200°C



5. MAXIMUM SURGE CURRENT AT RATED LOAD CONDITIONS Non-Repetitive (T_J = −40°C to +200°C)



6. TRANSIENT THERMAL RESISTANCE

Silicon Rectifier

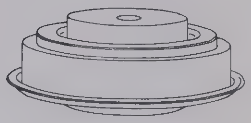
SERIES A390

400A Avg., Up to 1200 Volts, High Power

The A390 Series of high power rectifier diodes feature the proven, all-diffused construction used in the A90 Series in the new General Electric PRESS PAK.

Special characteristics of these new devices are:

- Pressure contacts
- Increased current capability when double-side cooling is used
- Smaller size and lighter weight
- Reversibility eliminates need for special reverse polarity units
- Hermetically sealed



IMPORTANT: Mounting instructions on the last page of this specification must be followed.

REFER TO PAGE 813 FOR RECOVERY CHARACTERISTICS.

MAXIMUM ALLOWABLE RATINGS

TYPES	REPETITIVE PEAK REVERSE VOLTAGE (PRV)(1)	TRANSIENT PEAK REVERSE VOLTAGE (non-recurrent 5 msec max)(2)	D.C. BLOCKING VOLTAGE(3)	FULL LOAD REVERSE CURRENT (full-cycle average, 130°C case temperature, single phase)
A390A	100 Volts	200 Volts	100 Volts	16.0 mA
A390B	200	300	200	16.0
A390C	300	400	300	16.0
A390D	400	525	400	16.0
A390E	500	650	500	15.0
A390M	600	800	600	12.5
A390S	700	925	700	12.5
A390N	800	1050	800	10.0
A390T	900	1175	900	10.0
A390P	1000	1300	1000	8.0
A390PA	1100	1400	1100	8.0
A390PB	1200	1500	1200	8.0

Average Forward Current		400 Amperes
Peak One-Cycle Surge Current		4500 Amperes
Minimum I^2t Rating (for times $\geq$ 1.5 msec)		31,000 Ampere^2 seconds
Maximum Full Load Voltage Drop (full-cycle avg., 130°C case temp., single phase)		0.4 Volts
Maximum Thermal Resistance, $R_{\theta JC}$	Double-side Cooling	0.095°C/Watt
	Single-side Cooling	0.15°C/Watt
Storage and Operating Junction Temperature, T_J		-40°C to +200°C
External Force Required(4)		800 Lbs ± 10%

NOTES:

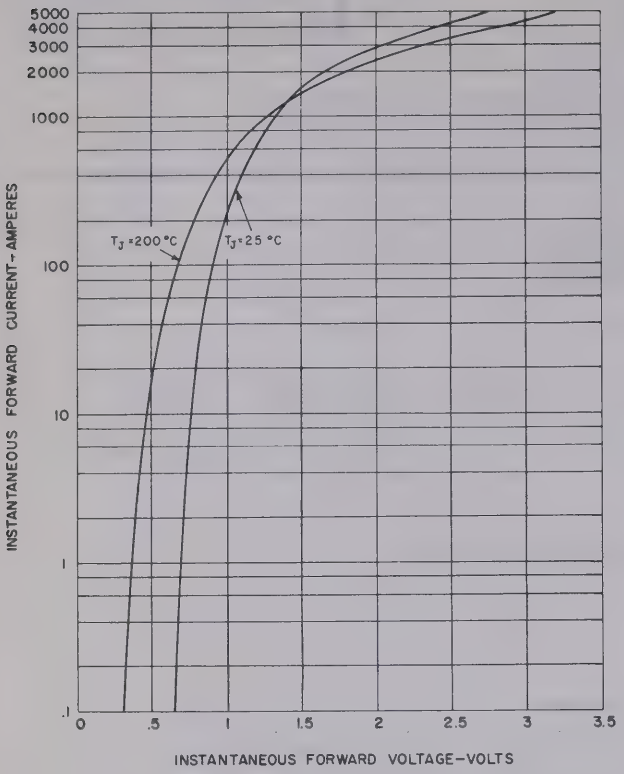
(1) Assumes a heatsink dissipation of less than 2.0°C/watt.

(2) Non-recurrent voltage and current ratings, as contrasted to repetitive ratings which apply for occasional or unpredictable overloads. For example, the forward surge current ratings are non-recurrent ratings that are used in fault coordination work.

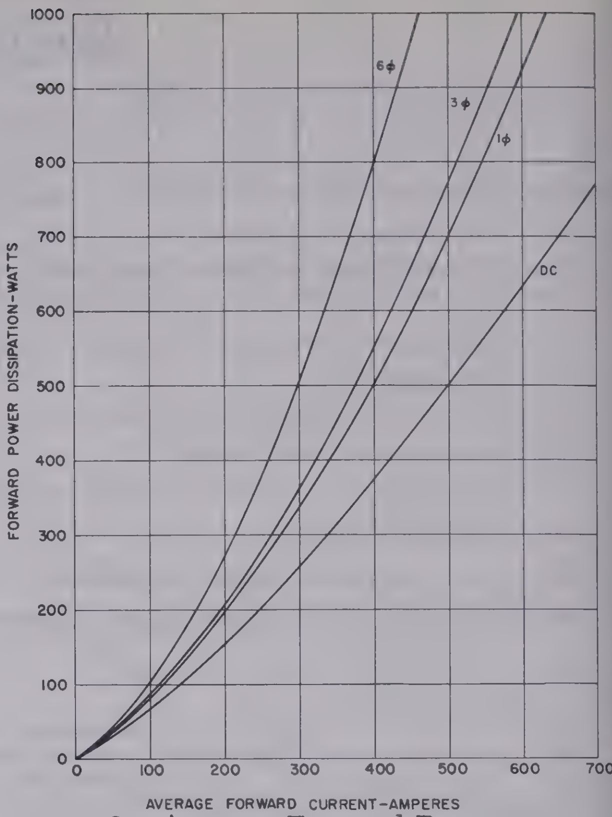
(3) Assumes a heatsink dissipation of less than 1.0°C/watt.

(4) Refer to the last page of this specification for Press-Pak mounting instructions. Also see Application Note #200.50, "Mounting Press-Pak Semiconductors", for further information.

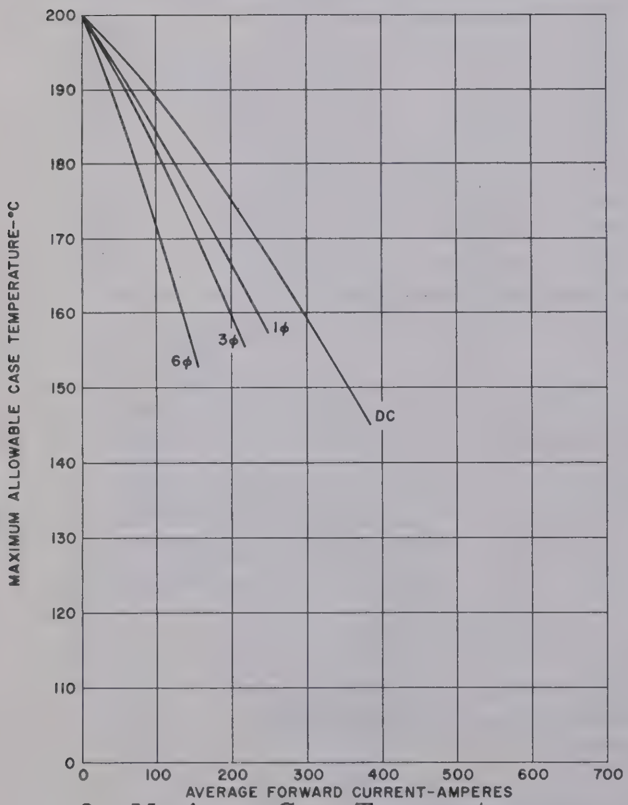
SERIES A390



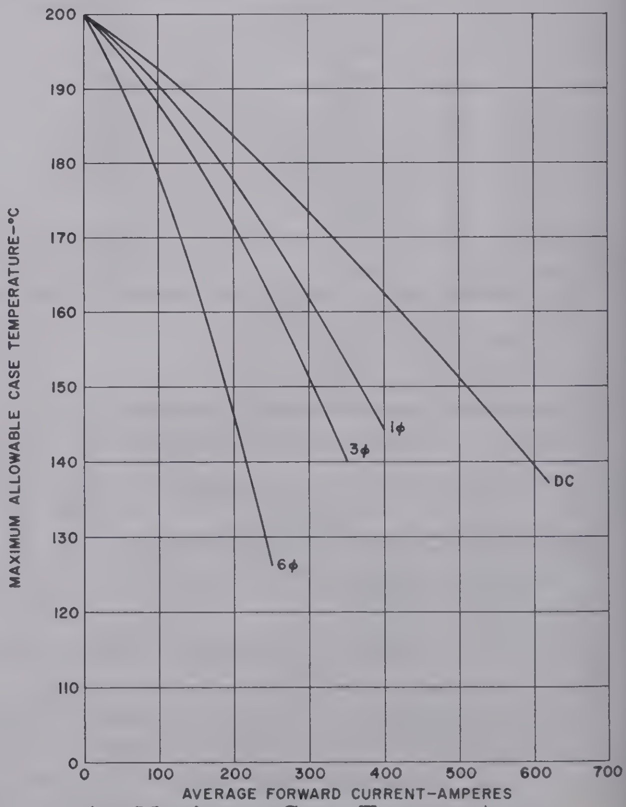
1. Maximum Forward Characteristics



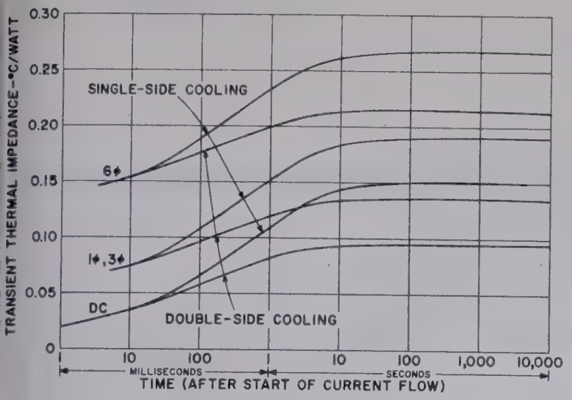
2. Average Forward Power Dissipation vs. Average Forward Current



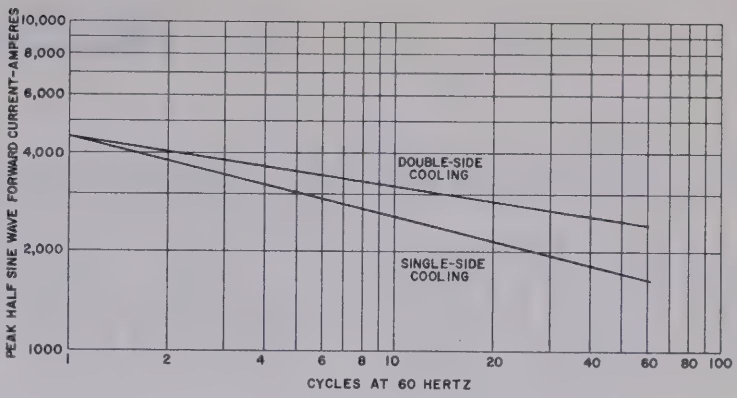
3. Maximum Case Temperature vs. Average Forward Current for Single-Side Cooling



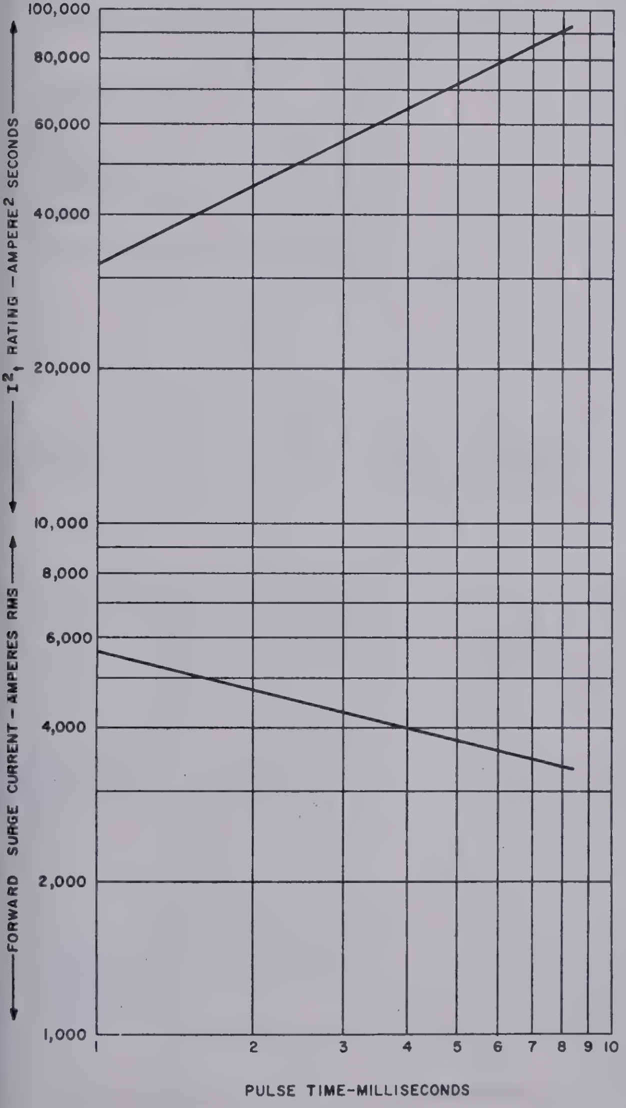
4. Maximum Case Temperature vs. Average Forward Current for Double-Side Cooling



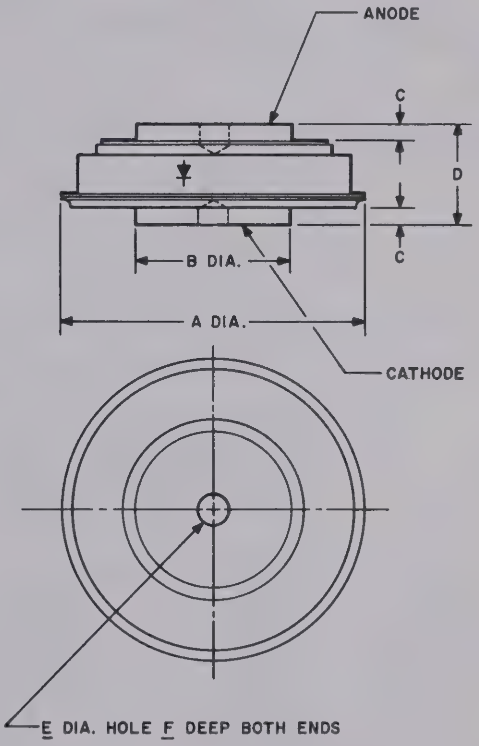
5. Transient Thermal Impedance-Junction to Case



6. Maximum Surge Current Following Rated Load Conditions



7. Subcycle Surge Forward Current and I^2t Rating Following Rated Load Conditions


ANODE
C
D
C
B DIA.
A DIA.
CATHODE
E DIA. HOLE F DEEP BOTH ENDS

FOR MOUNTING HARDWARE SEE SELECTOR GUIDE PAGE 171

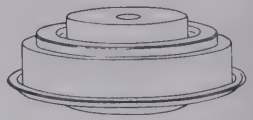
DIMENSIONS		
	DECIMAL (INCHES)	METRIC (MM)
A	1.500 1.430	38.100 36.320
B	.752 .744	19.101 18.897
C	.120 .080	3.048 2.031
D	.550 .500	13.970 12.699
E	.135 .145	3.429 3.683
F	.067 .083	1.702 2.108

8. Outline Drawing

Silicon Rectifier

A396

The General Electric Company offers the proven, high performance features of the all-diffused A96 silicon rectifier in a ½ inch, Press Pak package. The A396 power rectifier is designed for use in high frequency applications, or wherever a fast recovery diode is required. The A396 is rated for frequencies up to 10k Hz, and is available to 1000 volts.



CHARACTERISTICS

All ratings and characteristics of the A96/A97 series of rectifier diodes (refer to Pub. #145.55) apply with the following exceptions:

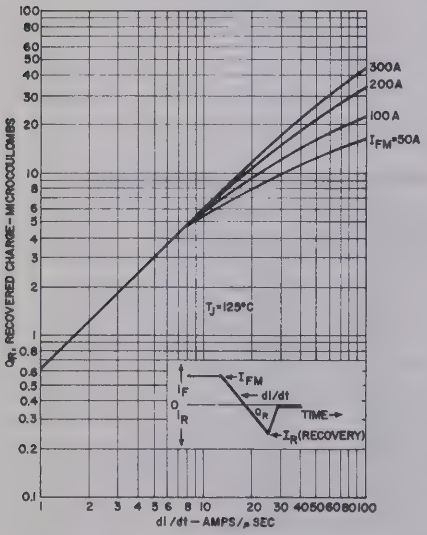
Average Forward Current		400 Amperes
Maximum Thermal Resistance, Θ_{J-C} (Double-side cooling)		
	DC	0.09°C/Watt
	1ϕ and 3ϕ	0.15°C/Watt
	6ϕ	0.22°C/Watt
External Mounting Force Required*		800 Lb. ±10%, 360 Kg. ±10%

*For complete mounting instructions, refer to publication #145.70 (A390 specifications).

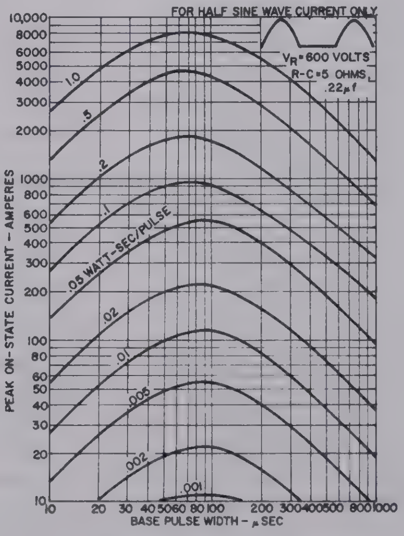
PRELIMINARY DATA

These ratings and characteristics are not necessarily definitive and are based only on the tests and findings made to date. Inasmuch as further information may be acquired, General Electric Company reserves the right to change these preliminary data without notice. Please contact your local General Electric Electronic Component Sales Manager for the latest status of data prior to ordering devices to the limits indicated by the data.

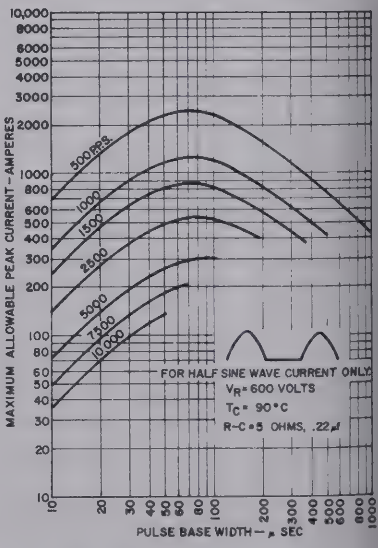
REFER TO PAGE 813 FOR RECOVERY CHARACTERISTICS.



Typical Recovered Charge (T_J = 125°C)



Energy per Pulse for Sinusoidal Pulses

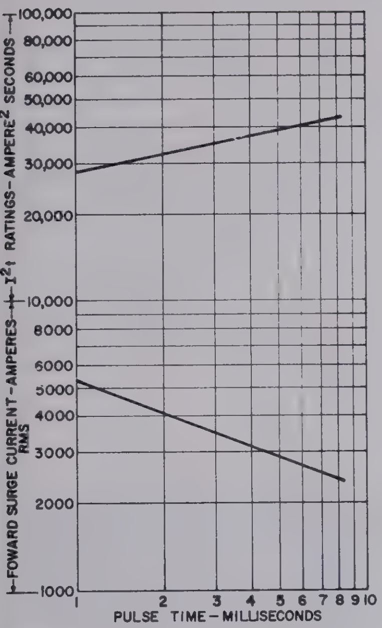


Maximum Allowable Peak Current Vs. Pulse Base Width (T_C = 90°C)

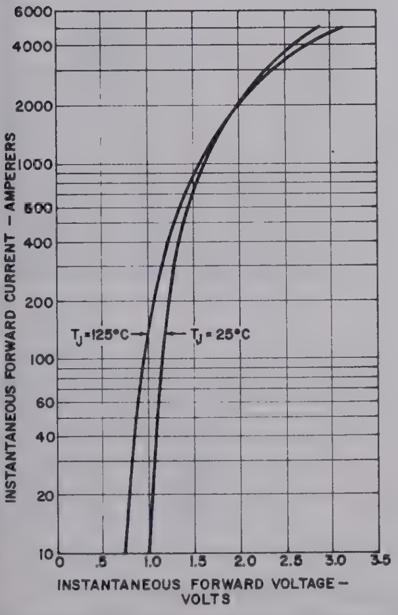
LOW FREQUENCY DATA

PRELIMINARY DATA

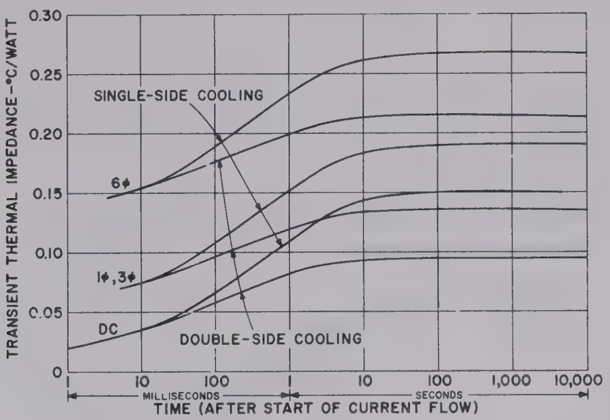
These ratings and characteristics are not necessarily definitive and are based only on the tests and findings made to date. Inasmuch as further information may be acquired, General Electric Company reserves the right to change these preliminary data without notice. Please contact your local General Electric Electronic Component Sales Manager for the latest status of data prior to ordering devices to the limits indicated by the data.



Subcycle Surge Forward Current and I²t Rating Following Rated Load Conditions

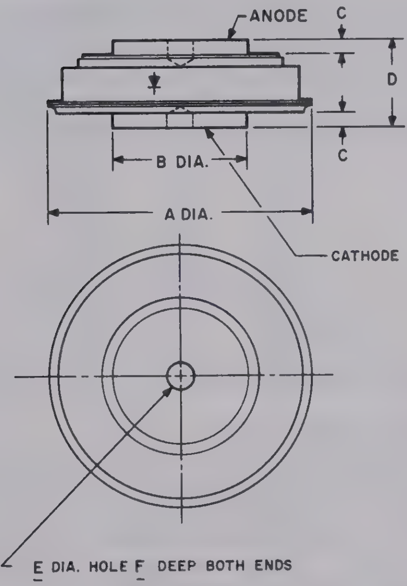


Maximum Forward Characteristics



Transient Thermal Impedance—Junction-to-Case

OUTLINE DRAWING



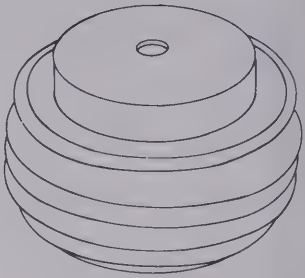
FOR MOUNTING HARDWARE SEE SELECTOR GUIDE PAGE 171

DIMENSIONS					
	DECIMAL (INCHES)	METRIC (MM)		DECIMAL (INCHES)	METRIC (MM)
A	1.500 1.430	38.100 36.320	D	.550 .500	13.970 12.699
B	.752 .744	19.101 18.897	E	.135 .145	3.429 3.683
C	.120 .080	3.048 2.031	F	.067 .083	1.702 2.108

Silicon
RECTIFIER

A500

The A500 Series of high power rectifier diodes feature the proven, alloy-diffused construction used in the new General Electric pressure-mounted package.



Special features of these new devices are:

- High current, high voltage
- Pressure contacts
- Glazed ceramic package with 1″ creepage path
- Reversability (eliminates need for special reverse polarity units)
- Hermetic seal
- Available in factory assembled heat exchangers or ready-to-mount

IMPORTANT: Mounting instructions on the last page of this specification must be followed.

MAXIMUM ALLOWABLE RATINGS

Types	Repetive Peak Reverse Voltage, V_{RRM} (1) T, $T_J = 0°C$ to $+175°C$	Transient Peak Reverse Voltage, V_{RSM}, (non-recurrent 5 msec max) (2) $T_J = 0°C$ to $+175°C$
A500P	1000 Volts	1100 Volts
A500PA	1100	1200
A500PB	1200	1300
A500PC	1300	1400
A500PD	1400	1500
A500PE	1500	1600
A500PM	1600	1700
A500PS	1700	1800
A500PN	1800	1900
A500PT	1900	2000
A500L	2000	2100

Types	Repetitive Peak Reverse Voltage, V_{RRM} (1) $T_J = 0°C$ to $+175°C$	Transient Peak Reverse Voltage, V_{RSM}, (non-recurrent 5 msec max) (2) $T_J = 0°C$ to $+175°C$
A500LA	2100 Volts	2200 Volts
A500LB	2200	2300
A500LC	2300	2400
A500LD	2400	2500
A500LE	2500	2600
A500LM	2600	2700
A500LS	2700	2800
A500LN	2800	2900
A500LT	2900	3000
A500LP	3000	3100

Average Forward Current	740 Amperes, 1ϕ average
Peak One-Cycle Surge Current	8400 Amperes
Minimum I^2t Rating (for times $\geq$ 1.5 msec)	225,000 Ampere^2 seconds
(at 8.3 msec)	270,000 Ampere^2 seconds
Maximum Full Load Voltage Drop (full-cycle avg., $T_C = 150°C$, 1000A peak, 1ϕ)	1.36 Volts
Peak Reverse Leakage Current, $T_J = 175°C$, V = rated V_{RRM}	30mA
Maximum Thermal Resistance, $R_{\theta JS}$ (1ϕ) Double-side Cooling	0.06°C/watt
Single-side Cooling	0.116°C/watt
Storage Temperature, T_{STG}	−40°C to +200°C
Operating Temperature, T_J	0°C to +175°C
Mounting Force Required (3)	2200 lbs. ± 10% 910 kg. ± 10%

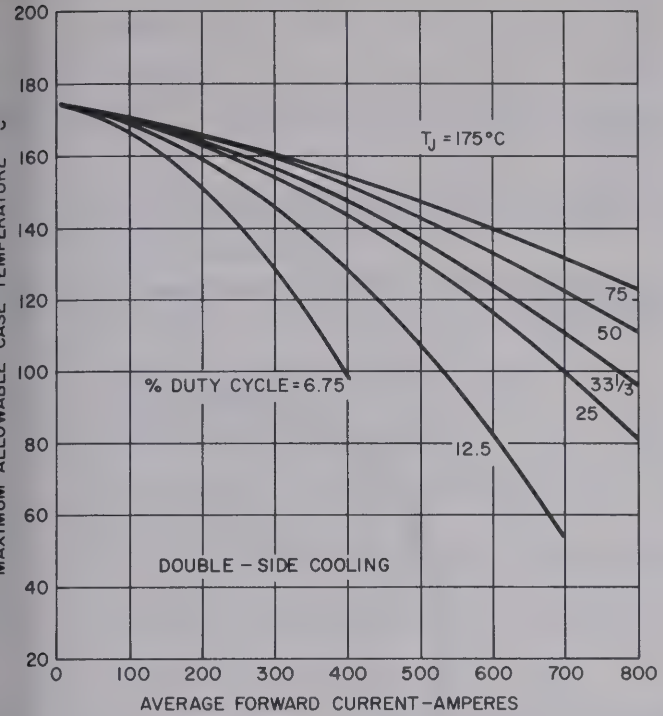
REFER TO PAGE 813 FOR RECOVERY CHARACTERISTICS.

NOTES:

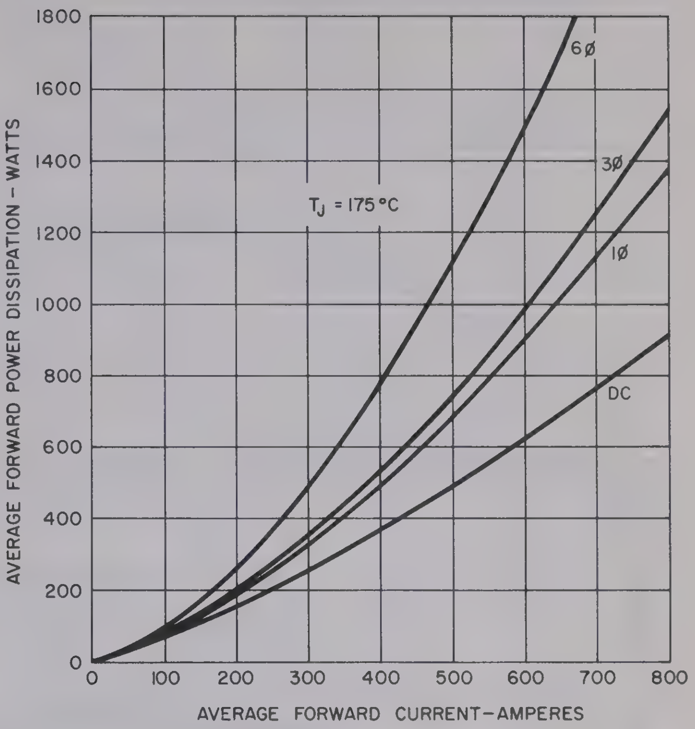
(1) Assumes a heatsink dissipation of less than 1.1°C/watt.

(2) Non-recurrent voltage and current ratings, as contrasted to repetitive ratings which apply for occasional or unpredictable overloads. For example, the forward surge current ratings are non-recurrent ratings that are used in fault coordination work.

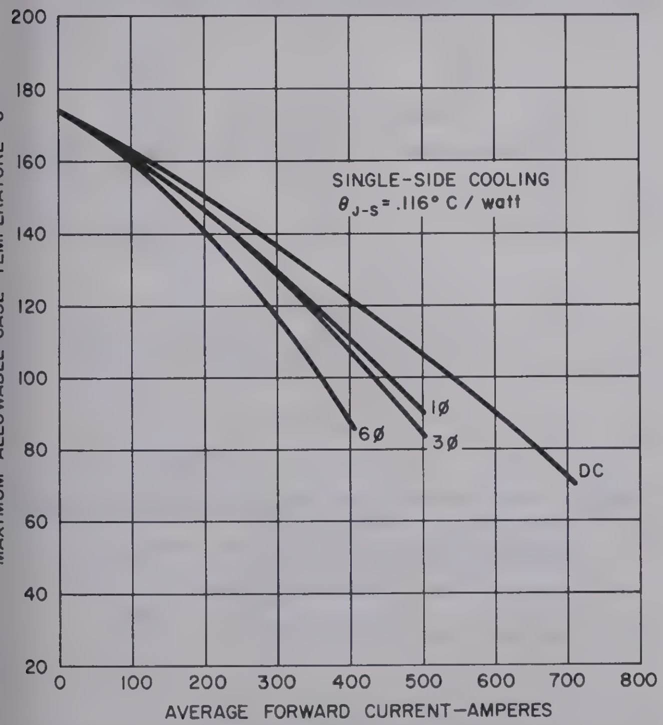
(3) Refer to the last page of this specification for mounting instructions.



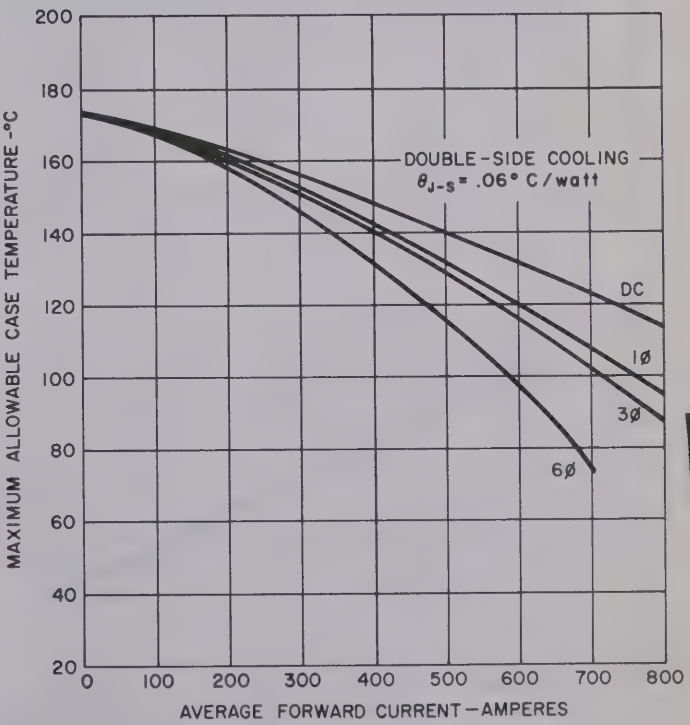
. AVERAGE FORWARD CURRENT VS. MAXIMUM ALLOWABLE CASE TEMPERATURE



2. AVERAGE FORWARD POWER DISSIPATION VS. AVERAGE FORWARD CURRENT

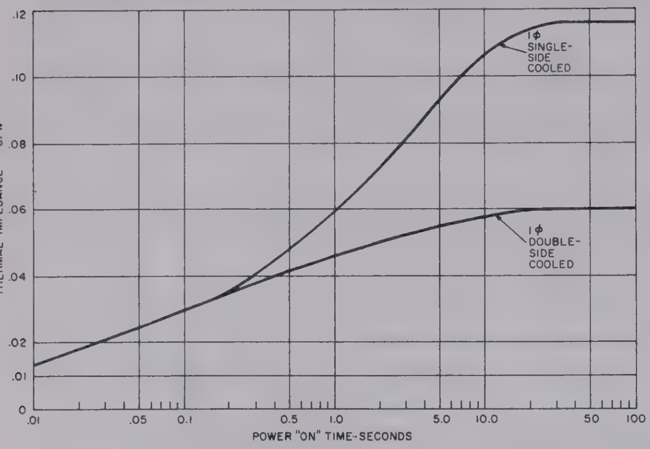


. MAXIMUM HEAT EXCHANGER TEMPERATURE VS. AVERAGE FORWARD CURRENT FOR SINGLE-IDE COOLING

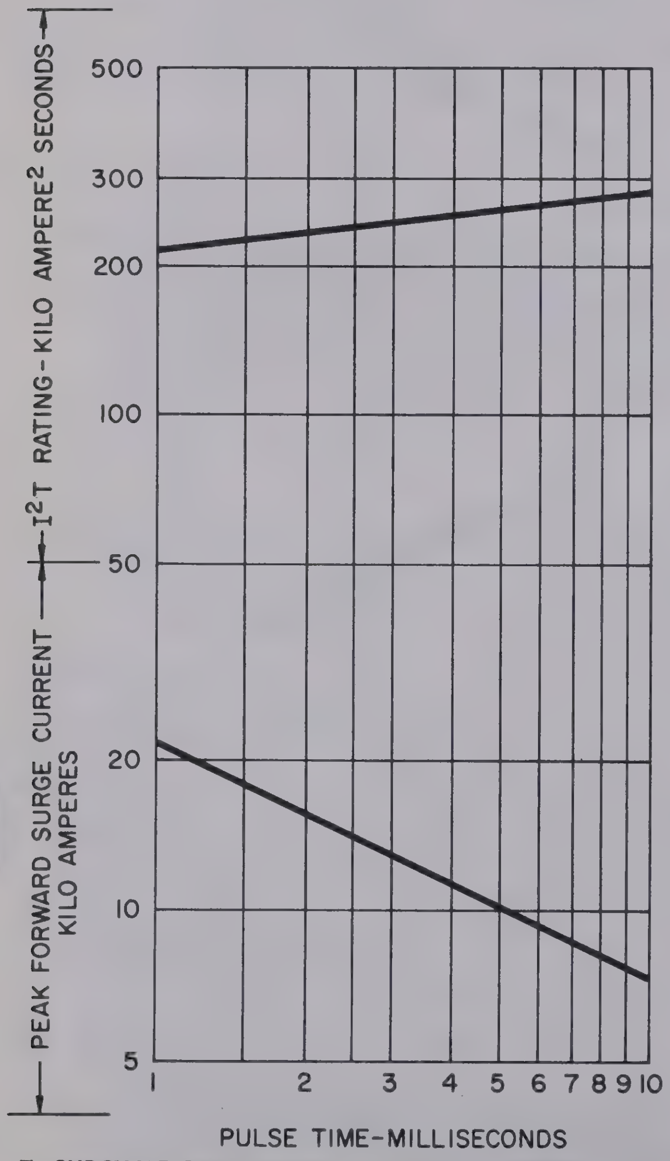


4. MAXIMUM HEAT EXCHANGER TEMPERATURE VS. AVERAGE FORWARD CURRENT FOR DOUBLE-SIDE COOLING

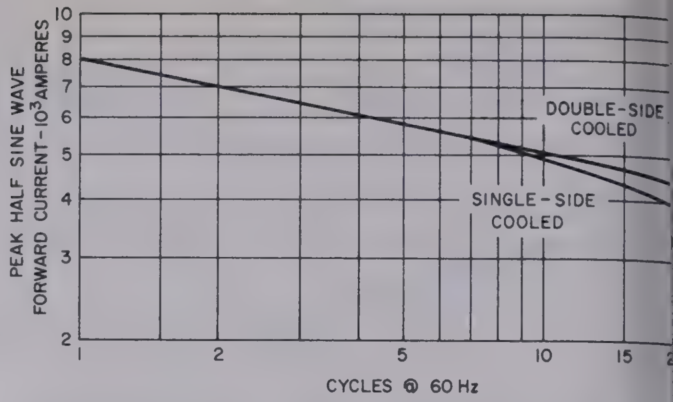
NOTES:
FOR 3ϕ THERMAL RESISTANCE ADD .005°C/W ALONG ENTIRE CURVE LENGTH
FOR 6ϕ THERMAL RESISTANCE ADD .01 °C/W ALONG ENTIRE CURVE LENGTH
FOR DC THERMAL RESISTANCE SUB .007 C/W ALONG ENTIRE CURVE LENGTH



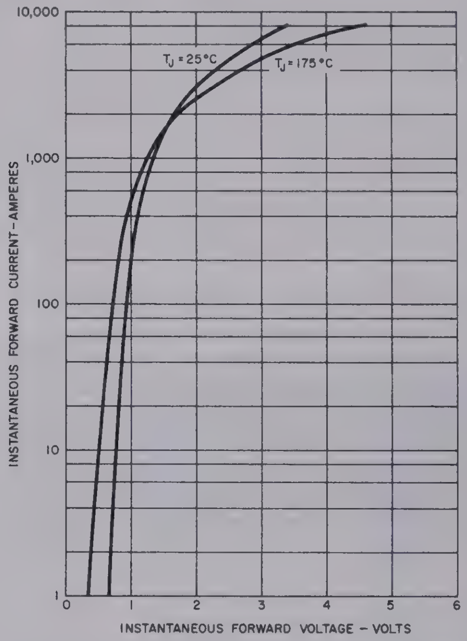
5. TRANSIENT THERMAL IMPEDANCE— JUNCTION TO SINK



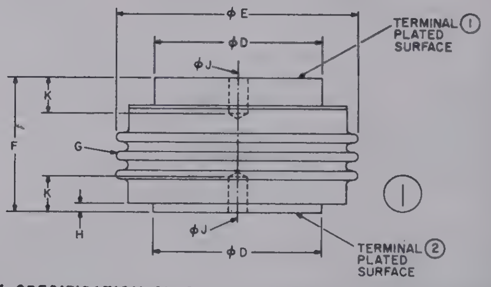
7. SUBCYCLE PEAK SURGE FORWARD CURRENT AND I²T RATING FOLLOWING RATED LOAD CONDITIONS



6. MAXIMUM SURGE CURRENT FOLLOWING RATED LOA CONDITIONS

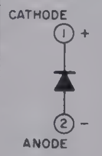


8. MAXIMUM ON-STATE CHARACTERISTICS


ϕE
ϕD
ϕJ
TERMINAL ① PLATED SURFACE
K
F
G
K
H
ϕJ
ϕD
TERMINAL ② PLATED SURFACE
①

SEE C501 SPECIFICATION SHEET FOR SUGGESTED MOUNTING METHOD.

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
ϕD	1.240	1.260	31.50	32.00	
ϕE		1.875		47.63	
F	1.000	1.040	25.40	26.42	
G					1
H	0.052		1.32		
ϕJ	0.136	0.146	3.45	3.71	
K	0.220	0.280	5.59	7.11	


CATHODE
① +
② -
ANODE

NOTE:
1. 1.000(25.40) MIN INSULATION (SURFACE CREEPAGE)

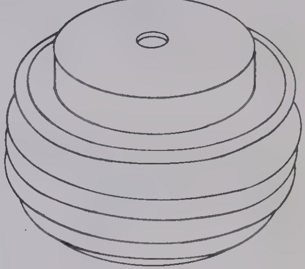
9. OUTLINE DRAWING

FOR MOUNTING HARDWARE SEE SELECTOR GUIDE PAGE 171

Silicon RECTIFIER

A540

The A540 Series of high power rectifier diodes feature the proven, alloy-diffused construction used in a new General Electric pressure-mounted package.



Special features of these new devices are:

- High current, high voltage
- Pressure contacts
- Glazed ceramic package with 1″ creepage path
- Reversability (eliminates need for special reverse polarity units)
- Hermetic seal
- Available in factory assembled heat exchangers or ready-to-mount

IMPORTANT: Mounting instructions on the last page of this specification must be followed.

MAXIMUM ALLOWABLE RATINGS

Types	Repetive Peak Reverse Voltage, V_{RRM}(1) $T_J = -40°C$ to $+200°C$	Transient Peak Reverse Voltage, V_{RSM}, (non-recurrent 5 msec max) (2) $T_J = -40°C$ to $+200°C$
A540A	100 Volts	200 Volts
A540B	200	300
A540C	300	400
A540D	400	500
A540E	500	600
A540M	600	700
A540S	700	800
A540N	800	900
A540T	900	1000
A540P	1000	1100

Types	Repetitive Peak Reverse Voltage, V_{RRM}(1) $T_J = -40°C$ to $+200°C$	Transient Peak Reverse Voltage, V_{RSM}, (non-recurrent 5 msec max)(2) $T_J = -40°C$ to $+200°C$
A540PA	1100 Volts	1200 Volts
A540PB	1200	1350
A540PC	1300	1450
A540PD	1400	1600
A540PE	1500	1700
A540PM	1600	1800
A540PS	1700	1900
A540PN	1800	2000
A540PT	1900	2100
A540L	2000	2200

Average Forward Current	1000 amperes, 1Φ average
Peak One-Cycle Surge Current	10,000 amperes
Minimum I^2t Rating (for times $\geqq$ 1.5 msec)	200,000 ampere² seconds
(at 8.3 msec)	400,000 ampere² seconds
Maximum Full Load Voltage Drop (full-cycle avg., 150°C case temp., single phase)	1.08 volts
Peak reverse leakage current, $T_J = 200°C$, $V =$ rated V_{RRM}	50 mA
Maximum Thermal Resistance, $R_{\theta JS}$. Double-side Cooling	0.06°C/watt
Single-side Cooling	0.116°C/watt
Storage and Operating Junction Temperature, T_{STG} & T_J	−40°C to +200°C
Mounting Force Required(3)	2200 lbs ± 10% 910 kg. ± 10%

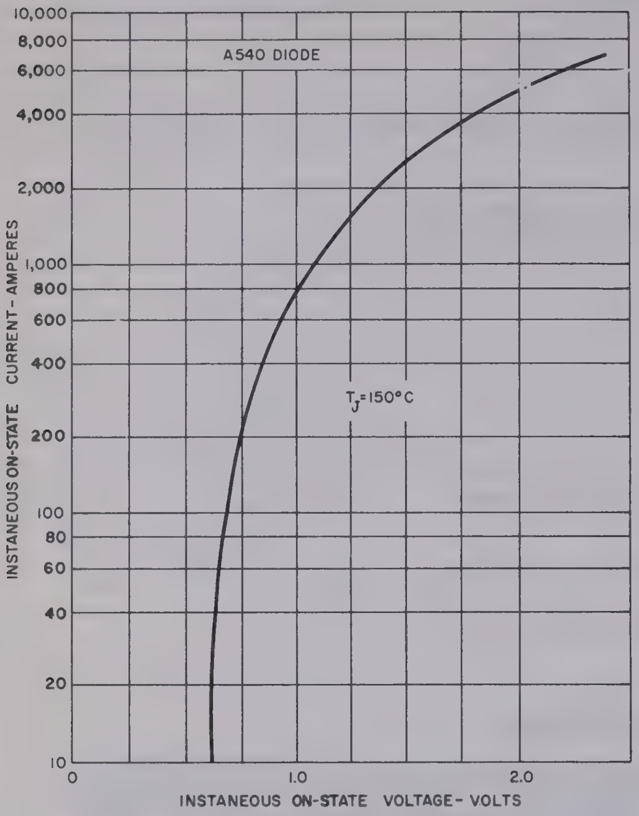
REFER TO PAGE 813 FOR RECOVERY CHARACTERISTICS.

NOTES:

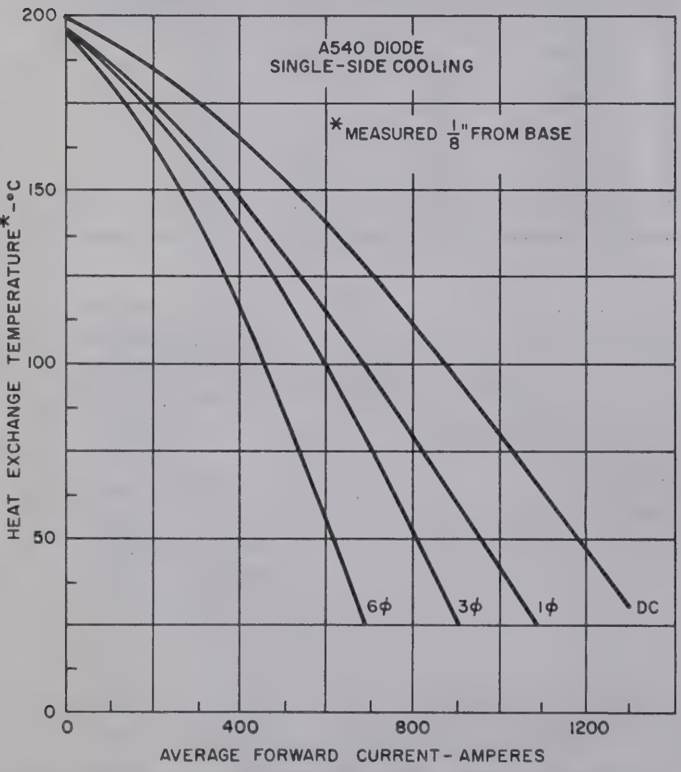
(1) Assumes a heatsink dissipation of less than 1.1°C/watt.

(2) Non-recurrent voltage and current ratings, as contrasted to repetitive ratings which apply for occasional or unpredictable overloads. For example, the forward surge current ratings are non-recurrent ratings that are used in fault coordination work.

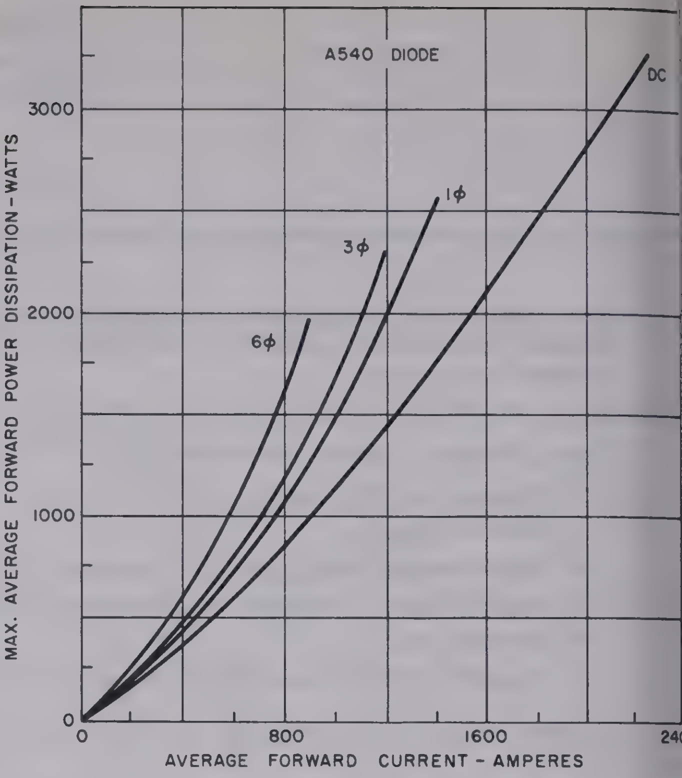
(3) Refer to the last page of this specification for mounting instructions.



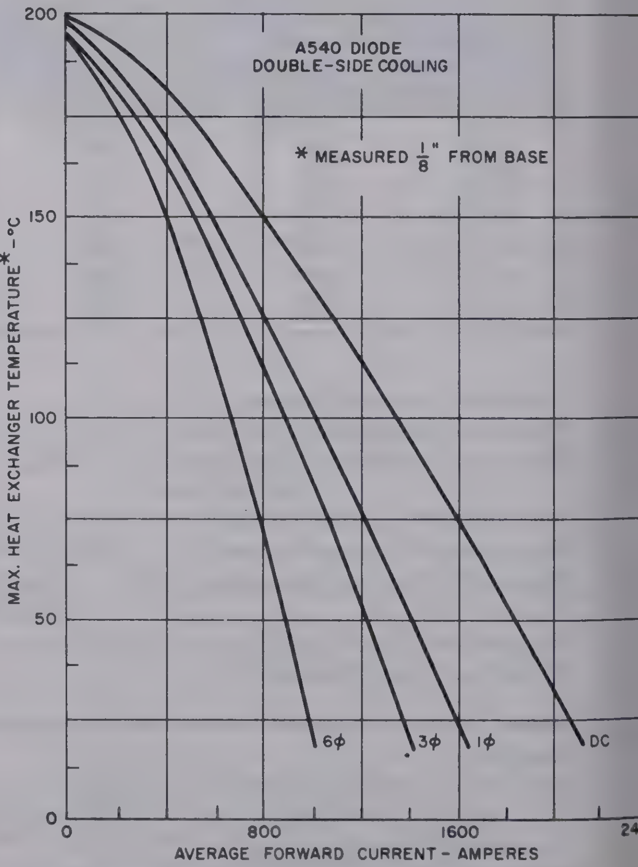
1. MAXIMUM ON-STATE CHARACTERISTICS



3. MAXIMUM HEAT EXCHANGER TEMPERATURE VS. AVERAGE FORWARD CURRENT FOR SINGLE-SIDE COOLING

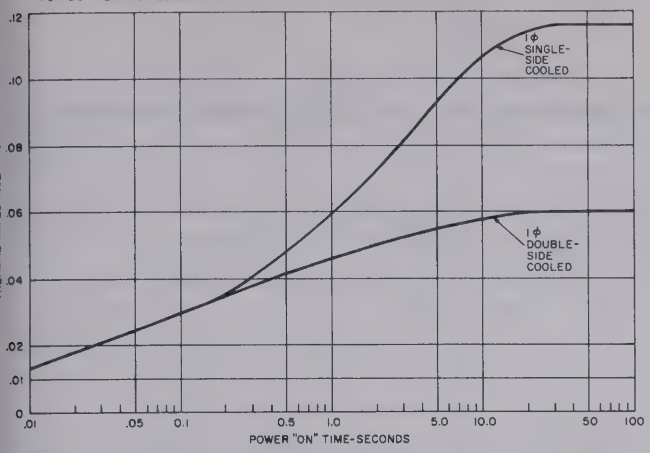


2. AVERAGE FORWARD POWER DISSIPATION VS. AVERA
FORWARD CURRENT

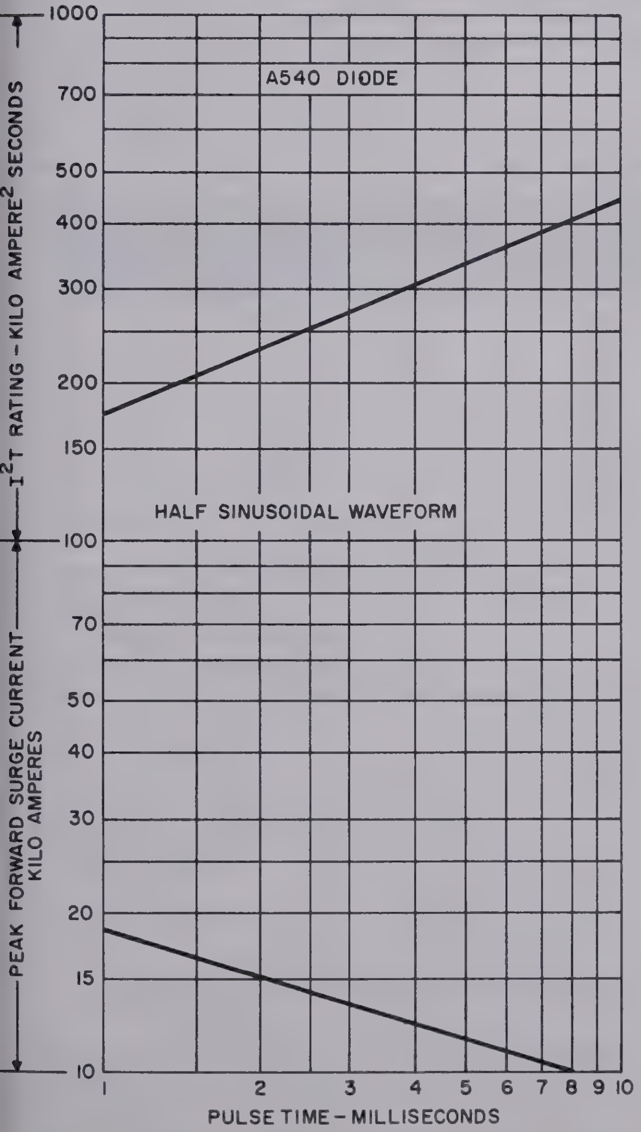


4. MAXIMUM HEAT EXCHANGER TEMPERATURE VS. AVERAGE FORWARD CURRENT FOR DOUBLE-SIDE COOLING

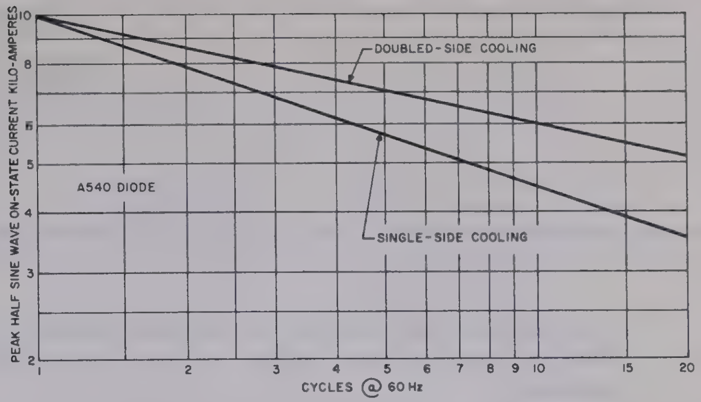
NOTES:
FOR 3ϕ THERMAL RESISTANCE ADD .005°C/W ALONG ENTIRE CURVE LENGTH
FOR 6ϕ THERMAL RESISTANCE ADD .01 °C/W ALONG ENTIRE CURVE LENGTH
FOR DC THERMAL RESISTANCE SUB .007 C/W ALONG ENTIRE CURVE LENGTH



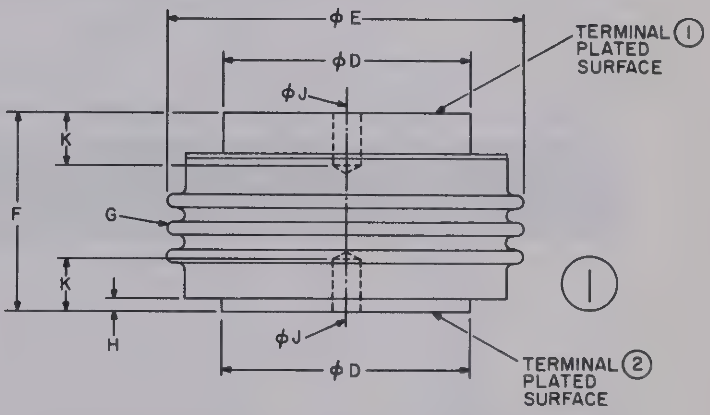
. TRANSIENT THERMAL IMPEDANCE— JUNCTION TO
INK



. SUBCYCLE PEAK SURGE FORWARD CURRENT AND
T RATING FOLLOWING RATED LOAD CONDITIONS

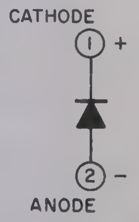


6. MAXIMUM SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS


ϕ E
ϕ D
ϕ J
TERMINAL ① PLATED SURFACE
K
F
G
K
H
ϕ J
ϕ D
TERMINAL ② PLATED SURFACE
①

SEE C501 SPECIFICATION SHEET FOR SUGGESTED MOUNTING METHOD.

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
ϕD	1.240	1.260	31.50	32.00	
ϕE		1.875		47.63	
F	1.000	1.040	25.40	26.42	
G					1
H	0.052		1.32		
ϕJ	0.136	0.146	3.45	3.71	
K	0.220	0.280	5.59	7.11	


CATHODE
① +
② –
ANODE

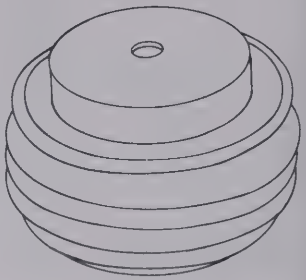
NOTE:
1. 1.000(25.40) MIN INSULATION (SURFACE CREEPAGE)

8. OUTLINE DRAWING

FOR MOUNTING HARDWARE SEE SELECTOR GUIDE PAGE 171

A570

The A570 Series of high power rectifier diodes feature the proven, alloy-diffused construction used in a new General Electric pressure-mounted package.



Special features of these new devices are:

- Highest current rectifier available
- Pressure contacts
- Glazed ceramic package with 1″ creepage path
- Reversability (eliminates need for special reverse polarity units)
- Hermetic seal
- Available in factory assembled heat exchangers or ready-to-mount

IMPORTANT: Mounting instructions on the last page of this specification must be followed.

MAXIMUM ALLOWABLE RATINGS

Types	Repetitive Peak Reverse Voltage, V_{RRM} (1)	Transient Peak Reverse Voltage, V_{RSM}, (non-recurrent 5 msec max) (2)	Full Load Reverse Current (full-cycle average, 130°C case temperature, single-phase)
A570A	100 Volts	200 Volts	50 mA
A570B	200	300	50
A570C	300	400	50
A570D	400	500	50
A570E	500	600	50
A570M	600	700	50
A570S	700	800	50
A570N	800	900	50
A570T	900	1000	50
A570P	1000	1100	50

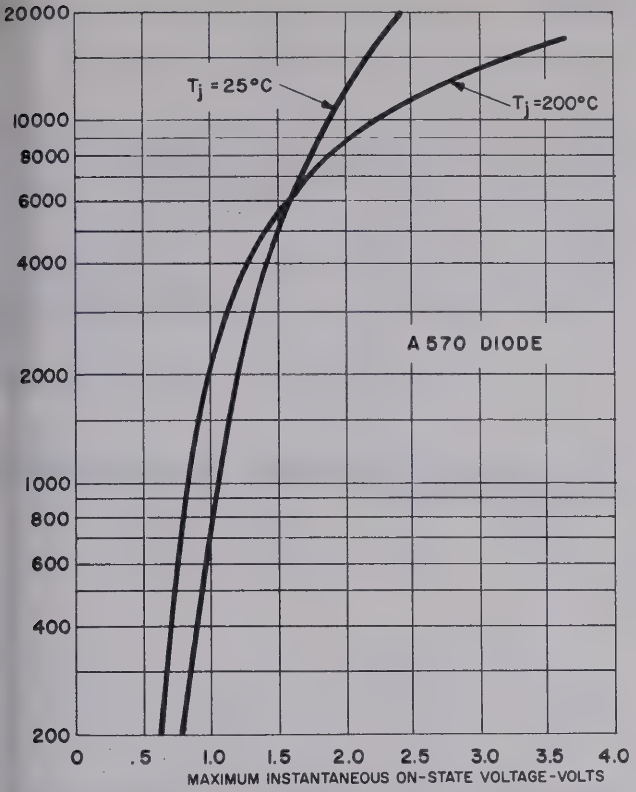
Average Forward Current	1500 amperes, 1Φ average
Peak One-Cycle Surge Current	15,000 amperes
Minimum I^2t Rating (for times ≧ 1.5 msec)	690,000 ampere² seconds
(at 8.3 msec)	920,000 ampere² seconds
Maximum Full Load Voltage Drop (full-cycle avg., 130°C case temp., single phase)	0.4 volts
Peak reverse leakage current, $T_J = 200°C$, V = rated V_{RRM}	50 mA
Maximum Thermal Resistance, Θ_{J-S} . . . . Double-side Cooling	0.053°C/watt
Single-side Cooling	0.108°C/watt
Storage and Operating Junction Temperature, T_J	−40°C to +200°C
Mounting Force Required (3)	2200 lbs ± 10% 910 kg. ± 10%

NOTES:

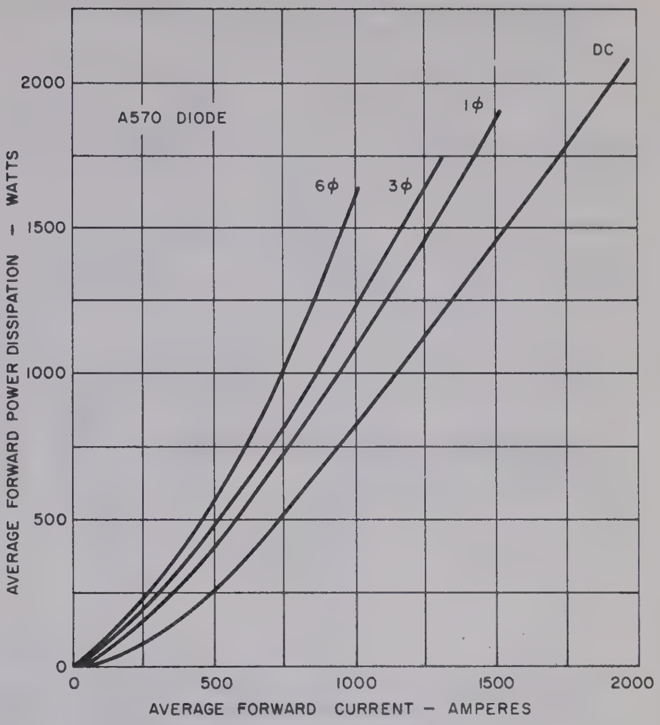
(1) Assumes a heatsink dissipation of less than 1.0°C/watt.

(2) Non-recurrent voltage and current ratings, as contrasted to repetitive ratings which apply for occasional or unpredictable overloads. For example, the forward surge current ratings are non-recurrent ratings that are used in fault coordination work.

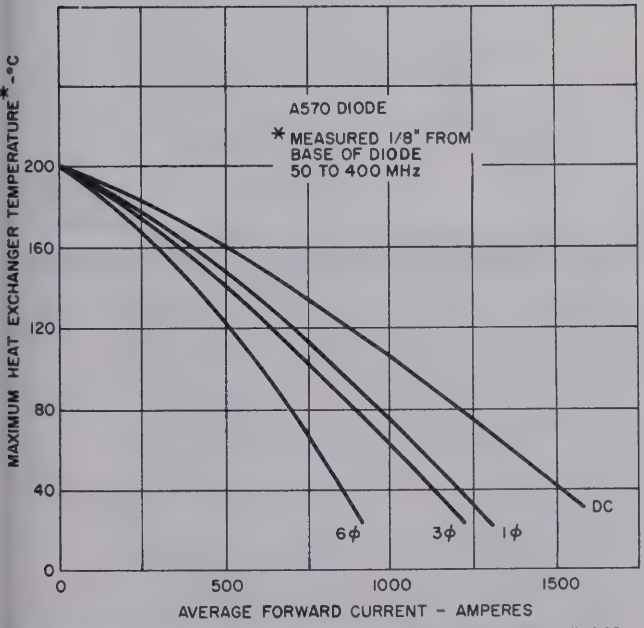
(3) Refer to the last page of this specification for mounting instructions.



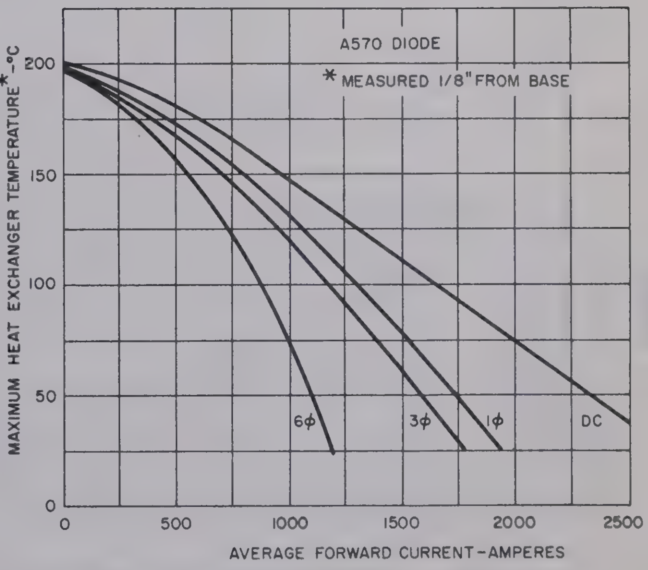
1. MAXIMUM ON-STATE CHARACTERISTICS



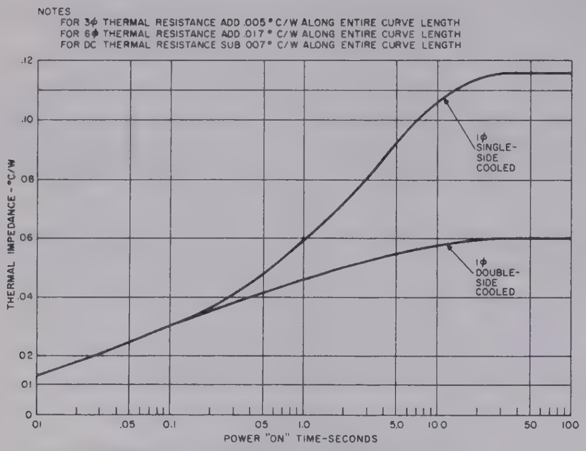
2. AVERAGE FORWARD POWER DISSIPATION VS. AVERAGE FORWARD CURRENT



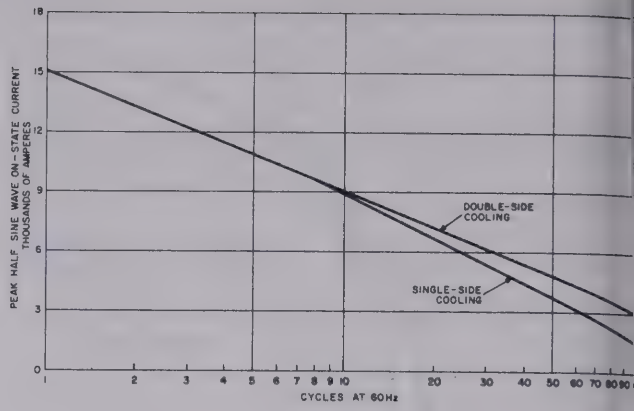
3. MAXIMUM HEAT EXCHANGER TEMPERATURE VS. AVERAGE FORWARD CURRENT FOR SINGLE-SIDE COOLING



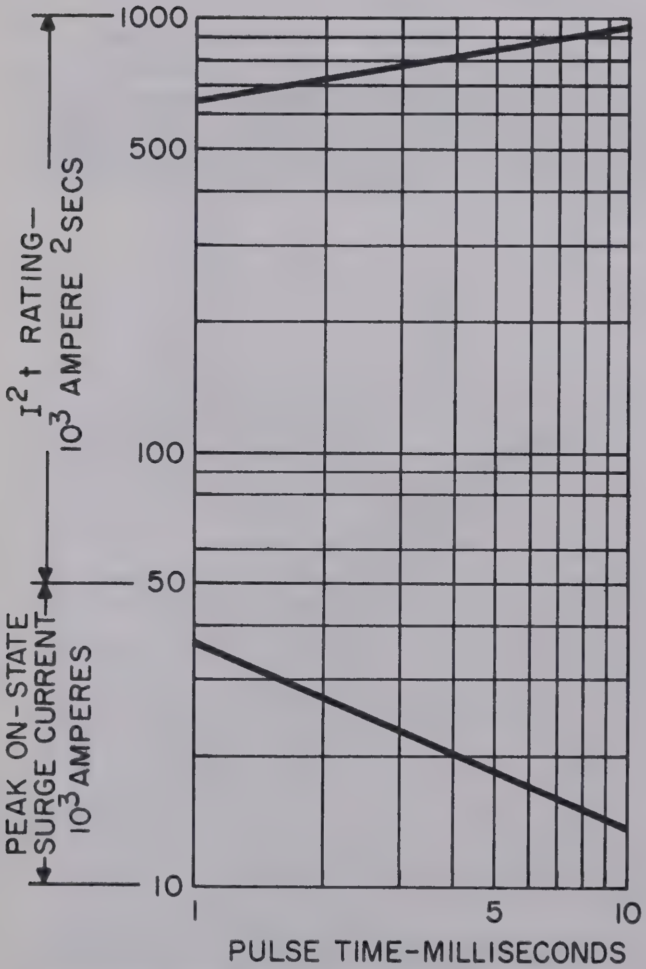
4. MAXIMUM HEAT EXCHANGER TEMPERATURE VS. AVERAGE FORWARD CURRENT FOR DOUBLE-SIDE COOLING



5. TRANSIENT THERMAL IMPEDANCE—JUNCTION TO SINK

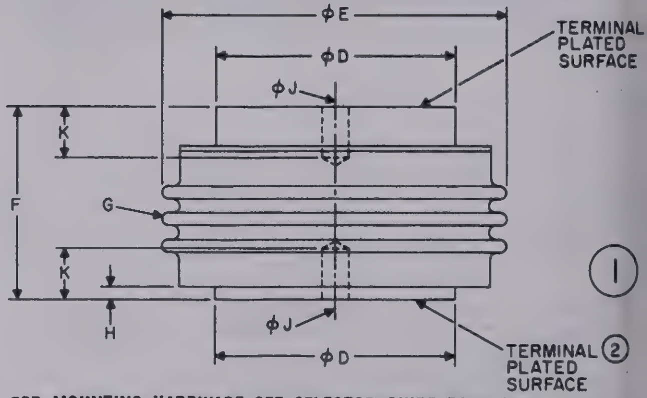


6. MAXIMUM SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS



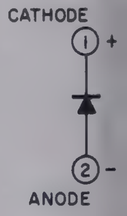
7. SUBCYCLE PEAK SURGE ON-STATE CURRENT AND I^2T RATING FOLLOWING RATED LOAD CONDITIONS

FOR MOUNTING HARDWARE SEE SELECTOR GUIDE PAGE 171


ϕE
ϕD
ϕJ
TERMINAL ① PLATED SURFACE
K
F
G
K
H
ϕJ
ϕD
TERMINAL ② PLATED SURFACE
①

FOR MOUNTING HARDWARE SEE SELECTOR GUIDE PAGE 173
SEE C501 SPECIFICATION SHEET FOR SUGGESTED MOUNTING METHOD.

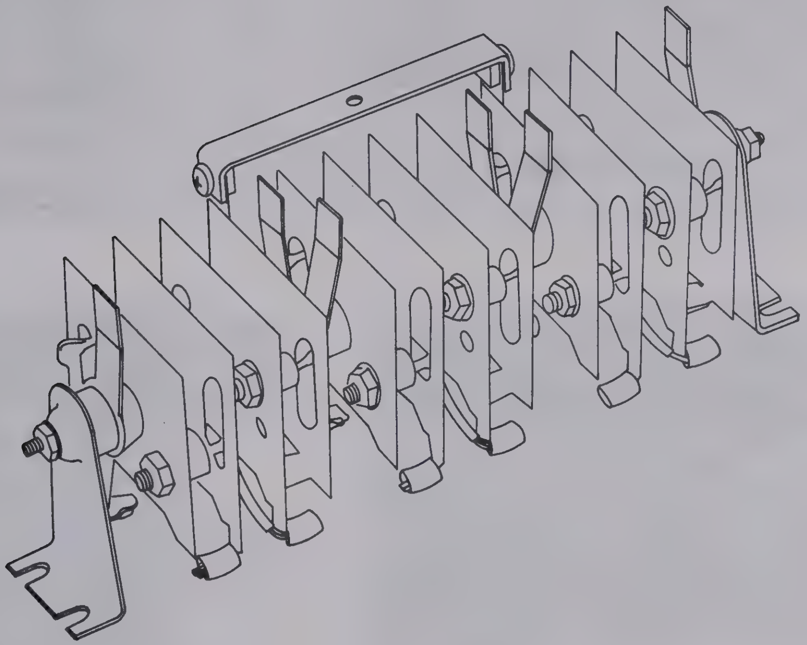
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
ϕD	1.240	1.260	31.50	32.00	
ϕE		1.875		47.63	
F	1.000	1.040	25.40	26.42	
G					1
H	0.052		1.32		
ϕJ	0.136	0.146	3.45	3.71	
K	0.220	0.280	5.59	7.11	


CATHODE
① +
② –
ANODE

NOTE:
1. 1.000 (25.40) MIN INSULATION (SURFACE CREEPAGE)

8. OUTLINE DRAWING

Silicon Rectifier Stacks



High Efficiency — Up to 99% in certain applications.

Excellent Regulation — Forward voltage drops of less than one volt per cell.

Low Leakage — Excellent for magnetic amplifier applications.

Wide Range of Operating and Storage Temperatures — Will operate from — 65°C to 175°C.

No Aging — Extremely long life — no transformer taps required — high reliability.

Rugged Construction — Meets stringent military environmental tests.

Small Size — Greatly reduces space and weight requirements.

Complete Packaged Rectifier Circuit — Requires only mounting bolts and electrical connections. No special fin design or insulating hardware.

Dependability — Backed by a General Electric one year written warranty.

Versatility — 140 stacked combinations with DC outputs up to 32.4 amperes to meet a variety of circuit conditions. Special circuits can be designed to your order.

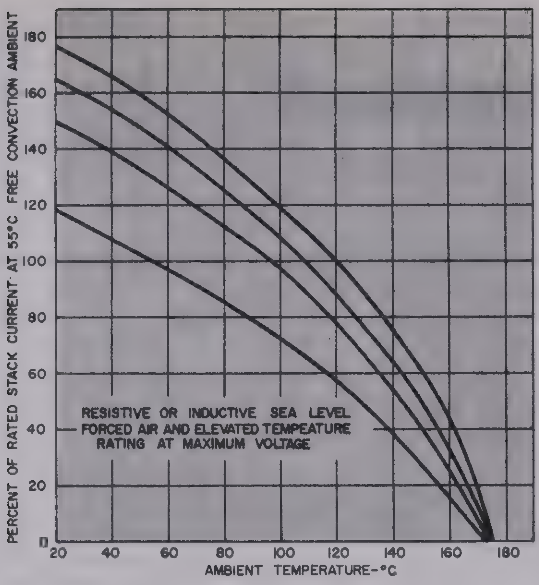


CHART NO. 1

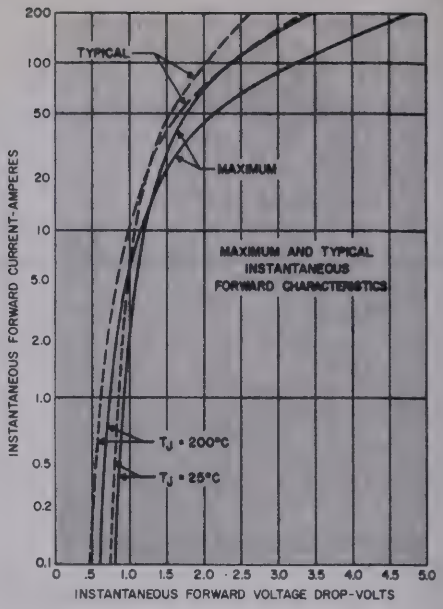


CHART NO. 2

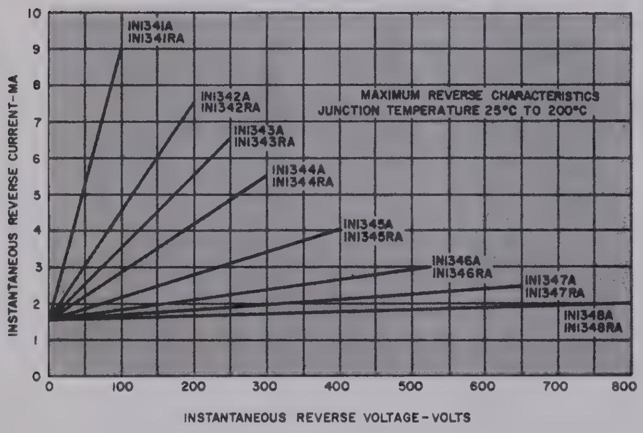


CHART NO. 3

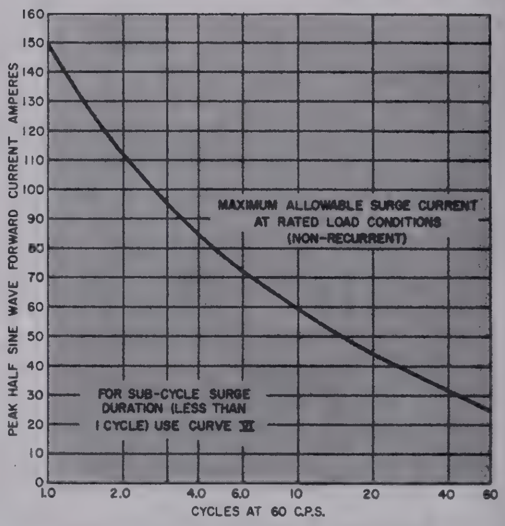


CHART NO. 4

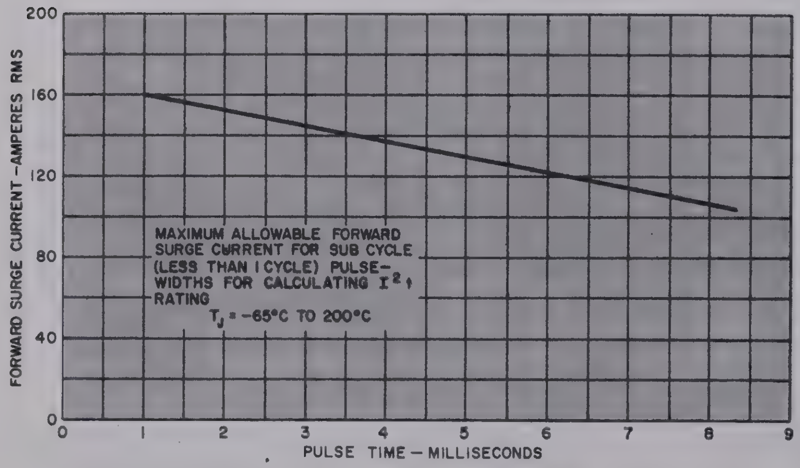
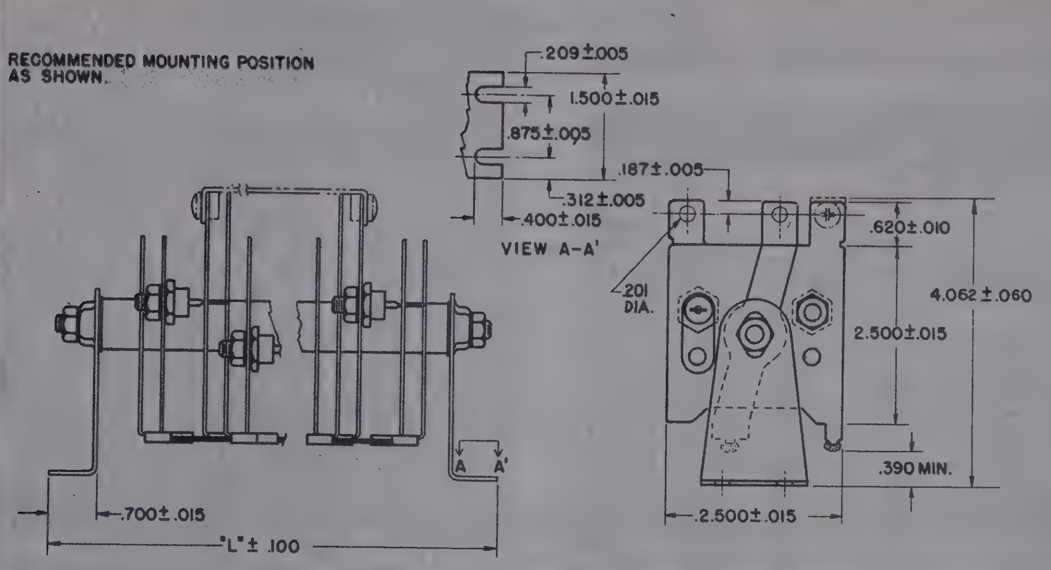


CHART NO. 5

OUTLINE DRAWING-A2011

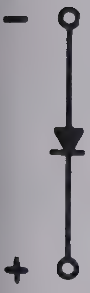


TERMINAL COLOR CODING

RED = +
BLACK = −
YELLOW = AC

SINGLE PHASE HALF WAVE*

A2011 Series Model No.	Outline Dimensions "L" (In.)	AC Input RMS Volts	DC Output	
			Volts	Amps
FH1AD1	3.006	35	15	6.3
FH1AD2	3.492	35	15	11.3
AH1AD1	3.006	70	31	6.3
AH1AD2	3.492	70	31	11.3
BH1AD1	3.006	140	62	6.3
BH1AD2	3.492	140	62	11.3
CH1AD1	3.006	210	94	6.3
CH1AD2	3.492	210	94	11.3
DH1AD1	3.006	280	125	6.3
DH1AD2	3.492	280	125	11.3
EH1AD1	3.006	350	157	6.3
EH1AD2	3.492	350	157	11.3
MH1AD1	3.006	420	188	6.3
MH1AD2	3.492	420	188	11.3
DH2AD1	3.489	560	251	6.3
DH2AD2	4.515	560	251	11.3
CH3AD1	4.510	630	282	6.3
CH3AD2	6.004	630	282	11.3
EH2AD1	3.489	700	314	6.3
EH2AD2	4.515	700	314	11.3
MH2AD1	3.489	840	377	6.3
MH2AD2	4.515	840	377	11.3
MH3AD1	4.510	1260	564	6.3
MH3AD2	6.004	1260	564	11.3



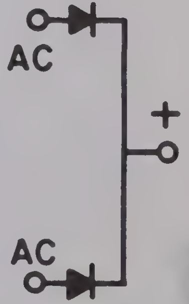
Maximum Operating Ratings, Resistive or Inductive Load, 60 CPS Sinusoidal at 55°C Ambient. For Other Ambient Conditions, Use Chart No. 1

SINGLE PHASE CENTER TAP*

A2011 Series Model No.	Outline Dimensions "L" (In.)	AC Input† RMS Volts	DC Output	
			Volts	Amps
FC1AD1	3.512	17.5	14	12.6
FC1AD2	4.961	17.5	14	22.6
AC1AD1	3.512	35.0	30	12.6
AC1AD2	4.961	35.0	30	22.6
BC1AD1	3.512	70.0	62	12.6
BC1AD2	4.961	70.0	62	22.6
CC1AD1	3.512	105.0	93	12.6
CC1AD2	4.961	105.0	93	22.6
DC1AD1	3.512	140.0	125	12.6
DC1AD2	4.961	140.0	125	22.6
EC1AD1	3.512	175.0	156	12.6
EC1AD2	4.961	175.0	156	22.6
MC1AD1	3.512	210.0	188	12.6
MC1AD2	4.961	210.0	188	22.6
DC2AD1	4.998	280.0	250	12.6
DC2AD2	6.996	280.0	250	22.6
CC3AD1	5.924	315.0	280	12.6
CC3AD2	10.011	315.0	280	22.6
EC2AD1	4.998	350.0	313	12.6
EC2AD2	6.996	350.0	313	22.6
MC2AD1	4.998	420.0	376	12.6
MC2AD2	6.996	420.0	376	22.6
MC3AD1	5.924	630.0	564	12.6
MC3AD2	10.011	630.0	564	22.6

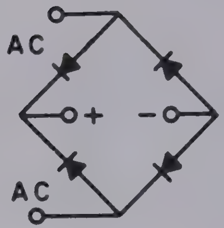
†Line to Center tap.
For negative output change second to last letter to "B".
For example: A2011BC2BD1

NOTE: Please designate full stack number by preceding Model No. desired with "A2011."



SINGLE PHASE BRIDGE*

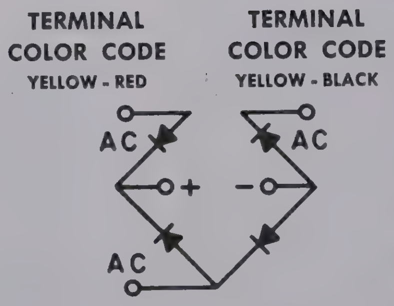
A2011 Series Model No.	Outline Dimensions "L" (In.)	AC Input RMS Volts	DC Output	
			Volts	Amps
FB1AD1	4.515	35	29	12.6
FB1AD2	7.502	35	29	22.6
AB1AD1	4.515	70	61	12.6
AB1AD2	7.502	70	61	22.6
BB1AD1	4.515	140	124	12.6
BB1AD2	7.502	140	124	22.6
CB1AD1	4.515	210	187	12.6
CB1AD2	7.502	210	187	22.6
DB1AD1	4.515	280	250	12.6
DB1AD2	7.502	280	250	22.6
EB1AD1	4.515	350	313	12.6
EB1AD2	7.502	350	313	22.6
MB1AD1	4.515	420	376	12.6
MB1AD2	7.502	420	376	22.6
DB2AD1	7.027	560	502	12.6
CB3AD1	9.519	630	564	12.6
EB2AD1	7.027	700	628	12.6
MB2AD1	7.027	840	754	12.6
MB3AD1	9.519	1260	1130	12.6



SINGLE PHASE MAGNETIC AMPLIFIER BRIDGE*

A2011 Series Model No.	Outline Dimensions "L" (In.)	AC Input RMS Volts	DC Output	
			†Volts	Amps
FM1AD1	4.478	35	29	12.6
FM1AD2	7.502	35	29	22.6
AM1AD1	4.478	70	61	12.6
AM1AD2	7.502	70	61	22.6
BM1AD1	4.478	140	124	12.6
BM1AD2	7.502	140	124	22.6
CM1AD1	4.478	210	187	12.6
CM1AD2	7.502	210	187	22.6
DM1AD1	4.478	280	250	12.6
DM1AD2	7.502	280	250	22.6
EM1AD1	4.478	350	313	12.6
EM1AD2	7.502	350	313	22.6
MM1AD1	4.478	420	376	12.6
MM1AD2	7.502	420	376	22.6
DM2AD1	6.990	560	502	12.6
DM3AD1	9.482	630	564	12.6
EM2AD1	6.990	700	628	12.6
MM2AD1	6.990	840	754	12.6
MM3AD1	9.482	1260	1130	12.6

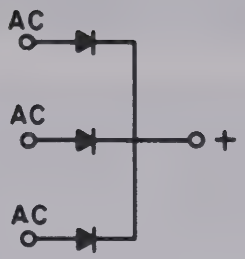
†Neglecting gate winding drop.



THREE PHASE HALF WAVE*

A2011 Series Model No.	Outline Dimensions "L" (In.)	AC Input† RMS Volts	DC Output	
			Volts	Amps
FY1AD1	4.478	20	22	18.0
FY1AD2	5.990	20	22	32.4
AY1AD1	4.478	40	45	18.0
AY1AD2	5.990	40	45	32.4
BY1AD1	4.478	80	92	18.0
BY1AD2	5.990	80	92	32.4
CY1AD1	4.478	120	139	18.0
CY1AD2	5.990	120	139	32.4
DY1AD1	4.478	160	186	18.0
DY1AD2	5.990	160	186	32.4
EY1AD1	4.478	200	232	18.0
EY1AD2	5.990	200	232	32.4
MY1AD1	4.478	240	279	18.0
MY1AD2	5.990	240	279	34.2
DY2AD1	5.987	320	372	18.0
DY2AD2	9.494	320	372	32.4
CY3AD1	7.976	360	418	18.0
EY2AD1	5.987	400	465	18.0
EY2AD2	9.494	400	465	32.4
MY2AD1	5.987	480	558	18.0
MY2AD2	9.494	480	558	32.4
MY3AD1	7.976	720	838	18.0

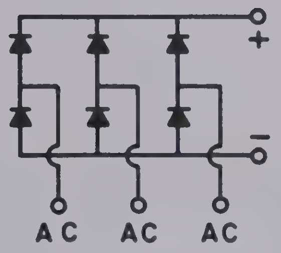
†Line to Neutral.
For negative output change second to last letter to "B".
For example: A2011FS1BD1



THREE PHASE BRIDGE*

A2011 Series Model No.	Outline Dimensions "L" (In.)	AC Input RMS Volts	DC Output	
			Volts	Amps
FF1AD1	5.987	35	45	18.0
FF1AD2	9.480	35	45	32.4
AF1AD1	5.987	70	92	18.0
AF1AD2	9.480	70	92	32.4
BF1AD1	5.987	140	186	18.0
BF1AD2	9.480	140	186	32.4
CF1AD1	5.987	210	281	18.0
CF1AD2	9.480	210	281	32.4
DF1AD1	5.987	280	375	18.0
DF1AD2	9.480	280	375	32.4
EF1AD1	5.987	350	470	18.0
EF1AD2	9.480	350	470	32.4
MF1AD1	5.987	420	564	18.0
MF1AD2	9.480	420	564	32.4
DF2AD1	9.485	560	751	18.0
EF2AD1	9.485	700	940	18.0
MF2AD1	9.485	840	1130	18.0

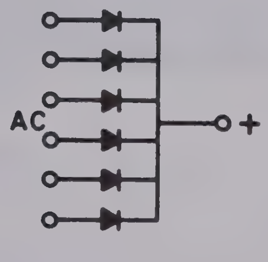
†Line to Line.



SIX PHASE STAR*

A2011 Series Model No.	Outline Dimensions "L" (In.)	AC Input† RMS Volts	DC Output	
			Volts	Amps
FS1AD1	6.536	17.5	22	28.8
AS1AD1	6.536	35.0	45	28.8
BS1AD1	6.536	70.0	93	28.8
CS1AD1	6.536	105.0	140	28.8
DS1AD1	6.536	140.0	187	28.8
ES1AD1	6.536	175.0	234	28.8
MS1AD1	6.536	210.0	282	28.8
DS2AD1	9.514	280.0	375	28.8
ES2AD1	9.514	350.0	469	28.8
MS2AD1	9.514	420.0	563	28.8

†Line to Center Tap.
For negative output change second to last letter to "B".
For example: A2011BC2BD1



Maximum Operating Ratings, Resistive or Inductive Load, 60 CPS Sinusoidal at 55°C Ambient. For Other Ambient Conditions, Use Chart No. 1

NOTE: Please designate full stack number by preceding Model No. desired with "A2011."

ADDITIONAL RATING AND SPECIFICATION PER FIN

	A2011F	A	B	C	D	E	M
Maximum Allowable Transient Peak Reverse Voltage* (Non-recurrent 5 millisec. max. duration)	100	200	350	450	600	700	800 volts
Maximum Allowable Peak Reverse Voltage* (Repetitive)	50	100	200	300	400	500	600 volts
Maximum Allowable DC Blocking Voltage* (At Maximum Ambient of 150°C)	50	100	200	300	400	500	600 volts
Maximum Full Load Voltage Drop* (6.3A DC Single Phase, Full Cycle Aver., 55°C Amb.)	.5V DC						
Maximum Leakage Current At Full Load** (Single Phase, Full Cycle Average)	3	2.5	2.0	1.75	1.5	1.25	1.0 ma
I^2t Ratings (For Fusing) at Rated Forward Current and PRV for t greater than .0008 seconds and less than .0083 seconds**	Minimum 25 Amperes² Sec (−65°C to +200°C Tj)						

Ambient Temperature Range	−65°C to +175°C
Storage Temperature Range	−65°C to +175°C
Maximum Operating Frequency	50,000-cps

* Per Series Cell

**Per Parallel Cell

Determine Series and Parallel Cells as Follows

Number of Series Cells

A2011FH1AD1

Number of Parallel Cells

NOTE: In practical circuits the transient peak reverse voltage (PRV) rating of each leg in a rectifier stack should be approximately three times the operating peak voltage of the circuit. This precaution is necessary because of the possibility of transient voltage peaks in excess of the operating peak reverse voltage. The RMS voltage ratings for stacks on the preceding pages are based on the assumption that special precautions have been taken to minimize transient voltages.

Max. Hi-Pot Voltage to Mounting Brackets	2600 V. RMS @ 25°C Amb., Sea Level
Mechanical Shock	Depends upon number of Fins per stack — For specific information, consult your General Electric District Sales Manager.
Vibration	MIL-STD-202 A 10G Max. 10-50 CPS 2 Hours in each plane.
Salt Spray	MIL-STD-202 A, Method 101A, 96 hours
Humidity	MIL-STD-202 A, Method 103A, 240 hours

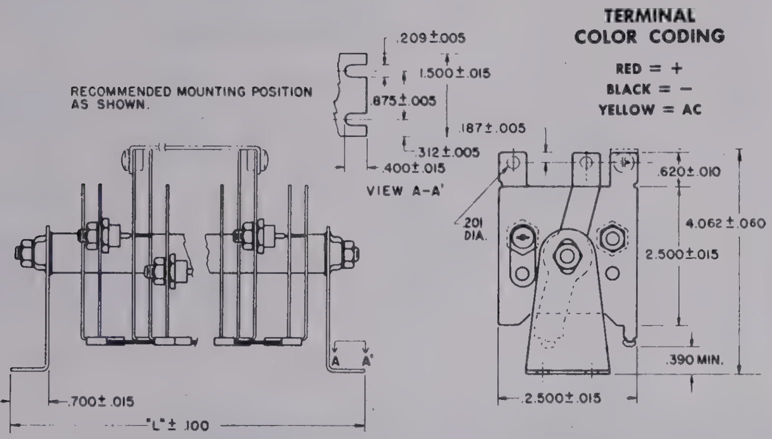
APPROXIMATE STACK WEIGHT

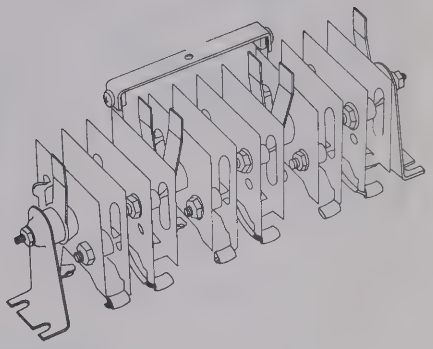
Number of Fins	Pounds
1	.40
2	.56
3	.66
4	.77
6	1.02
8	1.60
9	1.68
12	1.87

A2511

Silicon Rectifier Stacks

Up to 600 peak reverse volts (PRV) per cell
Up to 9.4 amps DC output per leg free convection rating


RECOMMENDED MOUNTING POSITION AS SHOWN.
.209±.005
1.500±.015
.875±.005
.187±.005
.312±.005
.400±.015
VIEW A-A'
TERMINAL COLOR CODING
RED = +
BLACK = −
YELLOW = AC
.620±.010
.201 DIA.
4.062±.060
2.500±.015
.390 MIN.
2.500±.015
A
A'
.700±.015
"L"±.100



OUTLINE DRAWING-A2511

Features

High Efficiency—Up to 99% in certain applications.

Excellent Regulation—Forward voltage drops of less than one volt per cell.

Low Leakage—Excellent for magnetic amplifier applications.

Wide Range of Operating and Storage Temperatures—Will operate from —65°C to 175°C.

No Aging—Extremely long life—no transformer taps required—high reliability.

Rugged Construction—Meets stringent military environmental tests.

Small Size—Greatly reduces space and weight requirements.

Complete Packaged Rectifier Circuit—Requires only mounting bolts and electrical connections. No special fin design or insulating hardware.

Dependability—Backed by a General Electric one year written warranty.

Versatility—164 stacked combinations with DC outputs up to 50 amperes to meet a variety of circuit conditions. Special circuits can be designed to your order.

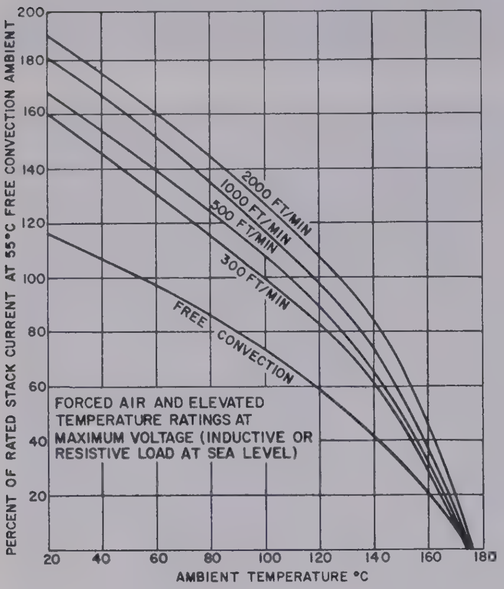


CHART NO. 1

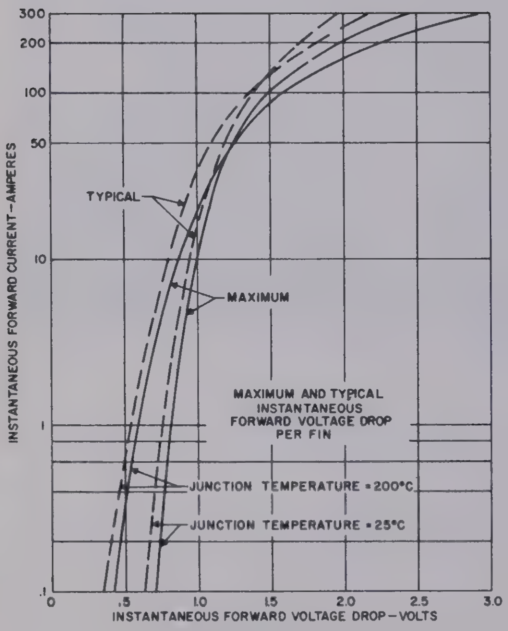


CHART NO. 2

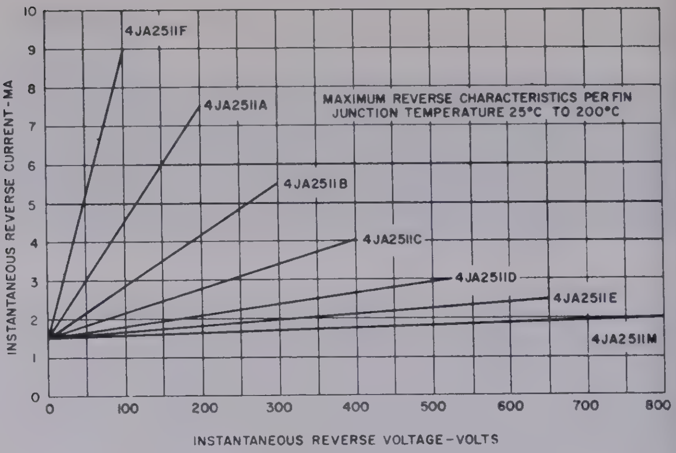
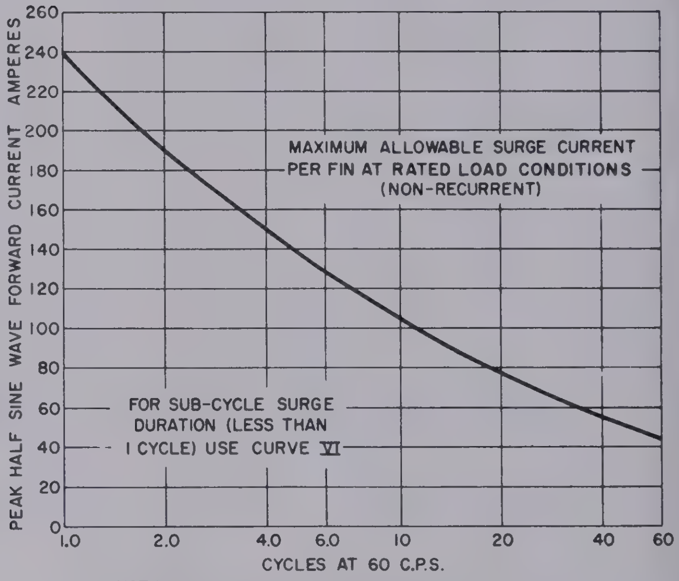


CHART NO. 3



NOTE:
WHEN FINS ARE OPERATED IN PARALLEL REDUCE SURGE RATING BY 10% PER FIN

CHART NO. 4

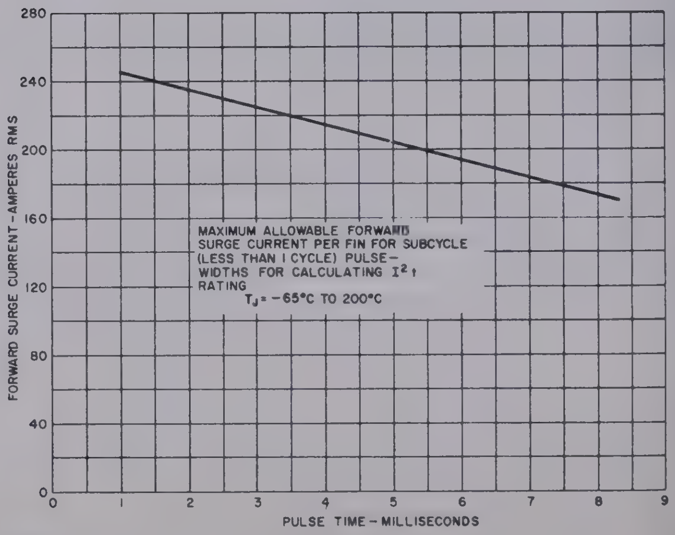
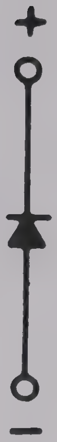


CHART NO. 5

SINGLE PHASE HALF WAVE*

A2511 Series Model No.	Outline Dimensions "L" (In.)	AC Input† RMS Volts	DC Output	
			Volts	Amps
FC1AD1	3.512	17.5	14	18.8
FC1AD2	4.961	17.5	14	33.8
AC1AD1	3.512	35.0	30	18.8
AC1AD2	4.961	35.0	30	33.8
BC1AD1	3.512	70.0	62	18.8
BC1AD2	4.961	70.0	62	33.8
CC1AD1	3.512	105.0	93	18.8
CC1AD2	4.961	105.0	93	33.8
DC1AD1	3.512	140.0	125	18.8
DC1AD2	4.961	140.0	125	33.8
EC1AD1	3.512	175.0	156	18.8
EC1AD2	4.961	175.0	156	33.8
MC1AD1	3.512	210.0	188	18.8
MC1AD2	4.961	210.0	188	33.8
DC2AD1	4.998	280.0	250	18.8
DC2AD2	6.996	280.0	250	33.8
CC3AD1	5.484	315.0	280	18.8
CC3AD2	10.011	315.0	280	33.8
EC2AD1	4.998	350.0	313	18.8
EC2AD2	6.996	350.0	313	33.8
MC2AD1	4.998	420.0	376	18.8
MC2AD2	6.996	420.0	376	33.8
MC3AD1	5.484	630.0	564	18.8
MC3AD2	10.011	630.0	564	33.8

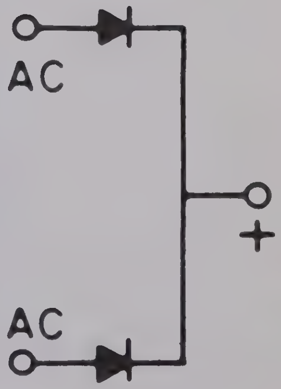
* Maximum Operating Ratings, Resistive or Inductive Load, 60 CPS Sinusoidal at 55°C Ambient. For Other Ambient Conditions, Use Chart No. 1



SINGLE PHASE CENTER TAP*

A2511 Series Model No.	Outline Dimensions "L" (In.)	AC Input RMS Volts	DC Output	
			Volts	Amps
FH1AD1	3.006	35	15	9.4
FH1AD2	3.492	35	15	16.9
AH1AD1	3.006	70	31	9.4
AH1AD2	3.492	70	31	16.9
BH1AD1	3.006	140	62	9.4
BH1AD2	3.492	140	62	16.9
CH1AD1	3.006	210	94	9.4
CH1AD2	3.492	210	94	16.9
DH1AD1	3.006	280	125	9.4
DH1AD2	3.492	280	125	16.9
EH1AD1	3.006	350	157	9.4
EH1AD2	3.492	350	157	16.9
MH1AD1	3.006	420	188	9.4
MH1AD2	3.492	420	188	16.9
DH2AD1	3.489	560	251	9.4
DH2AD2	4.515	560	251	16.9
CH3AD1	4.510	630	282	9.4
CH3AD2	6.004	630	282	16.9
EH2AD1	3.489	700	314	9.4
EH2AD2	4.515	700	314	16.9
MH2AD1	3.489	840	377	9.4
MH2AD2	4.515	840	377	16.9
MH3AD1	4.510	1260	564	9.4
MH3AD2	6.004	1260	564	16.9

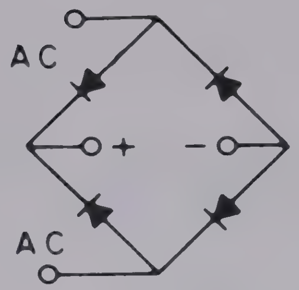
NOTE: Please designate full stack number by preceding Model No. desired with "A2511."



†Line to Center tap.
For negative output change second to last letter to "B".
For example: A2511BC2BD1

SINGLE PHASE BRIDGE*

A2511 Series Model No.	Outline Dimensions "L" (In.)	AC Input RMS Volts	DC Output	
			Volts	Amps
FB1AD1	4.515	35	29	18.8
FB1AD2	7.502	35	29	33.8
AB1AD1	4.515	70	61	18.8
AB1AD2	7.502	70	61	33.8
BB1AD1	4.515	140	124	18.8
BB1AD2	7.502	140	124	33.8
CB1AD1	4.515	210	187	18.8
CB1AD2	7.502	210	187	33.8
DB1AD1	4.515	280	250	18.8
DB1AD2	7.502	280	250	33.8
EB1AD1	4.515	350	313	18.8
EB1AD2	7.502	350	313	33.8
MB1AD1	4.515	420	376	18.8
MB1AD2	7.502	420	376	33.8
DB2AD1	7.027	560	502	18.8
CB3AD1	9.519	630	564	18.8
EB2AD1	7.027	700	628	18.8
MB2AD1	7.027	840	754	18.8
MB3AD1	9.519	1260	1130	18.8

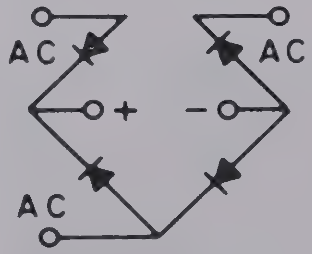


SINGLE PHASE MAGNETIC AMPLIFIER BRIDGE*

A2511 Series Model No.	Outline Dimensions "L" (In.)	AC Input RMS Volts	DC Output	
			†Volts	Amps
FM1AD1	4.478	35	29	18.8
FM1AD2	7.502	35	29	33.8
AM1AD1	4.478	70	61	18.8
AM1AD2	7.502	70	61	33.8
BM1AD1	4.478	140	124	18.8
BM1AD2	7.502	140	124	33.8
CM1AD1	4.478	210	187	18.8
CM1AD2	7.502	210	187	33.8
DM1AD1	4.478	280	250	18.8
DM1AD2	7.502	280	250	33.8
EM1AD1	4.478	350	313	18.8
EM1AD2	7.502	350	313	33.8
MM1AD1	4.478	420	376	18.8
MM1AD2	7.502	420	376	33.8
DM2AD1	6.990	560	502	18.8
DM3AD1	9.482	630	564	18.8
EM2AD1	6.990	700	628	18.8
MM2AD1	6.990	840	754	18.8
MM3AD1	9.482	1260	1130	18.8

†Neglecting gate winding drop.

TERMINAL COLOR CODE	TERMINAL COLOR CODE
YELLOW - RED	YELLOW - BLACK

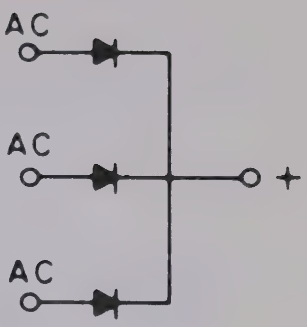


NOTE: Please designate full stack number by preceding Model No. desired with "A2511."

THREE PHASE HALF WAVE*

A2511 Series Model No.	Outline Dimensions "L" (In.)	AC Input† RMS Volts	DC Output	
			Volts	Amps
FY1AD1	4.478	20	22	26.4
FY1AD2	5.990	20	22	47.5
AY1AD1	4.478	40	45	26.4
AY1AD2	5.990	40	45	47.5
BY1AD1	4.478	80	92	26.4
BY1AD2	5.990	80	92	47.5
CY1AD1	4.478	120	139	26.4
CY1AD2	5.990	120	139	47.5
DY1AD1	4.478	160	186	26.4
DY1AD2	5.990	160	186	47.5
EY1AD1	4.478	200	232	26.4
EY1AD2	5.990	200	232	47.5
MY1AD1	4.478	240	279	26.4
MY1AD2	5.990	240	279	47.5
DY2AD1	5.987	320	372	26.4
DY2AD2	9.494	320	372	47.5
CY3AD1	7.976	360	418	26.4
EY2AD1	5.987	400	465	26.4
EY2AD2	9.494	400	465	47.5
MY2AD1	5.987	480	558	26.4
MY2AD2	9.494	480	558	47.5
MY3AD1	7.976	720	838	26.4

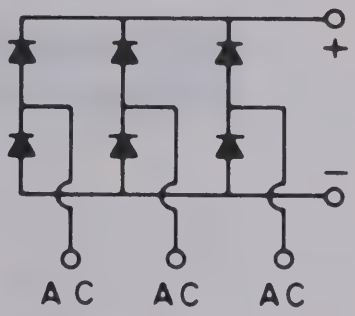
†Line to Neutral.
For negative output change second to last letter to "B".
For example: A2511FS1BD1



THREE PHASE BRIDGE*

A2511 Series Model No.	Outline Dimensions "L" (In.)	AC Input† RMS Volts	DC Output	
			Volts	Amps
FF1AD1	5.987	35	45	26.4
FF1AD2	9.480	35	45	47.5
AF1AD1	5.987	70	92	26.4
AF1AD2	9.480	70	92	47.5
BF1AD1	5.987	140	186	26.4
BF1AD2	9.480	140	186	47.5
CF1AD1	5.987	210	281	26.4
CF1AD2	9.480	210	281	47.5
DF1AD1	5.987	280	375	26.4
DF1AD2	9.480	280	375	47.5
EF1AD1	5.987	350	470	26.4
EF1AD2	9.480	350	425	47.5
MF1AD1	5.987	420	564	26.4
MF1AD2	9.480	420	564	47.5
DF2AD1	9.485	560	751	26.4
EF2AD1	9.485	700	940	26.4
MF2AD1	9.485	840	1130	26.4

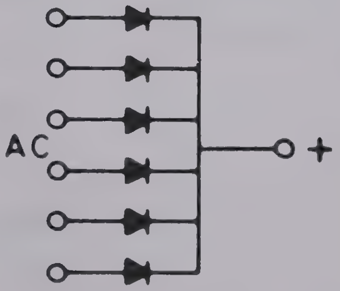
†Line to Line.
For negative output change second to last letter to "B".
For example: A2511BC2BD1



SIX PHASE STAR*

A2511 Series Model No.	Outline Dimensions "L" (In.)	AC Input† RMS Volts	DC Output	
			Volts	Amps
FS1AD1	6.536	17.5	22	42
AS1AD1	6.536	35.0	45	42
BS1AD1	6.536	70.0	93	42
CS1AD1	6.536	105.0	140	42
DS1AD1	6.536	140.0	187	42
ES1AD1	6.536	175.0	234	42
MS1AD1	6.536	210.0	282	42
DS2AD1	9.514	280.0	375	42
ES2AD1	9.514	350.0	469	42
MS2AD1	9.514	420.0	563	42

†Line to Center tap.
For negative output change second to last letter to "B".
For example: A2511BC2BD1



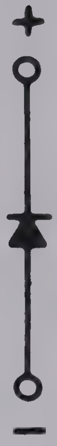
*** Maximum Operating Ratings, Resistive or Inductive Load, 60 CPS Sinusoidal at 55°C Ambient. For Other Ambient Conditions, Use Chart No. 1**

NOTE: Please designate full stack number by preceding Model No. desired with "A2511."

SINGLE PHASE HALF WAVE*

A2511 Series Model No.	Outline Dimensions "L" (In.)	AC Input† RMS Volts	DC Output Volts	DC Output Amps
FC1AD1	3.512	17.5	14	18.8
FC1AD2	4.961	17.5	14	33.8
AC1AD1	3.512	35.0	30	18.8
AC1AD2	4.961	35.0	30	33.8
BC1AD1	3.512	70.0	62	18.8
BC1AD2	4.961	70.0	62	33.8
CC1AD1	3.512	105.0	93	18.8
CC1AD2	4.961	105.0	93	33.8
DC1AD1	3.512	140.0	125	18.8
DC1AD2	4.961	140.0	125	33.8
EC1AD1	3.512	175.0	156	18.8
EC1AD2	4.961	175.0	156	33.8
MC1AD1	3.512	210.0	188	18.8
MC1AD2	4.961	210.0	188	33.8
DC2AD1	4.998	280.0	250	18.8
DC2AD2	6.996	280.0	250	33.8
CC3AD1	5.484	315.0	280	18.8
CC3AD2	10.011	315.0	280	33.8
EC2AD1	4.998	350.0	313	18.8
EC2AD2	6.996	350.0	313	33.8
MC2AD1	4.998	420.0	376	18.8
MC2AD2	6.996	420.0	376	33.8
MC3AD1	5.484	630.0	564	18.8
MC3AD2	10.011	630.0	564	33.8

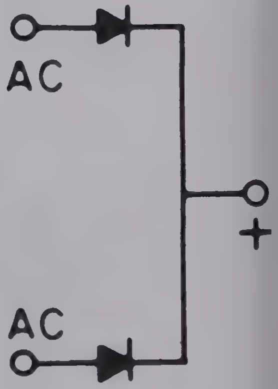
*** Maximum Operating Ratings, Resistive or Inductive Load, 60 CPS Sinusoidal at 55°C Ambient. For Other Ambient Conditions, Use Chart No. 1**



SINGLE PHASE CENTER TAP*

A2511 Series Model No.	Outline Dimensions "L" (In.)	AC Input RMS Volts	DC Output Volts	DC Output Amps
FH1AD1	3.006	35	15	9.4
FH1AD2	3.492	35	15	16.9
AH1AD1	3.006	70	31	9.4
AH1AD2	3.492	70	31	16.9
BH1AD1	3.006	140	62	9.4
BH1AD2	3.492	140	62	16.9
CH1AD1	3.006	210	94	9.4
CH1AD2	3.492	210	94	16.9
DH1AD1	3.006	280	125	9.4
DH1AD2	3.492	280	125	16.9
EH1AD1	3.006	350	157	9.4
EH1AD2	3.492	350	157	16.9
MH1AD1	3.006	420	188	9.4
MH1AD2	3.492	420	188	16.9
DH2AD1	3.489	560	251	9.4
DH2AD2	4.515	560	251	16.9
CH3AD1	4.510	630	282	9.4
CH3AD2	6.004	630	282	16.9
EH2AD1	3.489	700	314	9.4
EH2AD2	4.515	700	314	16.9
MH2AD1	3.489	840	377	9.4
MH2AD2	4.515	840	377	16.9
MH3AD1	4.510	1260	564	9.4
MH3AD2	6.004	1260	564	16.9

NOTE: Please designate full stack number by preceding Model No. desired with "A2511."



†Line to Center tap.
For negative output change second to last letter to "B".
For example: A2511BC2BD1

Silicon
Rectifier Stacks

A3512 SERIES

High Conversion Efficiency — Up to 99% in certain applications.

Excellent Regulation — Forward voltage drops of less than one volt per cell.

Low Reverse Current — Excellent for magnetic amplifier applications.

Wide Range of Operating and Storage Temperatures — Will operate from — 65°C to 175°C.

No Aging — Extremely long life — no transformer taps required — high reliability.

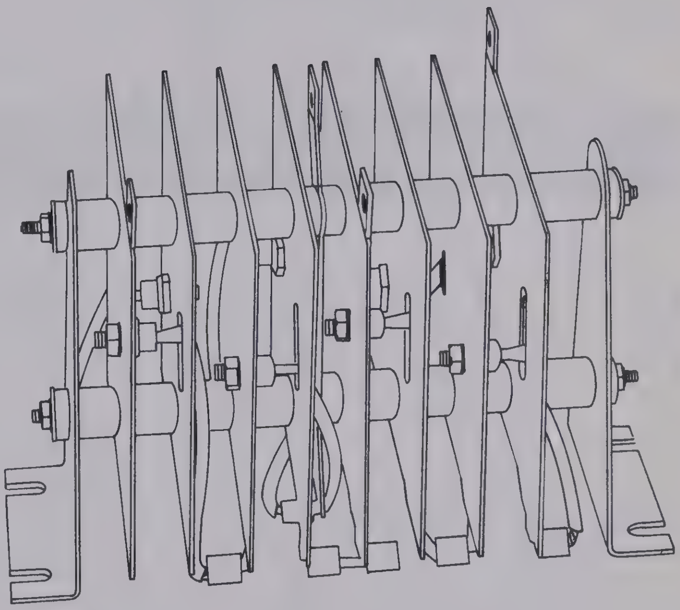
Rugged Construction — Meets stringent military environmental tests.

Small Size — Greatly reduces space and weight requirements.

Complete Packaged Rectifier Circuit — Requires only mounting bolts and electrical connections. No special fin design or insulating hardware.

Dependability — Backed by a General Electric one year written warranty.

Versatility — 171 stacked combinations with DC outputs up to 108 amperes to meet a variety of circuit conditions. Special circuits can be designed to your order.



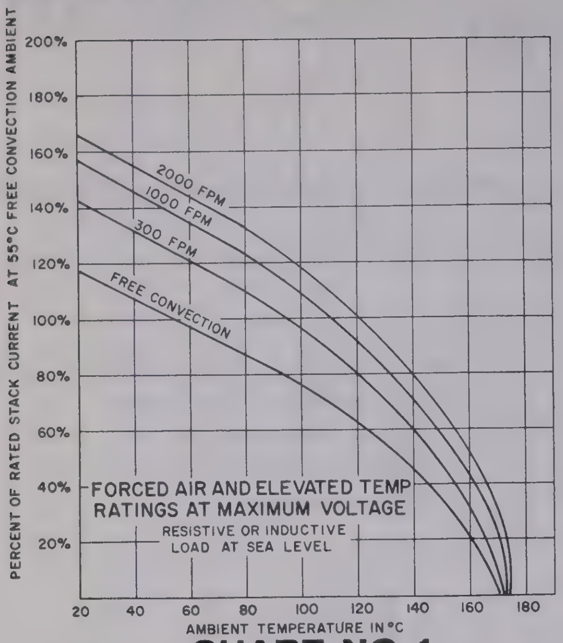
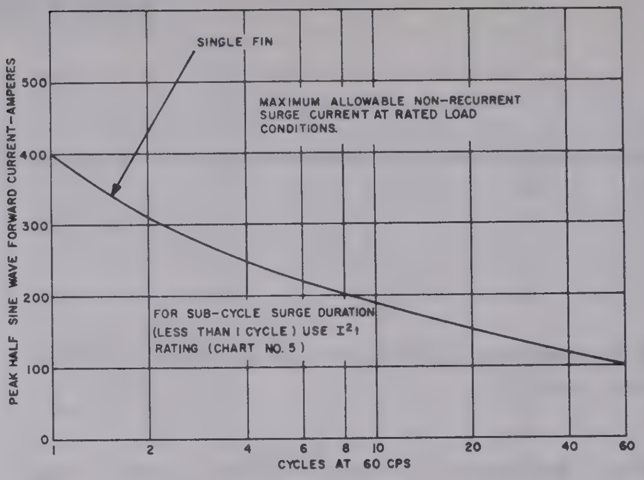


CHART NO. 1



NOTE—
WHEN FINS ARE OPERATED IN PARALLEL, REDUCE SURGE RATING BY 10% PER FIN

CHART NO. 4

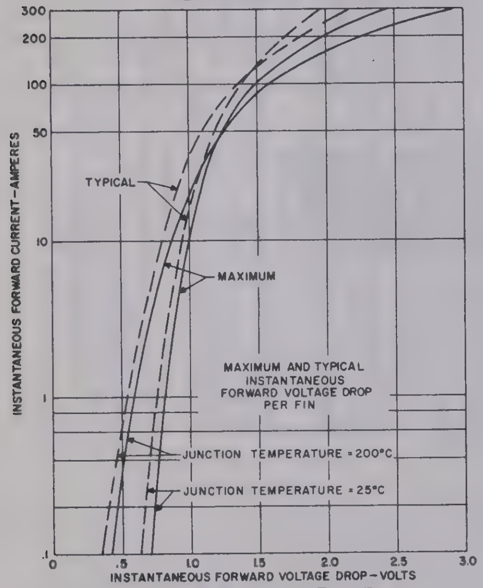


CHART NO. 2

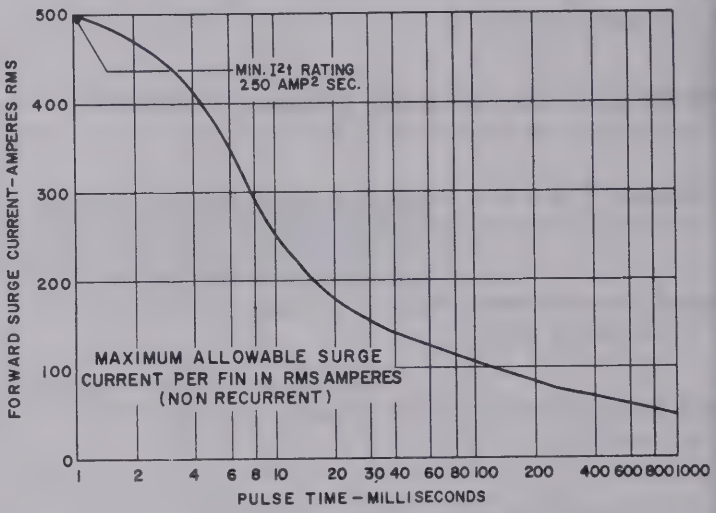


CHART NO. 5

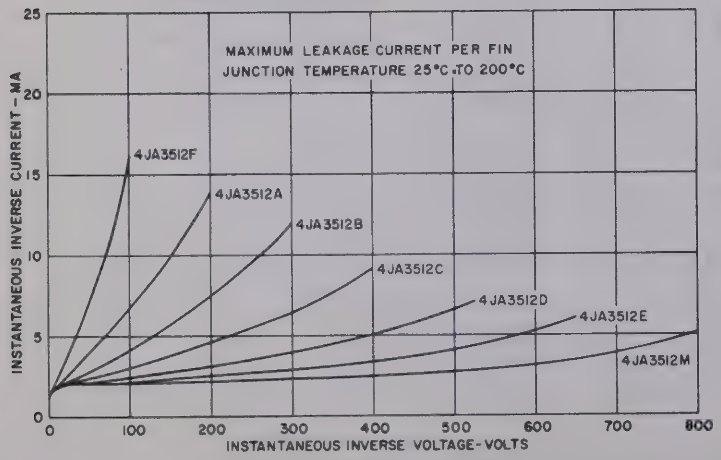
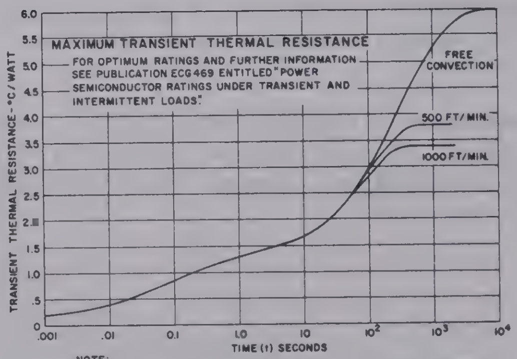


CHART NO. 3

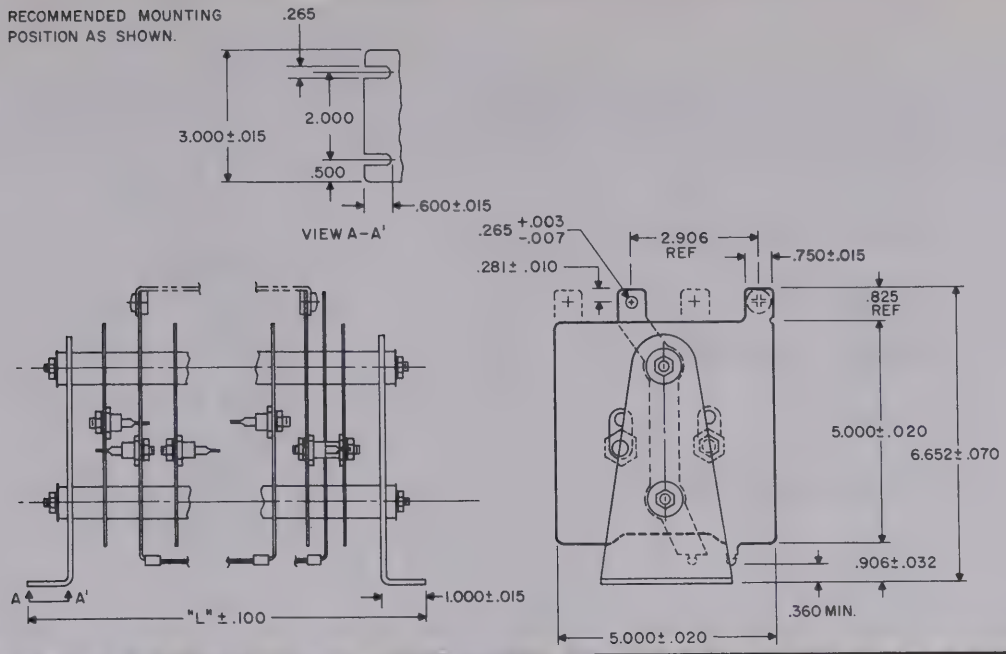


NOTE:
CURVE DEFINES TEMPERATURE RISE OF JUNCTION ABOVE AMBIENT FOR SINGLE LOAD PULSE OF DURATION t. PEAK ALLOWABLE DISSIPATION IN RECTIFIER FOR TIME t IF STARTING FROM AMBIENT TEMPERATURE EQUALS 200°C (MAX. T_J) MINUS MAXIMUM AMBIENT TEMPERATURE DIVIDED BY THE TRANSIENT THERMAL RESISTANCE:

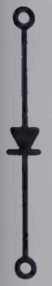
$$P_{PEAK} = \frac{200°C - T_{AMBIENT}}{r_T}$$

CHART NO. 6

OUTLINE DRAWING-4JA3512



SINGLE PHASE HALF WAVE

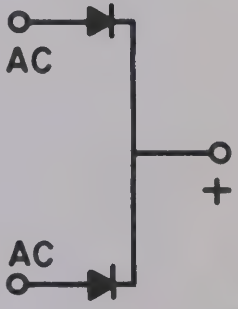


4JA3512 Series Model No.	Outline Dimensions "L" (In.)	AC Input RMS Volts	DC Output	
			Volts	Amps*
FH1AD1	4.012	35	15	20
FH1AD2	5.000	35	15	36
FH1AD3	6.000	35	15	54
AH1AD1	4.012	70	30	20
AH1AD2	5.000	70	30	36
AH1AD3	6.000	70	30	54
BH1AD1	4.012	140	62	20
BH1AD2	5.000	140	62	36
BH1AD3	6.000	140	62	54
CH1AD1	4.012	210	93	20
CH1AD2	5.000	210	93	36
CH1AD3	6.000	210	93	54
DH1AD1	4.012	280	125	20
DH1AD2	5.000	280	125	36
DH1AD3	6.000	280	125	54
EH1AD1	4.012	350	156	20
EH1AD2	5.000	350	156	36
EH1AD3	6.000	350	156	54
MH1AD1	4.012	420	187	20
MH1AD2	5.000	420	187	36
MH1AD3	6.000	420	187	54
DH2AD1	4.512	560	250	20
DH2AD2	6.000	560	250	36
DH2AD3	8.012	560	250	54
CH3AD1	5.500	630	281	20
CH3AD2	7.500	630	281	36
CH3AD3	10.500	630	281	54
EH2AD1	4.512	700	313	20
EH2AD2	6.000	700	313	36
EH2AD3	8.012	700	313	54
MH2AD1	4.512	840	376	20
MH2AD2	6.000	840	376	36
MH2AD3	8.012	840	376	54
MH3AD1	5.500	1260	564	20
MH3AD2	7.500	1260	564	36
MH3AD3	10.500	1260	564	54

***Maximum Operating Ratings, Resistive or Inductive Load, 60 cps Sinusoidal at 55°C Ambient. For Other Ambient Conditions, Use Chart No. 1**

SINGLE PHASE CENTER TAP

4JA3512 Series Model No.	Outline Dimension "L" (In.)	AC Input† RMS Volts	DC Output	
			Volts	Amps*
FC1AD1	5.000	17.5	14	40
FC1AD2	6.500	17.5	14	72
FC1AD3	8.000	17.5	14	108
AC1AD1	5.000	35.0	30	40
AC1AD2	6.500	35.0	30	72
AC1AD3	8.000	35.0	30	108
BC1AD1	5.000	70.0	61	40
BC1AD2	6.500	70.0	61	72
BC1AD3	8.000	70.0	61	108
CC1AD1	5.000	105.0	93	40
CC1AD2	6.500	105.0	93	72
CC1AD3	8.000	105.0	93	108
DC1AD1	5.000	140.0	124	40
DC1AD2	6.500	140.0	124	72
DC1AD3	8.000	140.0	124	108
EC1AD1	5.000	175.0	156	40
EC1AD2	6.500	175.0	156	72
EC1AD3	8.000	175.0	156	108
MC1AD1	5.000	210.0	187	40
MC1AD2	6.500	210.0	187	72
MC1AD3	8.000	210.0	187	108
DC2AD1	6.500	280.0	249	40
DC2AD2	9.500	280.0	249	72
DC2AD3	13.000	280.0	249	108
CC3AD1	7.500	315.0	280	40
CC3AD2	13.000	315.0	280	72
EC2AD1	6.500	350.0	312	40
EC2AD2	9.500	350.0	312	72
EC2AD3	13.000	350.0	312	108
MC2AD1	6.500	420.0	375	40
MC2AD2	9.500	420.0	375	72
MC2AD3	13.000	420.0	375	108
MC3AD1	7.500	630.0	562	40
MC3AD2	13.000	630.0	562	72

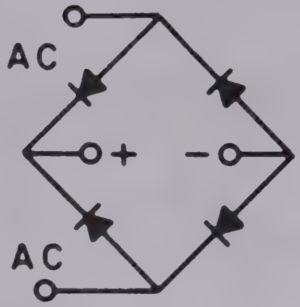


† **Line to Center Tap**
For negative output change second to last letter "B".
For example: 4JA3512BC1BD1

NOTE: Please designate full stack number by preceding Model No. desired with "4JA3512."

SINGLE PHASE BRIDGE

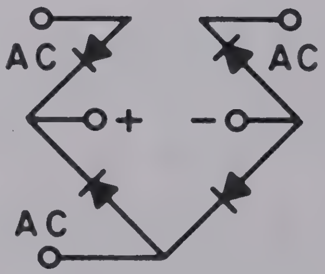
4JA3512 Series Model No.	Outline Dimensions "L" (In.)	AC Input RMS Volts	DC Output Volts	DC Output Amps*
FB1AD1	6.000	35	29	40
FB1AD2	9.524	35	29	72
FB1AD3	13.000	35	29	108
AB1AD1	6.000	70	60	40
AB1AD2	9.524	70	60	72
AB1AD3	13.000	70	60	108
BB1AD1	6.000	140	123	40
BB1AD2	9.524	140	123	72
BB1AD3	13.000	140	123	108
CB1AD1	6.000	210	186	40
CB1AD2	9.524	210	186	72
CB1AD3	13.000	210	186	108
DB1AD1	6.000	280	249	40
DB1AD2	9.524	280	249	72
DB1AD3	13.000	280	249	108
EB1AD1	6.000	350	312	40
EB1AD2	9.524	350	312	72
EB1AD3	13.000	350	312	108
MB1AD1	6.000	420	375	40
MB1AD2	9.524	420	375	72
MB1AD3	13.000	420	375	108
DB2AD1	9.512	560	499	40
CB3AD1	12.500	630	558	40
EB2AD1	9.512	700	625	40
MB2AD1	9.512	840	751	40
MB3AD1	12.500	1260	1122	40



SINGLE PHASE MAGNETIC AMPLIFIER BRIDGE

4JA3512 Series Model No.	Outline Dimensions "L" (In.)	AC Input RMS Volts	DC Output Volts†	DC Output Amps*
FM1AD1	6.000	35	29	40
FM1AD2	9.524	35	29	72
FM1AD3	13.000	35	29	108
AM1AD1	6.000	70	60	40
AM1AD2	9.524	70	60	72
AM1AD3	13.000	70	60	108
BM1AD1	6.000	140	123	40
BM1AD2	9.524	140	123	72
BM1AD3	13.000	140	123	108
CM1AD1	6.000	210	186	40
CM1AD2	9.524	210	186	72
CM1AD3	13.000	210	186	108
DM1AD1	6.000	280	249	40
DM1AD2	9.524	280	249	72
DM1AD3	13.000	280	249	108
EM1AD1	6.000	350	312	40
EM1AD2	9.524	350	312	72
EM1AD3	13.000	350	312	108
MM1AD1	6.000	420	375	40
MM1AD2	9.524	420	375	72
MM1AD3	13.000	420	375	108
DM2AD1	9.512	560	499	40
CM3AD1	12.500	630	558	40
EM2AD1	9.512	700	625	40
MM2AD1	9.512	840	751	40
MM3AD1	12.500	1260	1122	40

† Neglecting gate winding drop.



NOTE: Please designate full stack number by preceding Model No. desired with "4JA3512."

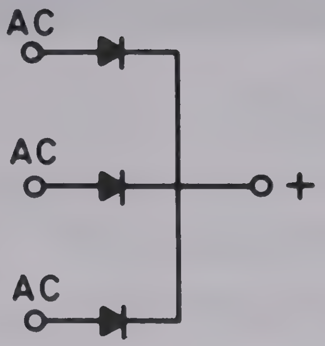
*Maximum Operating Ratings, Resistive or Inductive Load, 60 cps Sinusoidal at 55°C Ambient. For Other Ambient Conditions, Use Chart No. 1

4JA3512

THREE PHASE HALF WAVE

4JA3512 Series Model No.	Outline Dimensions "L" (In.)	AC Input† RMS Volts	DC Output	
			Volts	Amps*
FY1AD1	6.012	20	22	55
FY1AD2	8.000	20	22	100
AY1AD1	6.012	40	45	55
AY1AD2	8.000	40	45	100
BY1AD1	6.012	80	92	55
BY1AD2	8.000	80	92	100
CY1AD1	6.012	120	139	55
CY1AD2	8.000	120	139	100
DY1AD1	6.012	160	185	55
DY1AD2	8.000	160	185	100
EY1AD1	6.012	200	232	55
EY1AD2	8.000	200	232	100
MY1AD1	6.012	240	279	55
MY1AD2	8.000	240	279	100
DY2AD1	8.000	320	371	55
DY2AD2	12.512	320	371	100
CY3AD1	10.500	360	417	55
EY2AD1	8.000	400	465	55
EY2AD2	12.512	400	465	100
MY2AD1	8.000	480	558	55
MY2AD2	12.512	480	558	100
MY3AD1	10.500	720	838	55

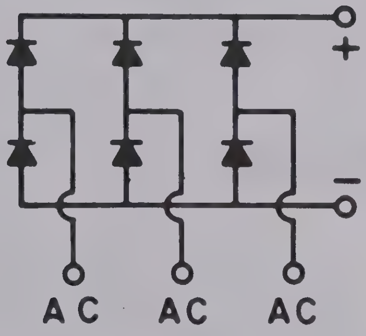
† Line to Neutral.
For negative output change second to last letter to "B".
For example: 4JA3512FS1BD1



THREE PHASE BRIDGE

4JA3512 Series Model No.	Outline Dimensions "L" (In.)	AC Input† RMS Volts	DC Output	
			Volts	Amps*
FF1AD1	8.000	35	44	55
FF1AD2	12.500	35	44	100
AF1AD1	8.000	70	91	55
AF1AD2	12.500	70	91	100
BF1AD1	8.000	140	186	55
BF1AD2	12.500	140	186	100
CF1AD1	8.000	210	280	55
CF1AD2	12.500	210	280	100
DF1AD1	8.000	280	375	55
DF1AD2	12.500	280	375	100
EF1AD1	8.000	350	469	55
EF1AD2	12.500	350	469	100
MF1AD1	8.000	420	563	55
MF1AD2	12.500	420	563	100
DF2AD1	12.500	560	750	55
EF2AD1	12.500	700	939	55
MF2AD1	12.500	840	1127	55

†Line to line.

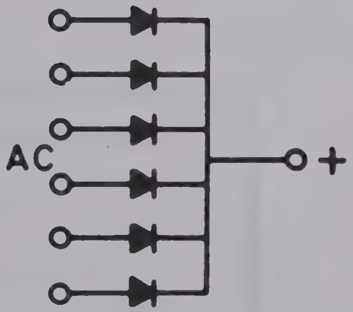


SIX PHASE STAR

4JA3512 Series Model No.	Outline Dimensions "L" (In.)	AC Input† RMS Volts	DC Output	
			Volts	Amps*
FS1AD1	8.000	17.5	22	90
AS1AD1	8.000	35.0	45	90
BS1AD1	8.000	70.0	92	90
CS1AD1	8.000	105.0	140	90
DS1AD1	8.000	140.0	187	90
ES1AD1	8.000	175.0	234	90
MS1AD1	8.000	210.0	281	90
DS2AD1	12.512	280.0	374	90
ES2AD1	12.512	350.0	468	90
MS2AD1	12.512	420.0	562	90

†Line to Center Tap.

For negative output change second to last letter to "B". For example: 4JA3512BC2BD1



***Maximum Operating Ratings, Resistive or Inductive Load, 60 cps Sinusoidal at 55°C Ambient. For Other Ambient Conditions, Use Chart No. 1**

NOTE: Please designate full stack number by preceding Model No. desired with "4JA3512."

ADDITIONAL RATINGS AND SPECIFICATIONS PER FIN

4JA3512	F	A	B	C	D	E	M
*Maximum Allowable Transient Peak Reverse Voltage (non-recurrent 5 millisec. max. duration)	100	200	350	450	600	700	800 volts
*Maximum Allowable Peak Reverse Voltage (Repetitive)	50	100	200	300	400	500	600 volts
*Maximum Allowable DC Blocking Voltage (At Maximum Ambient of 150°C)	50	100	200	300	400	500	600 volts
*Maximum Full Load Voltage Drop (20A DC Single Phase, Full Cycle Ave., 55°C Ambient)	← .6 Volts DC →						
**Maximum Reverse Current at Full Load (Single Phase, Full Cycle Average)	5	4.5	4.0	3.5	3	2.5	2.0 ma

**I_2t Ratings (For Fusing) at Rated Forward Current and PRV for t greater than .0008 seconds and less than .0083 sec. . . . . 250 Ampere^2 Sec.

Ambient Temperature Range . . . . −65°C to +175°C

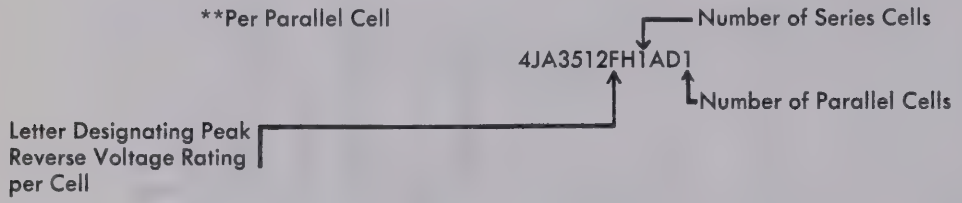
Storage Temperature Range . . . . −65°C to +175°C

Maximum Operating Frequency . . . . 50,000 cps

*Per Series Cell

**Per Parallel Cell

Determine Series and Parallel Cells as Follows:



NOTE: The RMS voltage ratings for stacks on the preceding pages are based on the assumption that the required precautions have been taken to keep transient voltage per fin within the ratings specified above. For a discussion of voltage transients and corrective action, request "Rectifier Voltage Transients: Their Generation, Detection, and Reduction," ECG-544.

Maximum Hi-Pot Voltage to Mounting Brackets . . . . 2600 V. RMS @ 25°C Ambient, Sea Level

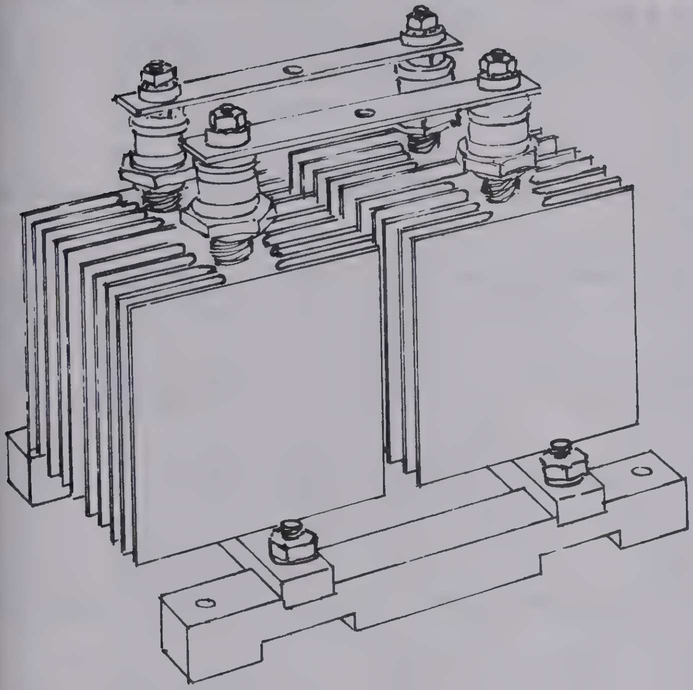
Salt Spray . . . . MIL-STD-202 A, Method 101A, 96 hours

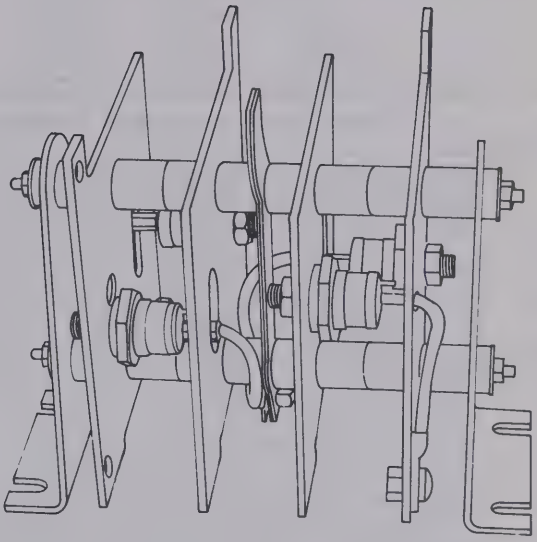
Humidity . . . . MIL-STD-202 A, Method 103A, 240 hours

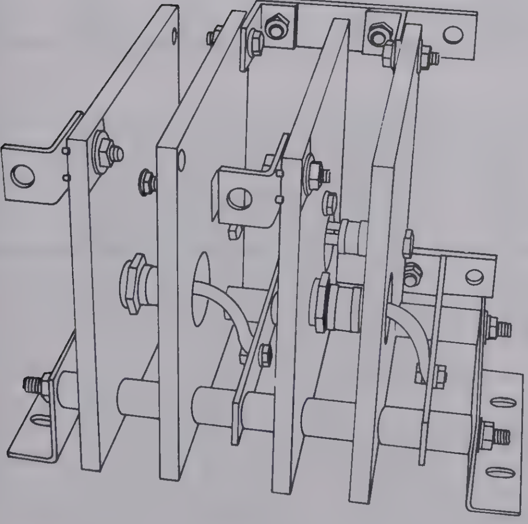
APPROXIMATE STACK WEIGHT

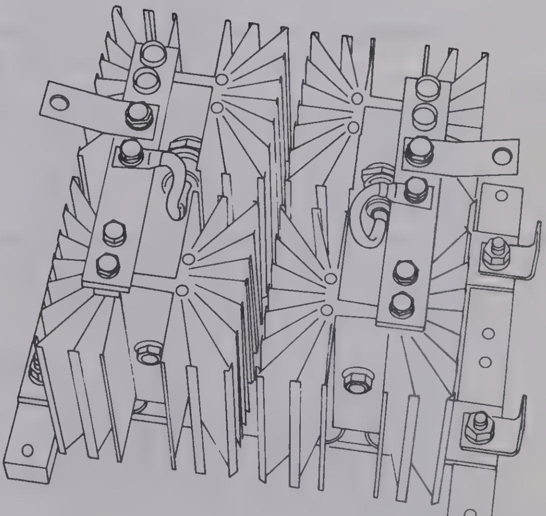
Number of Fins	Pounds
1	2.0
2	2.75
3	3.25
4	3.5
6	4.0
8	4.5
9	4.75
12	5.5

Silicon
Rectifier Stacks



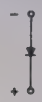




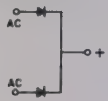


1. **RECTIFIER STACK SELECTION CHART for 40°C ambient, free convection cooling, resistive or inductive load (For other conditions—see Fig. 2 thru 7.)**

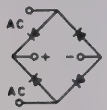
SINGLE PHASE HALF WAVE

CIRCUIT OUTPUT CURRENT	48 ADC	65 ADC	70 ADC	85 ADC	90 ADC	175 ADC	Max. Repetitive AC Input Volts RMS *	Max. Circuit Output Volts DC	Max. Diode PRV	Max. Allow. Transient PRV Non-Recurrer
	4JA7012AH1AD1	4JA7011AH1AD1	4JA7013AH1AD1	4JA7014AH1AD1	4JA9013AH1AD1	4JA9015AH1AD1	70	29	100	200
	BH1AD1	BH1AD1	BH1AD1	BH1AD1	BH1AD1	BH1AD1	140	61	200	300
	CH1AD1	CH1AD1	CH1AD1	CH1AD1	CH1AD1	CH1AD1	210	92	300	400
	DH1AD1	DH1AD1	DH1AD1	DH1AD1	DH1AD1	DH1AD1	280	124	400	525
	EH1AD1	EH1AD1	EH1AD1	EH1AD1	EH1AD1	EH1AD1	350	155	500	650
	MH1AD1	MH1AD1	MH1AD1	MH1AD1	MH1AD1	MH1AD1	420	187	600	800
	NH1AD1	NH1AD1	NH1AD1	NH1AD1	NH1AD1	NH1AD1	560	250	800	1050
	PH1AD1	PH1AD1	PH1AD1	PH1AD1	PH1AD1	PH1AD1	700	313	1000	1300

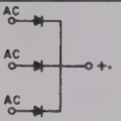
SINGLE PHASE CENTER TAP

CIRCUIT OUTPUT CURRENT	96 ADC	130 ADC	140 ADC	170 ADC	180 ADC	350 ADC	(Line to Neutral)			
	4JA7012AC1AD1	4JA7011AC1AD1	4JA7013AC1AD1	4JA7014AC1AD1	4JA9013AC1AD1	4JA9015AC1AD1	35	28	100	200
	BC1AD1	BC1AD1	BC1AD1	BC1AD1	BC1AD1	BC1AD1	70	60	200	300
	CC1AD1	CC1AD1	CC1AD1	CC1AD1	CC1AD1	CC1AD1	105	91	300	400
	DC1AD1	DC1AD1	DC1AD1	DC1AD1	DC1AD1	DC1AD1	140	123	400	525
	EC1AD1	EC1AD1	EC1AD1	EC1AD1	EC1AD1	EC1AD1	175	154	500	650
	MC1AD1	MC1AD1	MC1AD1	MC1AD1	MC1AD1	MC1AD1	210	186	600	800
	NC1AD1	NC1AD1	NC1AD1	NC1AD1	NC1AD1	NC1AD1	280	249	800	1050
	PC1AD1	PC1AD1	PC1AD1	PC1AD1	PC1AD1	PC1AD1	350	312	1000	1300

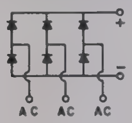
SINGLE PHASE BRIDGE

CIRCUIT OUTPUT CURRENT	96 ADC	130 ADC	140 ADC	170 ADC	180 ADC	350 ADC				
	4JA7012AB1AD1	4JA7011AB1AD1	4JA7013AB1AD1	4JA7014AB1AD1	4JA9013AB1AD1	4JA9015AB1AD1	70	59	100	200
	BB1AD1	BB1AD1	BB1AD1	BB1AD1	BB1AD1	BB1AD1	140	121	200	300
	CB1AD1	CB1AD1	CB1AD1	CB1AD1	CB1AD1	CB1AD1	210	185	300	400
	DB1AD1	DB1AD1	DB1AD1	DB1AD1	DB1AD1	DB1AD1	280	248	400	525
	EB1AD1	EB1AD1	EB1AD1	EB1AD1	EB1AD1	EB1AD1	350	311	500	650
	MB1AD1	MB1AD1	MB1AD1	MB1AD1	MB1AD1	MB1AD1	420	374	600	800
	NB1AD1	NB1AD1	NB1AD1	NB1AD1	NB1AD1	NB1AD1	560	500	800	1050
	PB1AD1	PB1AD1	PB1AD1	PB1AD1	PB1AD1	PB1AD1	700	626	1000	1300

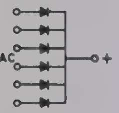
THREE PHASE HALF WAVE

CIRCUIT OUTPUT CURRENT	135 ADC	180 ADC	195 ADC	240 ADC	270 ADC	500 ADC	(Line to Neutral)			
	4JA7012AY1AD1	4JA7011AY1AD1	4JA7013AY1AD1	4JA7014AY1AD1	4JA9013AY1AD1	4JA9015AY1AD1	40	44	100	200
	BY1AD1	BY1AD1	BY1AD1	BY1AD1	BY1AD1	BY1AD1	80	91	200	300
	CY1AD1	CY1AD1	CY1AD1	CY1AD1	CY1AD1	CY1AD1	120	138	300	400
	DY1AD1	DY1AD1	DY1AD1	DY1AD1	DY1AD1	DY1AD1	160	184	400	525
	EY1AD1	EY1AD1	EY1AD1	EY1AD1	EY1AD1	EY1AD1	200	231	500	650
	MY1AD1	MY1AD1	MY1AD1	MY1AD1	MY1AD1	MY1AD1	240	278	600	800
	NY1AD1	NY1AD1	NY1AD1	NY1AD1	NY1AD1	NY1AD1	320	371	800	1050
	PY1AD1	PY1AD1	PY1AD1	PY1AD1	PY1AD1	PY1AD1	400	465	1000	1300

THREE PHASE BRIDGE

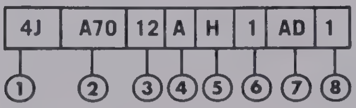
CIRCUIT OUTPUT CURRENT	135 ADC	180 ADC	195 ADC	240 ADC	270 ADC	500 ADC				
	4JA7012AF1AD1	4JA7011AF1AD1	4JA7013AF1AD1	4JA7014AF1AD1	4JA9013AF1AD1	4JA9015AF1AD1	70	91	100	200
	BF1AD1	BF1AD1	BF1AD1	BF1AD1	BF1AD1	BF1AD1	140	185	200	300
	CF1AD1	CF1AD1	CF1AD1	CF1AD1	CF1AD1	CF1AD1	210	279	300	400
	DF1AD1	DF1AD1	DF1AD1	DF1AD1	DF1AD1	DF1AD1	280	374	400	525
	EF1AD1	EF1AD1	EF1AD1	EF1AD1	EF1AD1	EF1AD1	350	468	500	650
	MF1AD1	MF1AD1	MF1AD1	MF1AD1	MF1AD1	MF1AD1	420	563	600	800
	NF1AD1	NF1AD1	NF1AD1	NF1AD1	NF1AD1	NF1AD1	560	752	800	1050
	PF1AD1	PF1AD1	PF1AD1	PF1AD1	PF1AD1	PF1AD1	700	941	1000	1300

SIX PHASE STAR

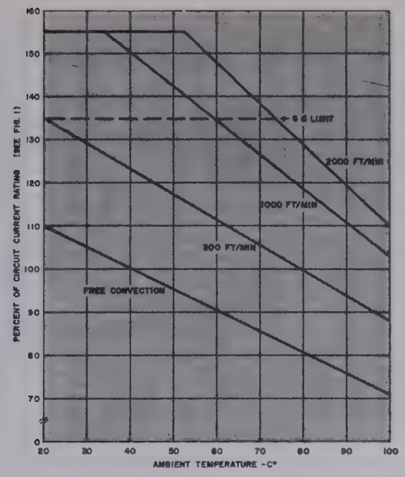
CIRCUIT OUTPUT CURRENT	240 ADC	294 ADC	318 ADC	390 ADC	420 ADC	840 ADC				
	4JA7012AS1AD1	4JA7011AS1AD1	4JA7013AS1AD1	4JA7014AS1AD1	4JA9013AS1AD1	4JA9015AS1AD1	35	44	100	200
	BS1AD1	BS1AD1	BS1AD1	BS1AD1	BS1AD1	BS1AD1	70	91	200	300
	CS1AD1	CS1AD1	CS1AD1	CS1AD1	CS1AD1	CS1AD1	105	139	300	400
	DS1AD1	DS1AD1	DS1AD1	DS1AD1	DS1AD1	DS1AD1	140	186	400	525
	ES1AD1	ES1AD1	ES1AD1	ES1AD1	ES1AD1	ES1AD1	175	233	500	650
	MS1AD1	MS1AD1	MS1AD1	MS1AD1	MS1AD1	MS1AD1	210	280	600	800
	NS1AD1	NS1AD1	NS1AD1	NS1AD1	NS1AD1	NS1AD1	280	375	800	1050
	PS1AD1	PS1AD1	PS1AD1	PS1AD1	PS1AD1	PS1AD1	350	469	1000	1300

* **NOTE:** The RMS voltage ratings are based on the assumption that the required precautions have been taken to keep transient voltage per fin within the transient ratings specified above. For a discussion of voltage transient and corrective action, request "Rectifier Voltage Transients: Their Generation, Detection, and Reduction," 200.11.

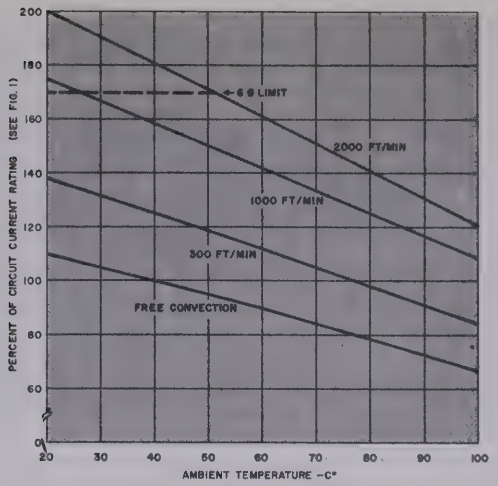
NOMENCLATURE IDENTIFICATION



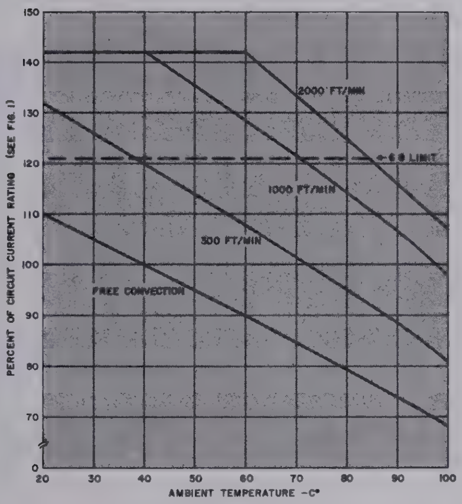
1. Identifies the Rectifier Components Department of the G.E. Company.
2. Basic rectifier diode used in stack. For further diode details, refer to or write for specification 145.15 for A70 and 145.30 for A90.
3. Identifies heat sink as follows:
   - 11 — 1½ x 3½ x 3½ aluminum extrusion
   - 12 — 5 x 5 x ⅛ copper plate
   - 13 — 7 x 7 x ⅜ aluminum plate
   - 14 — 4 x 4 x 5 aluminum extrusion
   - 15 — 5 x 5 x 5½ aluminum extrusion
4. Diode voltage classification see Fig. 1 colum headed "Max Diode PRV."
5. Basic circuit
6. Number of series diodes in each leg
7. Mechanical construction
8. Number of parallel diodes in each leg.



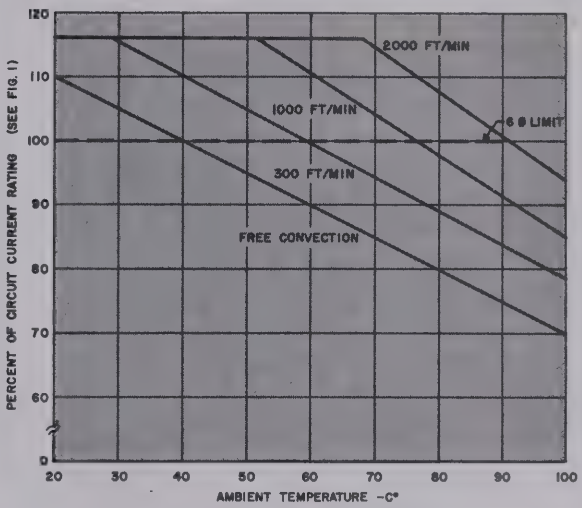
2. A7011 STACK CURRENT RATING AS A FUNCTION OF AMBIENT TEMPERATURE & COOLING CONDITIONS



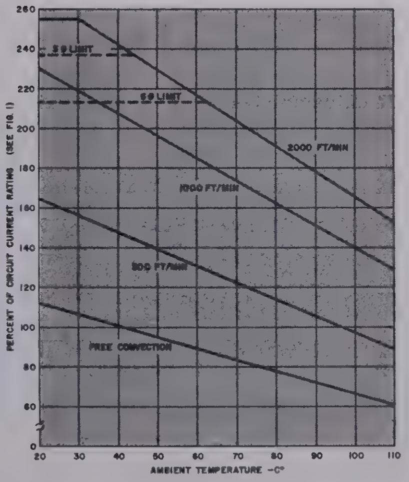
3. A7012 STACK CURRENT RATING AS A FUNCTION OF AMBIENT TEMPERATURE & COOLING CONDITIONS



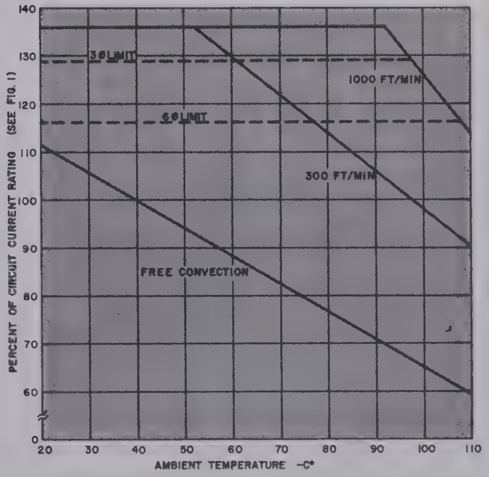
4. A7013 STACK CURRENT RATING AS A FUNCTION OF AMBIENT TEMPERATURE & COOLING CONDITIONS



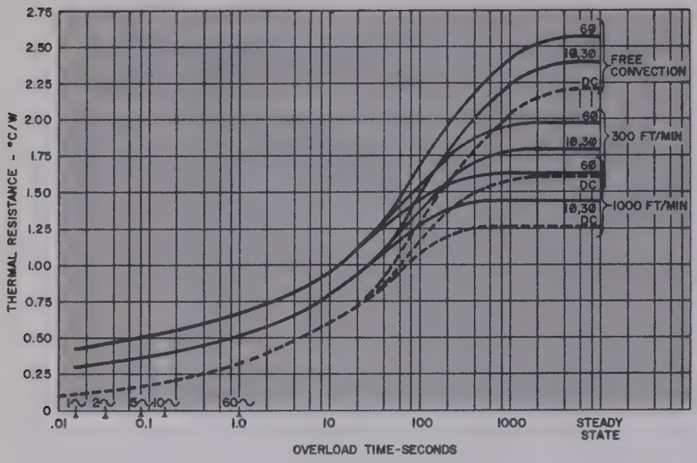
5. A7014 STACK CURRENT RATING AS A FUNCTION OF AMBIENT TEMPERATURE & COOLING CONDITIONS



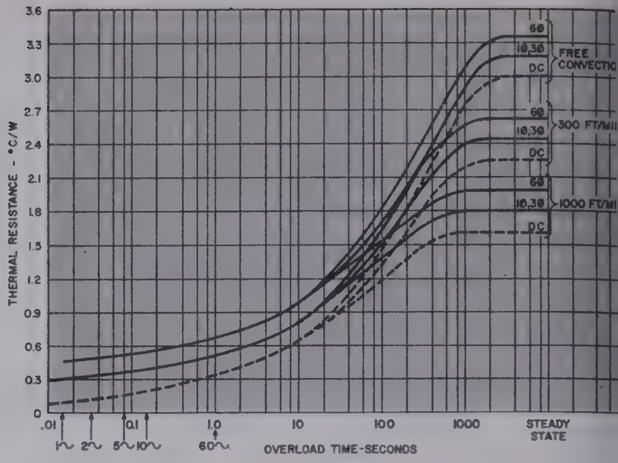
6. A9013 STACK CURRENT RATING AS A FUNCTION OF AMBIENT TEMPERATURE & COOLING CONDITIONS



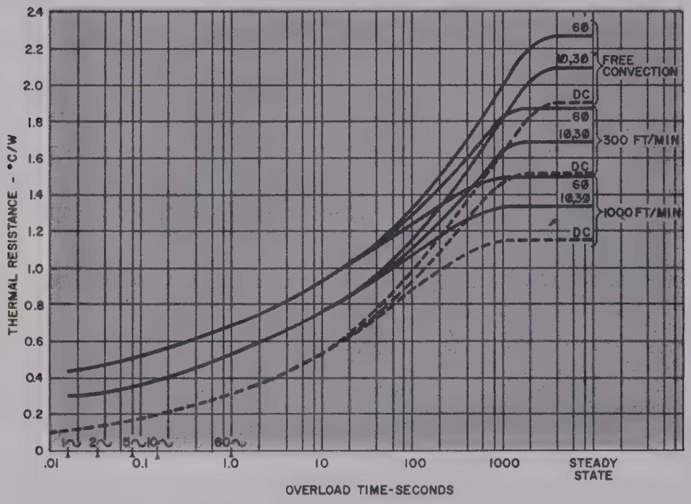
7. A9015 STACK CURRENT RATING AS A FUNCTION OF AMBIENT TEMPERATURE & COOLING CONDITIONS



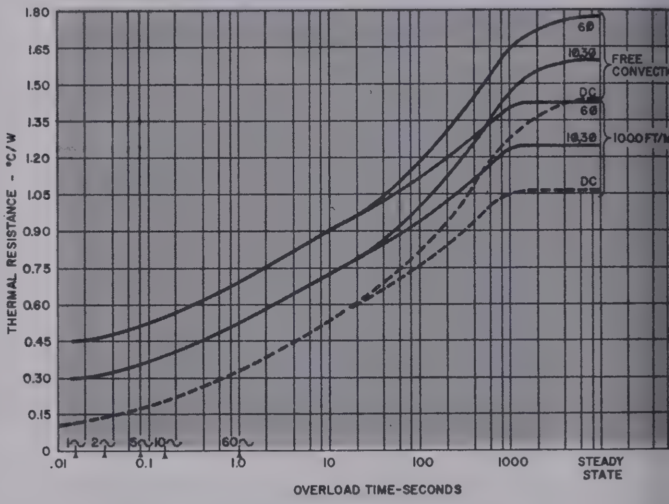
8. A7011 TRANSIENT THERMAL RESISTANCE AT 60 CPS, JUNCTION TO AMBIENT, VS. OVERLOAD TIME



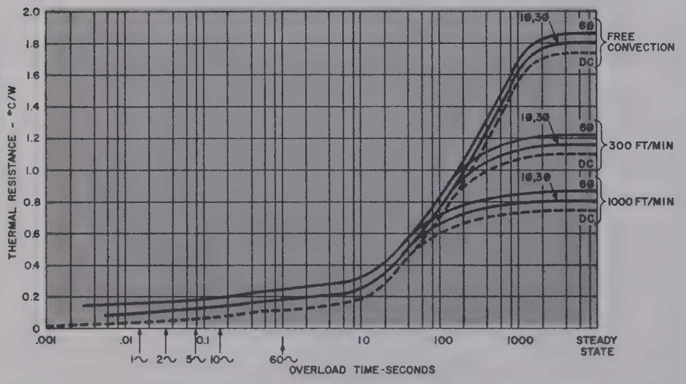
9. A7012 TRANSIENT THERMAL RESISTANCE AT 60 CPS, JUNCTION TO AMBIENT, VS. OVERLOAD TIME



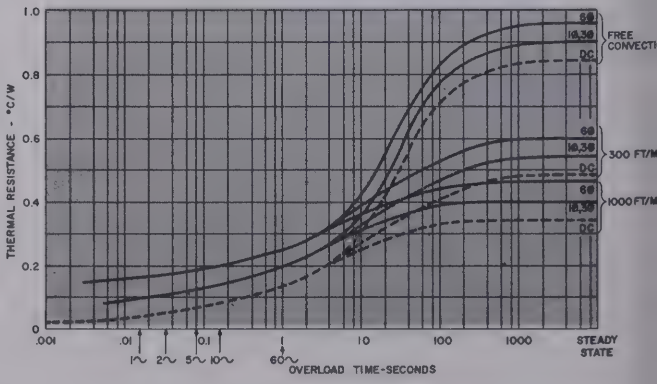
10. A7013 TRANSIENT THERMAL RESISTANCE AT 60 CPS, JUNCTION TO AMBIENT, VS. OVERLOAD TIME



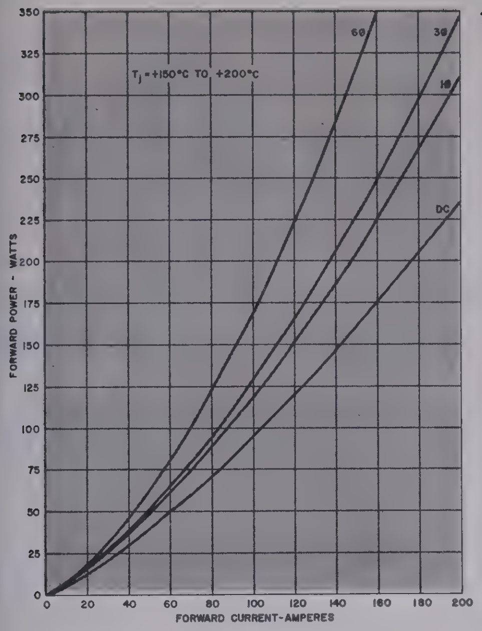
11. A7014 TRANSIENT THERMAL RESISTANCE AT 60 CPS, JUNCTION TO AMBIENT, VS. OVERLOAD TIME



12. A9013 TRANSIENT THERMAL RESISTANCE AT 60 CPS, JUNCTION TO AMBIENT, VS. OVERLOAD TIME

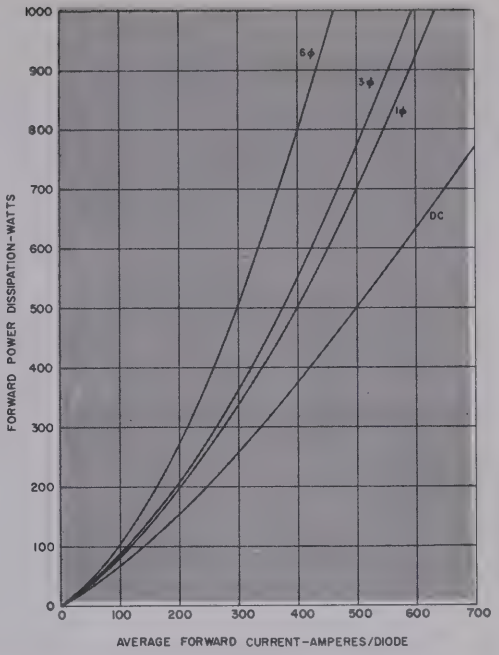


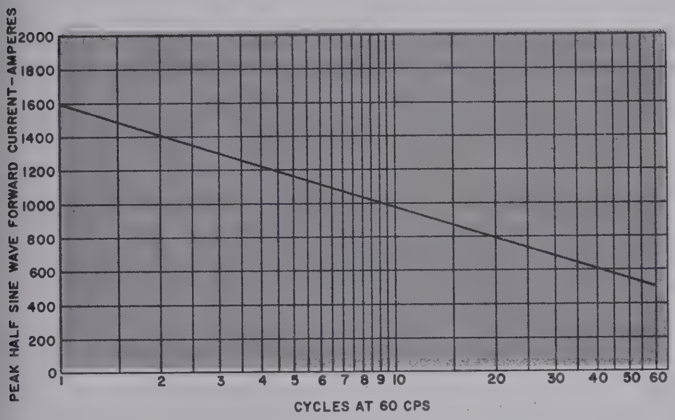
13. A9015 TRANSIENT THERMAL RESISTANCE AT 60 CPS, JUNCTION TO AMBIENT, VS. OVERLOAD TIME



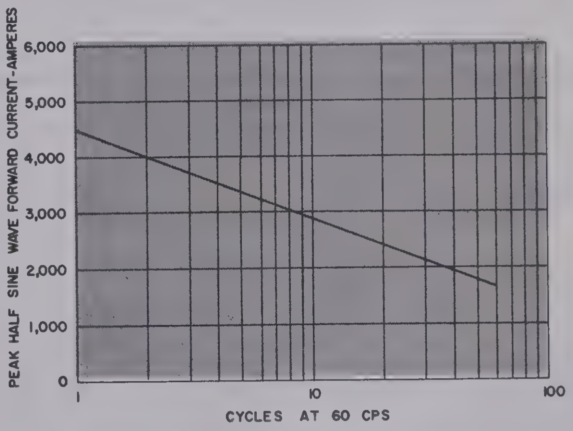
14. A7011, 7012, 7013, 7014 AVERAGE FORWARD POWER VS. AVERAGE FORWARD CURRENT
Tj = +150°C to +200°C

15. A9013, 9015 AVERAGE FORWARD POWER DISSIPATION VS. AVERAGE FORWARD CURRENT
(Tj = +150 to +200°C)

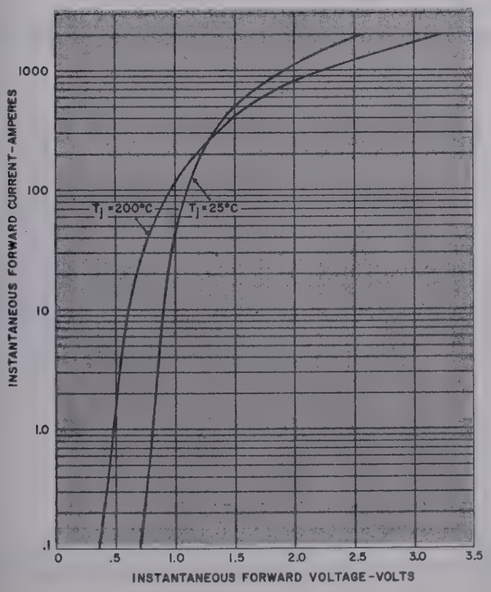




16. A7011, 7012, 7013, 7014 MAXIMUM SURGE CURRENT AT RATED LOAD CONDITIONS (PRV APPLIED AFTER SURGE) (NON-RECURRENT)
Tj = −40°C to +200°C

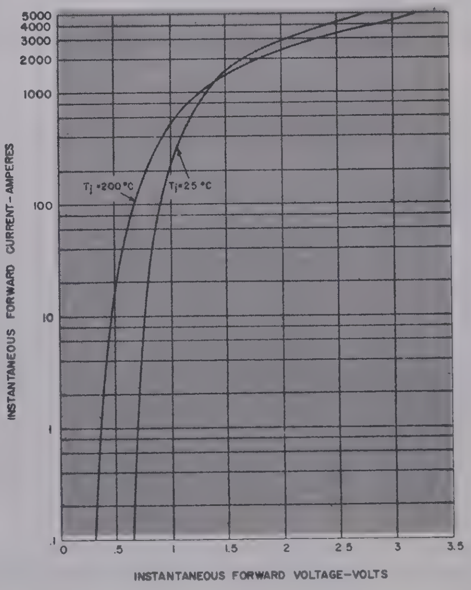


17. A9013, 9015 MAXIMUM SURGE CURRENT AT RATED LOAD CONDITIONS (PRV APPLIED AFTER SURGE) (NON-RECURRENT)
Tj = −40°C to +200°C



18. A7011, 7012, 7013, 7014 MAXIMUM FORWARD CHARACTERISTICS

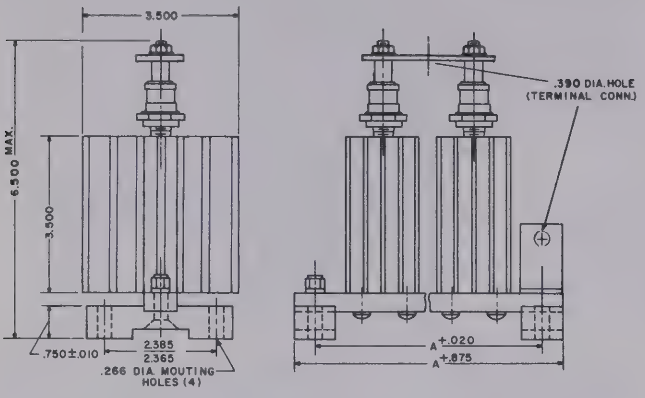
19. A9013, 9015 MAXIMUM FORWARD CHARACTERISTICS



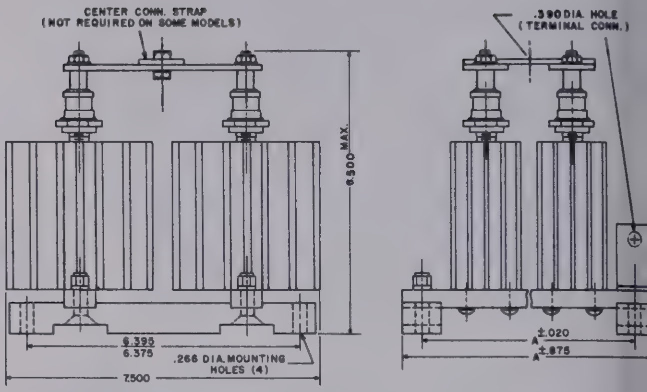
OUTLINE DRAWINGS

	A	APPROX. WEIGHT	OUTLINE NO.
SINGLE PHASE HALF WAVE	2.937	1.5 LBS.	1
SINGLE PHASE CENTER TAP	4.875	3.0	1
SINGLE PHASE BRIDGE	4.875	5.5	2
3 φ BRIDGE	6.812	8.0	2
3 φ HALF WAVE	6.812	4.0	1
6 φ STAR	12.625	8.0	1

A7011


3.500
6.500 MAX.
3.500
.750±.010
2.385
2.365
.266 DIA. MOUTING HOLES (4)
.390 DIA. HOLE (TERMINAL CONN.)
A ±.020
A ±.875

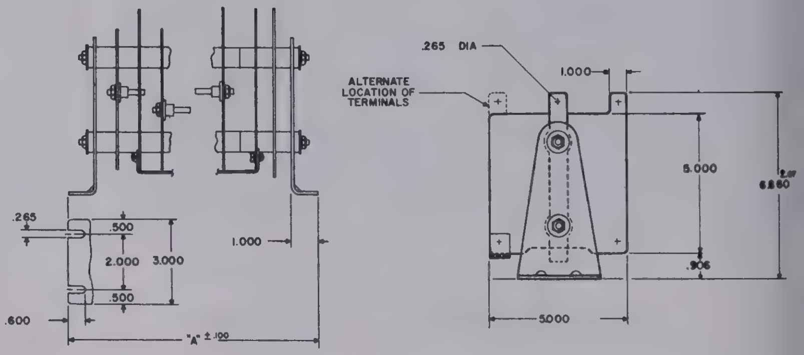
①


CENTER CONN. STRAP (NOT REQUIRED ON SOME MODELS)
6.500 MAX.
6.395
6.375
.266 DIA. MOUNTING HOLES (4)
7.500
.390 DIA. HOLE (TERMINAL CONN.)
A ±.020
A ±.875

②

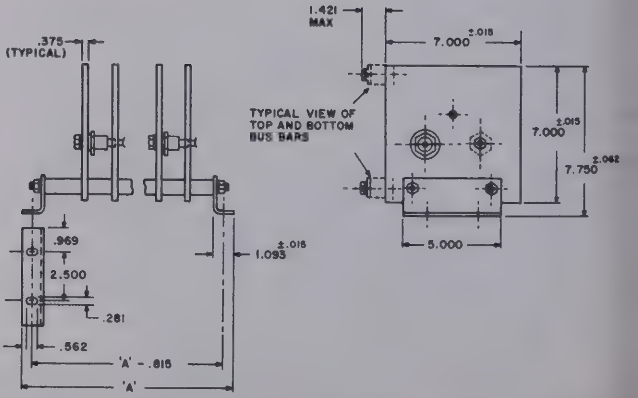
A7012

	A	APPROX. WEIGHT
SINGLE PHASE HALF WAVE	4.875	3 LBS.
SINGLE PHASE CENTER TAP	5.750	4
SINGLE PHASE BRIDGE	8.750	7
3 φ HALF WAVE	8.750	5
3 φ BRIDGE	11.750	10
6 φ STAR	11.750	10

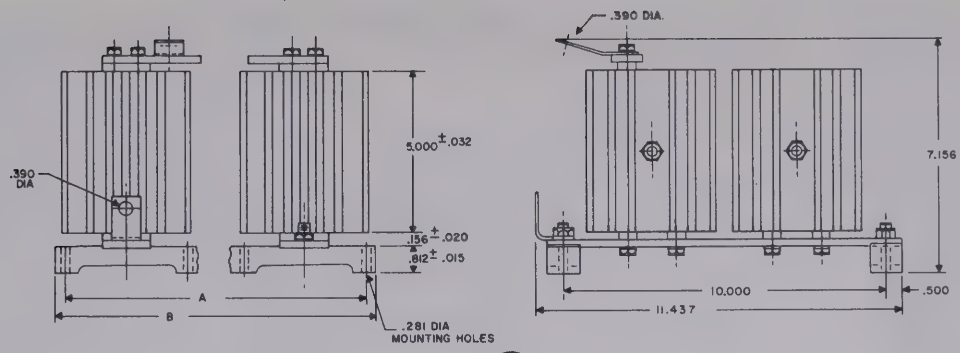

.265
.500
2.000
3.000
.500
.600
1.000
"A" ±.100
.265 DIA
1.000
ALTERNATE LOCATION OF TERMINALS
5.000
6.860
.906
5.000

A7013
A9013

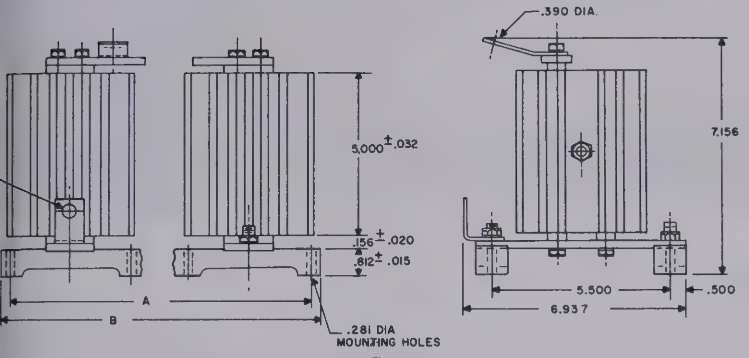
	A	APPROX. WEIGHT
SINGLE PHASE HALF WAVE	6.076 ±.060	6 LBS.
SINGLE PHASE CENTER TAP	6.776 ±.060	8
SINGLE PHASE BRIDGE	10.500 ±.105	14
3 PHASE HALF WAVE	10.500 ±.105	12
3 PHASE BRIDGE	14.496 ±.150	19
6 φ STAR	14.496 ±.150	19


.375 (TYPICAL)
.969
2.500
.281
.562
1.093 ±.015
'A' - .815
'A'
1.421 MAX
7.000 ±.015
TYPICAL VIEW OF TOP AND BOTTOM BUS BARS
7.000 ±.015
7.750 ±.062
5.000

A7014


.390 DIA.
.390 DIA
5.000 ±.032
.156 ±.020
.812 ±.015
A
B
.281 DIA MOUNTING HOLES
7.156
10.000
.500
11.437

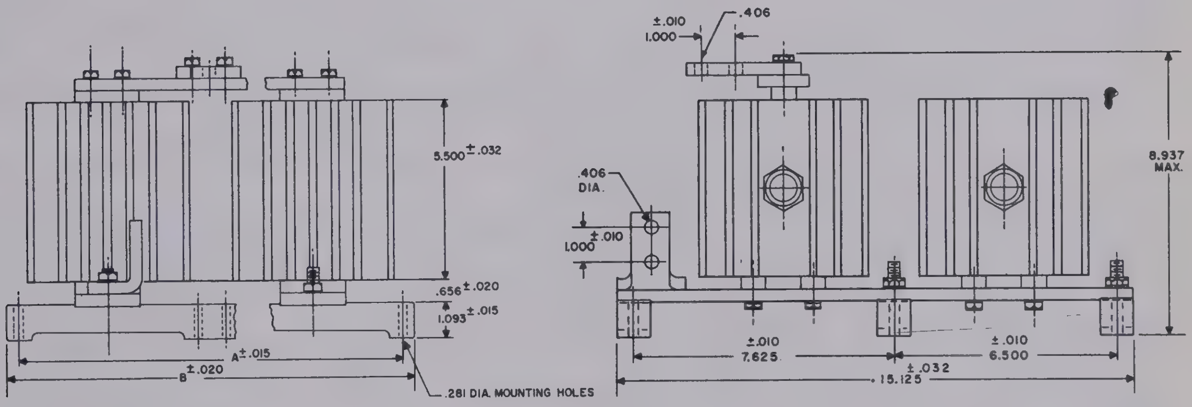
②


.390 DIA.
5.000 ±.032
.156 ±.020
.812 ±.015
A
B
.281 DIA MOUNTING HOLES
7.156
5.500
.500
6.937

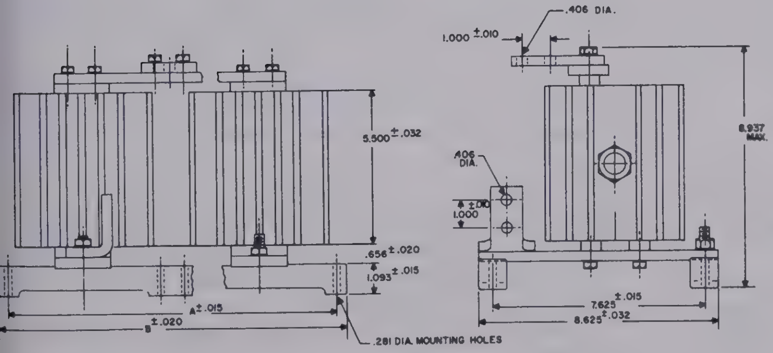
①

	A	B	APPROX. WEIGHT	OUTLINE NO.
SINGLE PHASE HALF WAVE	3.750	4.437	3 LBS.	1
SINGLE PHASE CENTER TAP	8.250	8.937	5	1
SINGLE PHASE BRIDGE	8.250	8.937	10	2
3 φ HALF WAVE	12.750	13.437	8	1
3 φ BRIDGE	12.750	13.437	15	2
6 φ STAR	12.750	13.437	15	2

A9015

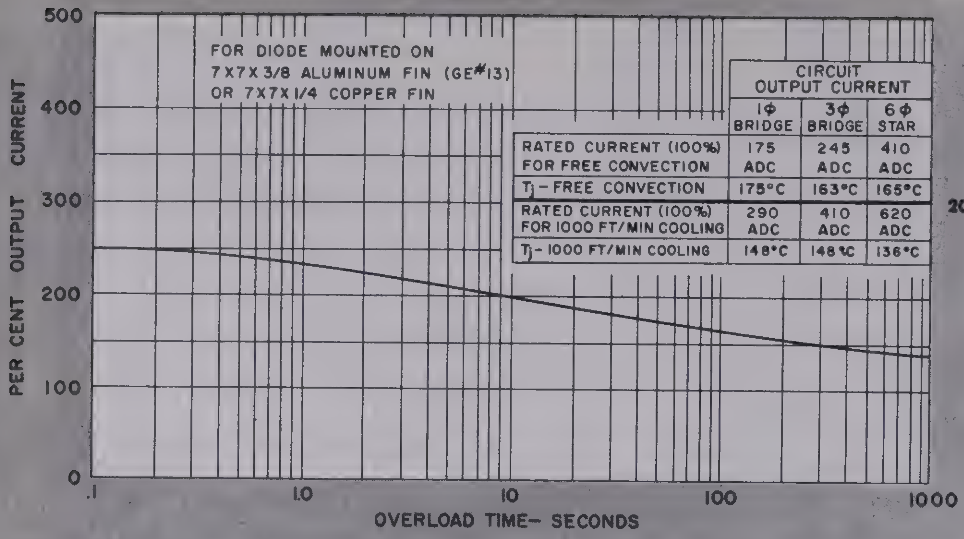

±.010
1.000
.406
5.500 ±.032
.656 ±.020
1.093 ±.015
A ±.015
B ±.020
.281 DIA. MOUNTING HOLES
.406 DIA.
1.000 ±.010
8.937 MAX.
±.010 7.625
±.010 6.500
±.032 15.125

②


1.000 ±.010
.406 DIA.
5.500 ±.032
.656 ±.020
1.093 ±.015
A ±.015
B ±.020
.281 DIA. MOUNTING HOLES
.406 DIA.
±.010 1.000
8.937 MAX.
7.625 ±.015
8.625 ±.032

①

	A	B	APPROX. WEIGHT	OUTLINE NO.
SINGLE PHASE HALF WAVE	5.500	6.250	4 LBS.	1
SINGLE PHASE CENTER TAP	11.812	12.562	8	1
SINGLE PHASE BRIDGE	11.812	12.562	17	2
3 φ HALF WAVE	18.125	18.875	14	1
3 φ BRIDGE	18.125	18.875	22	2
6 φ STAR	18.125	18.875	22	2



	CIRCUIT OUTPUT CURRENT		
	1φ BRIDGE	3φ BRIDGE	6φ STAR
RATED CURRENT (100%) FOR FREE CONVECTION	175 ADC	245 ADC	410 ADC
T_j – FREE CONVECTION	175°C	163°C	165°C
RATED CURRENT (100%) FOR 1000 FT/MIN COOLING	290 ADC	410 ADC	620 ADC
T_j – 1000 FT/MIN COOLING	148°C	148°C	136°C

20. RECURRENT OVERLOAD CURVE MEETING NEMA STANDARDS FOR "GENERAL PURPOSE RECTIFIER EQUIPMENTS UNDER 100 KW" AT 40°C AMBIENT

RECURRENT OVERLOAD RATING DETERMINATION

For Overload Conditions Other Than Shown in Figure 20

Many applications require that electrical equipment be designed to permit operation at higher than normal current for short periods of time. This planned overload requirement is called a recurrent overload condition. (For non-recurrent current overloads, see the surge curve for the product being considered.)

Whenever a recurrent overload rating is required it is possible to take advantage of the thermal capacity of the rectifier diode and the heat sink to which it is attached.

The following procedure will permit a recurrent overload providing another overload is not applied until sufficient time has elapsed to permit the rectifier diode to reach temperature equilibrium at the calculated continuous rating. In general, a cool-down period of twice the length of the overload time is sufficient for the rectifier diode to reach the calculated continuous rating temperature equilibrium.

If the reapplication time (of overload) is shorter, please contact the factory for application assistance.

To calculate the steady state current rating required to permit a recurrent overload, the following "cut and try" method is recommended. The example given is for the 4JA9013 stacks; however by using the appropriate curves, recurrent overload ratings can be determined for the other stacks listed.

$$T_j \max = T_A + P_{SS} \times \theta + (P_{OL} - P_{SS})\ \theta_t$$

where $T_j \max$ = Max. Junction Temperature (200°C)

T_A = Max. Ambient (in °C)

P_{SS} = Diode Power Dissipation (Steady State) from Curve 15

θ = Thermal Resistance (Steady State) from Curve 12

P_{OL} = Diode Power Dissipation (Under Recurrent Overload Conditions) from Curve 15

θ_t = Transient Thermal Resistance (Under Overload Conditions) from Curve 12

As a starting point, it is suggested that the steady state diode current without recurrent overload current be determined (see Fig. 1).

To permit a recurrent overload rating, the maximum rated diode current must be reduced. Using a reduced value of steady state current as an estimate, the data for insertion into the formula can be obtained from Curves 15 and 12.

When the estimate is correct, the right side of the formula given above will equal the maximum T_j, which is 200°C.

EXAMPLE: 200% recurrent overload required for 10 seconds;
3-phase bridge;
1000 ft/min forced air;
maximum ambient = 40°C.

From Fig. 1 and 6, steady state rating without provision for recurrent overload equals 185 amps/diode. Therefore, a first approximation may be 125 amps steady state and 250 amps overload. Substituting these values in the formula, we have:

$$T_j \max = 40 + 115 \times .82 + (280 - 115)\ .26$$
$$T_j \max = 177.2$$

The answer of 177.2 indicates that our steady state selection was slightly low. By choosing 140 amps steady state and 280 amps overload, we come closer to the maximum rating permissible, based on T_j max = 200°C.

Of course, the 3-phase-bridge output current will be three times the diode current, 420 amps average steady state, and 840 amps, or 200% current, for 10 seconds.

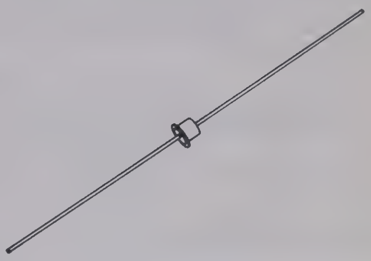
NOTES:

1. The recurrent overload calculation procedure outlined above was used to obtain the ratings shown by Curve 20.
2. NEMA overload ratings for semiconductor unit power supplies (100 KW or less) are:
   a. 100% rated load current and voltage continuously, then:
   b. 150% rated current for 1 minute, following 100% load; or
   c. 200% rated current for 10 seconds, following 100% load.

Germanium Diodes

BD1-7

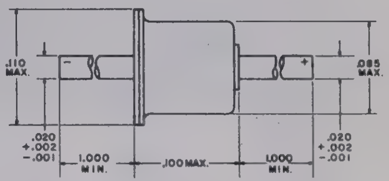
The General Electric types 4JFBD1-7 are germanium back diodes which make use of the quantum mechanical tunneling phenomenon, thereby attaining a very low forward voltage drop and eliminating charge storage effects. They feature closely controlled forward voltage characteristics with very small temperature coefficients. The very low forward voltage and low capacity of the back diode make it ideal for use in high frequency applications and in transistor and tunnel diode switching circuits. The germanium back diodes are characterized in seven types according to the forward current at a forward voltage of 90 millivolts and according to the maximum reverse leakage current.



absolute maximum ratings: (25°C) (unless otherwise specified)

Part Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**units**
Forward Current (-55 to + 100°C)	30	15	10	5	5	5	5	ma
Reverse Current (-55 to + 100°C)	10	5	5	5	5	5	5	ma
Lead Temperature, 1/16" + 1/32" from case for 10 seconds			260°C					

AXIAL DIODE OUTLINE



ALL DIMENSIONS IN INCHES.
DIMENSIONS ARE REFERENCE UNLESS TOLERANCED.

electrical characteristics: (25°C) (unless otherwise specified)

	Sym.	**BD1**	**BD2**	**BD3**	**BD4**	**BD5**	**BD6**	**BD7**	**Units**
Forward Voltage, $V_{F1} = 90$ MV ± 10 mv at $I_{F1} =$		10	5	2	1	.5	.2	.1 ma	
Forward Voltage at I_{F2} ($I_{F2} = 3 I_{F1}$)	V_{F2}	120	130	170	170	170	160	160 mv	typ.
Reverse Voltage, $I_R = I_P$ max	V_{R1}	440	420	400	380	350	330	330 mv	min.
Reverse Voltage, $I_R = 1$ ma	V_{R2}	440	465	465	465	465	465	465 mv	min.
Reverse Peak Point Current	I_P	1	.5	.2	.1	.05	.02	.01 ma	max.
Series Inductance (Measured at case)	L_S	1.5	1.5	1.5	1.5	1.5	1.5	1.5 nh	typ.
Total Terminal Capacity	C	8	6	4	3	3	3	3 pf	typ.
($V_R = 350$ mv)		20	10	10	10	10	10	10 pf	max.
Recovery Time*	t_r	1.0	0.7	0.5	0.4	0.4	0.4	0.4 ns	typ.

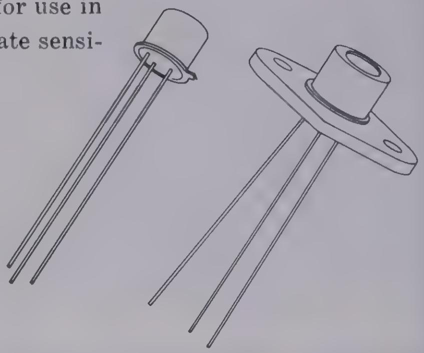
*The recovery time is measured to a reverse current of 1 ma. when switching from 0.1 volt forward to 0.4 volt reverse from a 50 ohm source. Since the back diode does not exhibit charge storage, the recovery time is determined by the charging time of the total device capacity.

SCR

1.6A RMS Up to 400 Volts

C5 Series
2N2322-29
2N2322A-28A
C511 (Diamond Base)‡

The C5 Series of Silicon Controlled Rectifiers are reverse blocking thyristors for use in low power switching and control applications. They feature two ranges of gate sensitivity and high external gate-cathode shunting resistance.



- All-diffused
- Two ranges of gate sensitivity—2N2322-29—200μA max. & 2N2322A-28A—20μA max.
- Diamond flange types (C511) for convenient power dissipation
- Low holding current
- Broad voltage range
- Designed to meet MIL-S-19500/276

MAXIMUM ALLOWABLE RATINGS

TYPES†		REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM} $T_C = -65°C$ to $+125°C$ $R_{GK} = 1000$ OHMS (2N2322-29) $= 2000$ OHMS (2N2322A-28A)	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM} $T_C = -65°C$ to $+125°C$	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{RSM} ($\leqq$ 10 Millisec.) $T_C = -65°C$ to $+125°C$
JEDEC	GE			
2N2322	C5U	25V.*	25V.*	40V.*
2N2322A	—	25V.*	25V.*	40V.*
2N2323	C5F	50V.*	50V.*	75V.*
2N2323A	—	50V.*	50V.*	75V.*
2N2324	C5A	100V.*	100V.*	150V.*
2N2324A	—	100V.*	100V.*	150V.*
2N2325	C5G	150V.*	150V.*	225V.*
2N2325A	—	150V.*	150V.*	225V.*
2N2326	C5B	200V.*	200V.*	300V.*
2N2326A	—	200V.*	200V.*	300V.*
2N2327	C5H	250V.*	250V.*	350V.*
2N2327A	—	250V.*	250V.*	350V.*
2N2328	C5C	300V.*	300V.*	400V.*
2N2328A	—	300V.*	300V.*	400V.*
2N2329	C5D	400V.*	400V.*	500V.*

Peak Positive Anode Voltage, PFV	500 Volts
RMS On-State Current, $I_{T(RMS)}$	1.6 Amperes (all conduction angles)
Average On-State Current, $I_{T(AV)}$	Depends on conduction angle (see Charts 2, 3, 5 and 6)
Critical Rate-of-Rise of On-State Current, di/dt: Gate Triggered Operation, Switching from Rated Voltage	50 Amperes per microsecond
Peak One Cycle Surge (non-rep) On-State Current, I_{TSM}	15 Amperes*
I^2t (for fusing), for times $\geqslant$ 1.5 milliseconds	0.5 Ampere²seconds
Peak Gate Power Dissipation, P_{GM}	0.1 Watts*
Average Gate Power Dissipation, $P_{G(AV)}$	0.01 Watts*
Peak Positive Gate Current, I_{GM}	0.1 Amperes*
Peak Positive Gate Voltage, V_{GM}	6 Volts*
Peak Negative Gate Voltage, V_{GM}	6 Volts*
Storage Temperature, T_{STG}	−65°C to +150°C*
Operating Temperature, T_J	−65°C to +125°C*

*Indicates data included on JEDEC type number registration

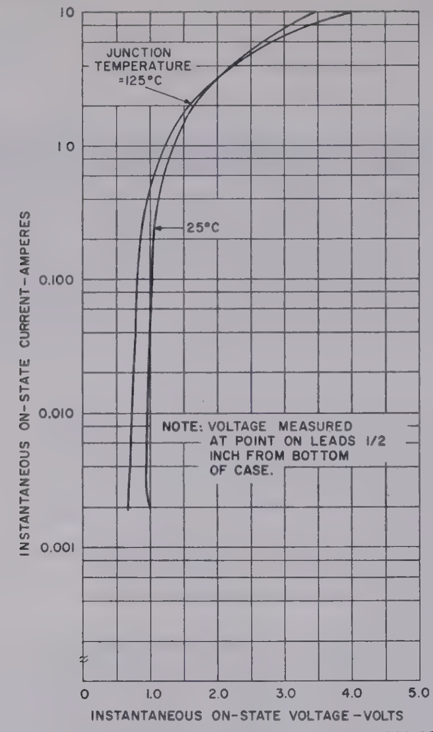
†When ordering the Diamond Base versions, be sure to include the proper voltage letter symbol. For example: The 25V Diamond Base version of the C5U (2N2322) is type number C511U.

‡The C511 series is identical to the C5 (2N2322-29) series except that a diamond base flange is soldered to the base of the unit. All ratings and characteristics are common to both series. See charts 17 thru 21 for Transient Thermal Impedance and Current Curves.

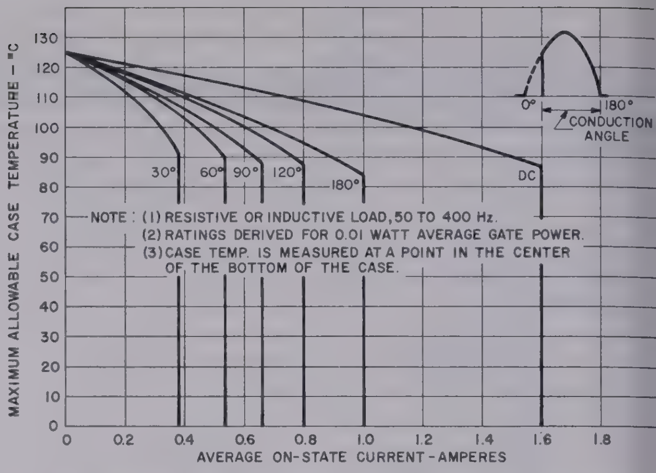
CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
PEAK REVERSE or OFF-STATE CURRENT	I_{RRM} or I_{DRM}				μA	$V_{RRM} = V_{DRM}$ = Rated.
		—	2.0	10.0		T_C = +25°C, R_{GK} = 1000 Ohms 2N2322-29 (C5 Series) = 2000 Ohms 2N2322A-28A
All Types		—	40	100*		T_C = +125°C, R_{GK} = 1000 Ohms 2N2322-29 (C5 Series) = 2000 Ohms 2N2322A-28A
GATE TRIGGER CURRENT	I_{GT}				μAdc	
2N2322-29 (C5 Series)		—	10	200		T_C = +25°C, V_D = 6Vdc, R_L = 100 Ohms R_{GK} = 1000 Ohms
2N2322A-28A		—	2	20		T_C = +25°C, V_D = 6Vdc, R_L = 100 Ohms R_{GK} = 2000 Ohms
2N2322-29 (C5 Series)		—	20.0	350*		T_C = −65°C, V_D = 6Vdc, R_L = 100 Ohms R_{GK} = 1000 Ohms
2N2322A-28A		—	10	75*		T_C = −65°C, V_D = 6Vdc, R_L = 100 Ohms R_{GK} = 2000 Ohms
GATE TRIGGER VOLTAGE	V_{GT}				Vdc	
2N2322-29 (C5 Series)		0.35	0.5	0.8		T_C = +25°C, V_D = 6Vdc, R_L = 100 Ohms R_{GK} = 1000 Ohms
2N2322A-28A		0.35	0.4	0.6		T_C = +25°C, V_D = 6Vdc, R_L = 100 Ohms R_{GK} = 2000 Ohms
2N2322-29 (C5 Series)		—	0.7	1.0*		T_C = −65°C, V_D = 6Vdc, R_L = 100 Ohms R_{GK} = 1000 Ohms
2N2322A-28A		—	—	0.9*		T_C = −65°C, V_D = 6Vdc, R_L = 100 Ohms R_{GK} = 2000 Ohms
2N2322-29 (C5 Series)		0.1*	0.25	0.5		T_C = +125°C, V_{DM} = Rated V_{DRM} Value R_{GK} = 1000 Ohms, R_L = 100 Ohms
2N2322A-28A		0.1*	—	—		T_C = +125°C, V_{DM} = Rated V_{DRM} Value R_{GK} = 2000 Ohms, R_L = 100 Ohms
PEAK ON-STATE VOLTAGE	V_{TM}	—	2.0	2.2	V	T_C = +25°C, I_{TM} = 4.0A, Single Half Sine Wave Pulse, 2.0 Millisec. Wide
All Types		—	1.9	2.0*		T_C = +85°C, $I_{T(AV)}$ = 1.0A, Half Sine Wave, 60 Hz, 180° Conduction Angle
HOLDING CURRENT	I_H				mAdc	R_{GK} = 1000 Ohms 2N2322-29 (C5 Series) = 2000 Ohms 2N2322A-28A
All Types		—	1.0	2.0		T_C = +25°C, R_L = 10K
All Types		—	1.5	3.0*		T_C = −65°C, R_L = 10K
2N2322-29		0.15*	0.4	—		T_C = +125°C, R_L = 50K
2N2322A-28A		0.10*	0.4	—		
TURN-ON TIME All Types	$t_d + t_r$	—	1.4	—	μsec	T_C = +25°C, I_F = 1.0A, V_{DM} = Rated V_{DRM} Value, Gate Supply: 6 Volt Open Circuit, 330 Ohm Load Line, 0.1 μsec. Rise Time, 5 μsec. Min. Pulse Width.
CIRCUIT-COMMUTATED TURN-OFF TIME All Types	t_q	—	40	—	μsec	T_C = +125°C, I_{TM} = 1.0A Peak. Rectangular current pulse, 50 μsec duration. Rate of rise of current <10 amperes/μsec. Commutation rate ≤5 amperes/μsec. Peak reverse voltage = rated V_{RRM} volts max. Reverse voltage at end of turn-off time interval = 15V. Repetition rate = 60 pps. Rate of rise of re-applied off-state voltage (dv/dt) = 20V/μsec. Off-state voltage = rated V_{DRM} volts. Gate bias during turn-off time interval = 0 volts, 100 ohms.

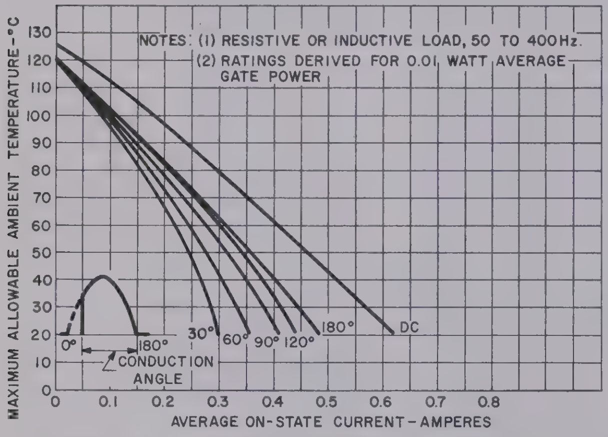
*Indicates data included on JEDEC type number registration



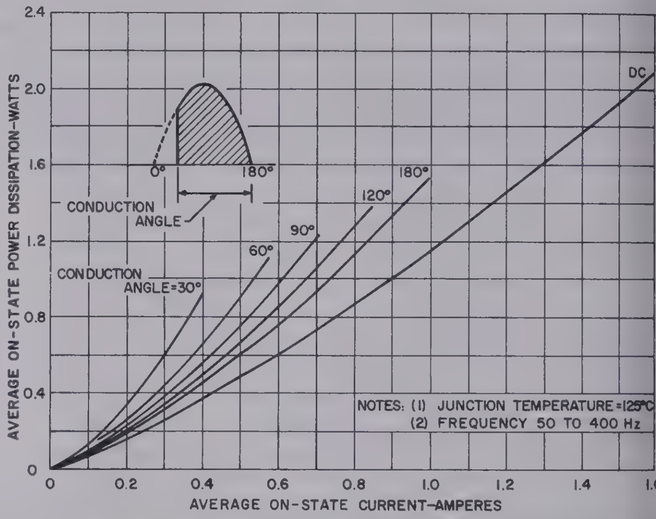
1. MAXIMUM ON-STATE CHARACTERISTICS



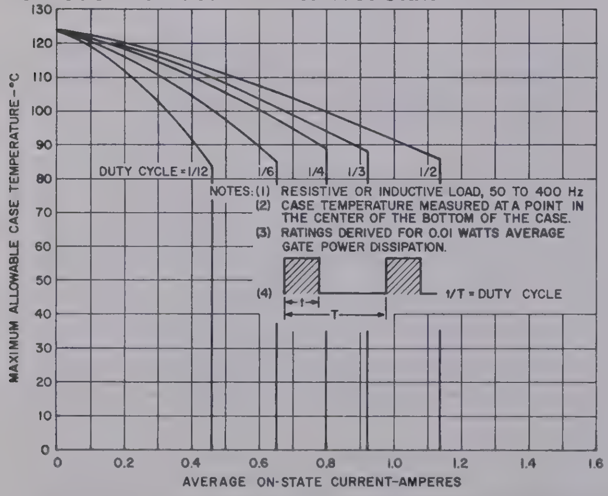
2. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



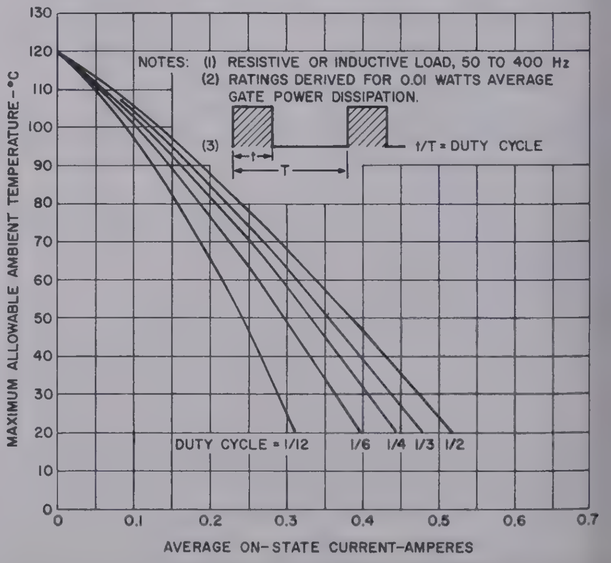
3. MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



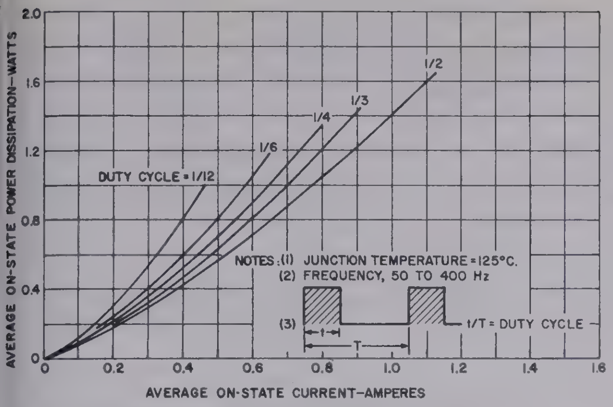
4. MAXIMUM ON-STATE POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



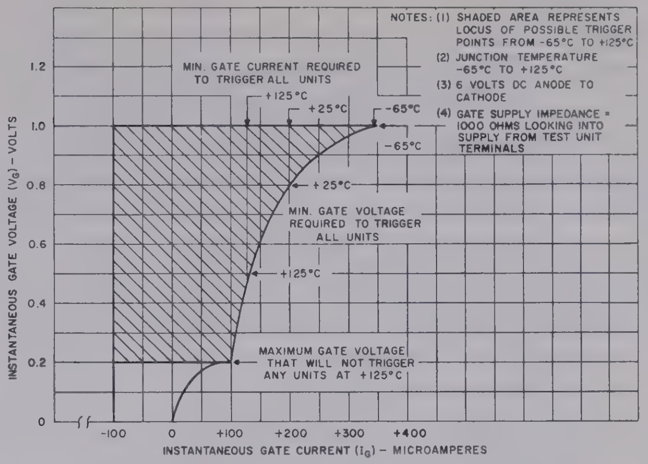
5. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



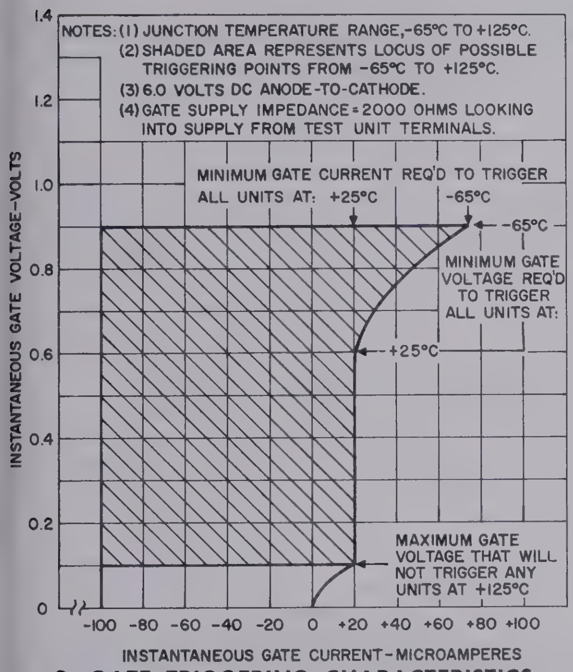
6. MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



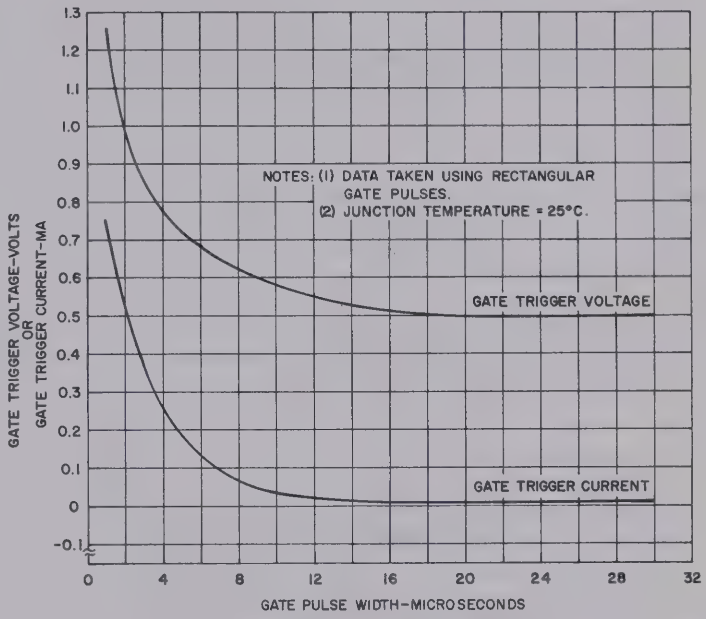
7. MAXIMUM ON-STATE POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



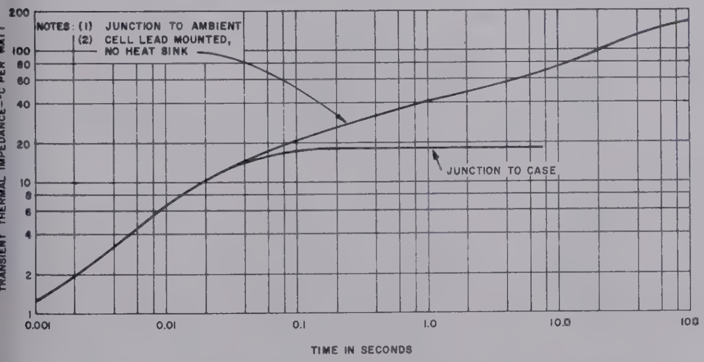
8. GATE TRIGGERING CHARACTERISTICS FOR 2N2322-29 (C5 SERIES) ONLY



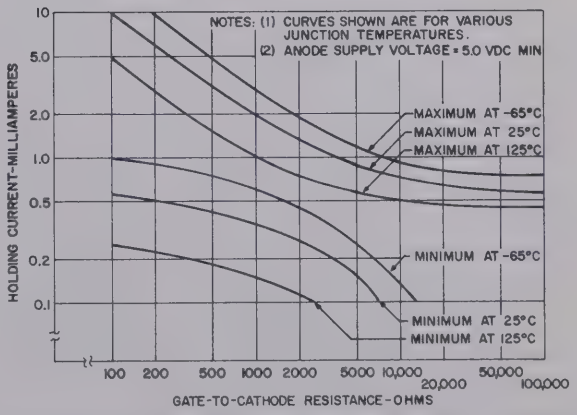
9. GATE TRIGGERING CHARACTERISTICS FOR 2N2322A-28A ONLY



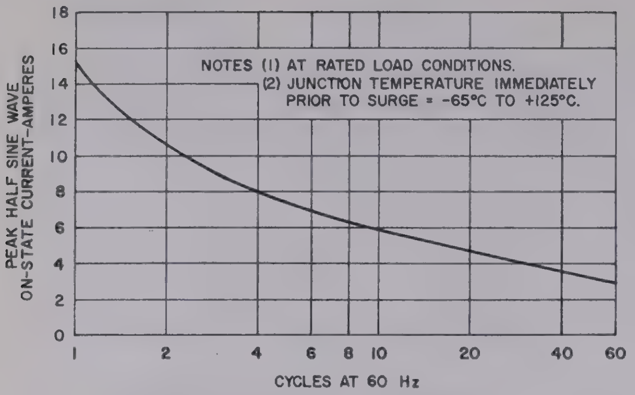
10. TYPICAL GATE TRIGGER CURRENT AND VOLTAGE VARIATION WITH GATE PULSE WIDTH



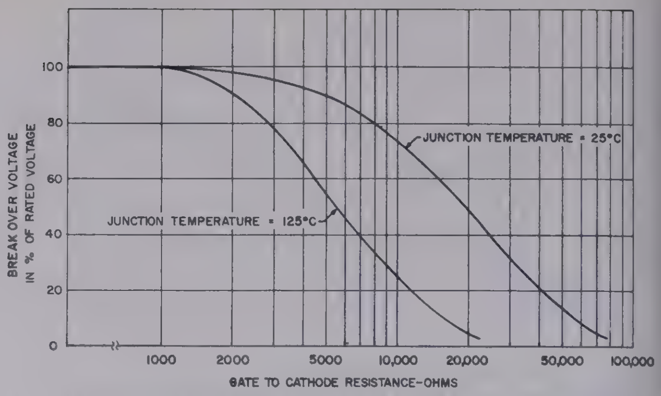
11. MAXIMUM TRANSIENT THERMAL IMPEDANCE



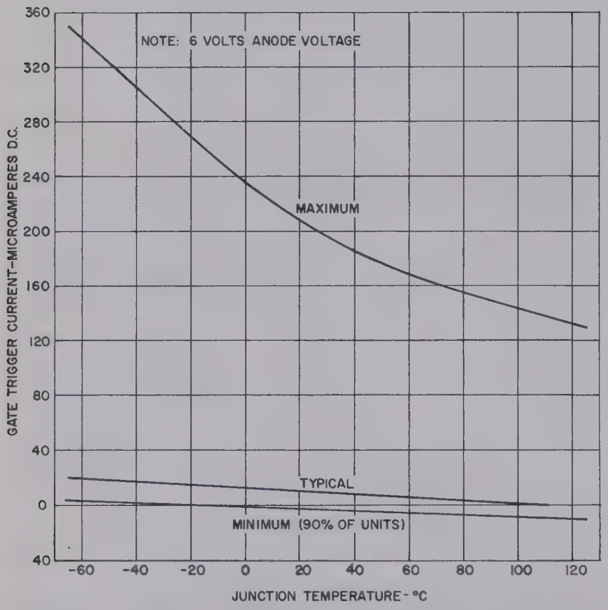
12. MAXIMUM AND MINIMUM HOLDING CURRENT VARIATION WITH EXTERNAL GATE-TO-CATHODE RESISTANCE FOR 2N2322-29 (C5 SERIES) ONLY



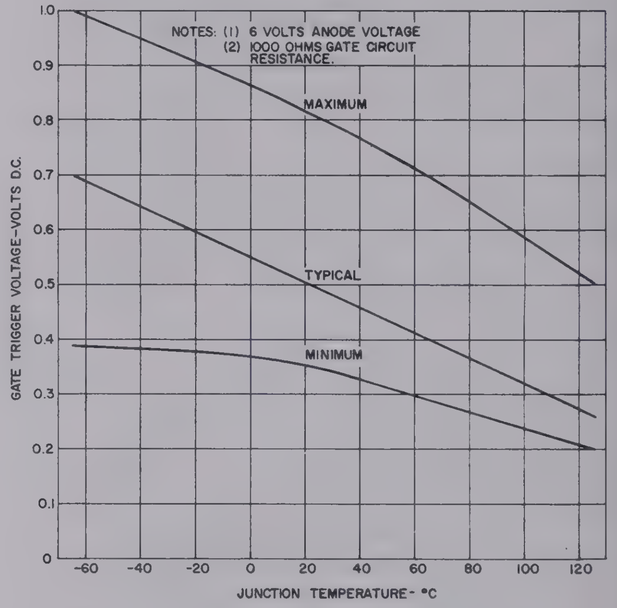
13. MAXIMUM ALLOWABLE SURGE (NON-REPETITIVE) ON-STATE CURRENT



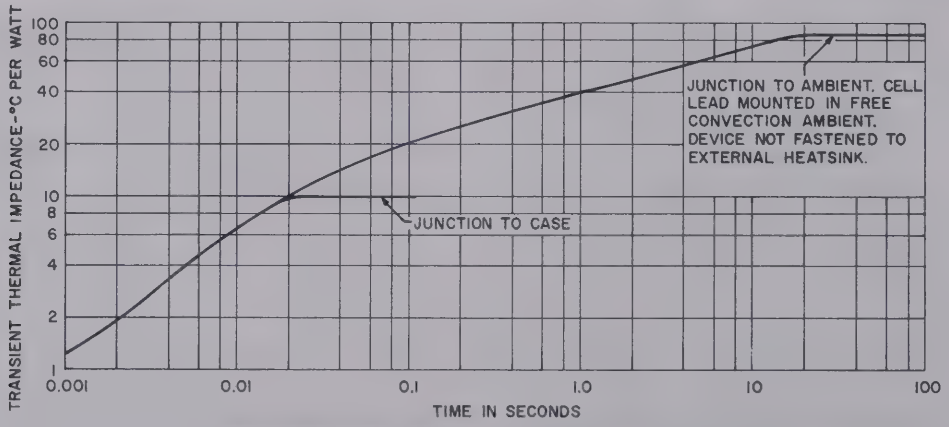
14. TYPICAL BREAKOVER VOLTAGE VARIATION WITH EXTERNAL GATE-TO-CATHODE RESISTANCE 2N2322-29 (C5 SERIES) ONLY



15. VARIATION OF GATE TRIGGER CURRENT WITH TEMPERATURE FOR 2N2322-29 (C5 SERIES) ONLY

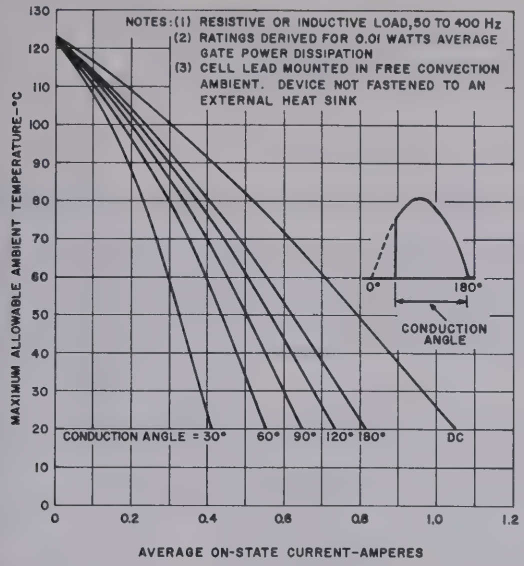


16. VARIATION OF GATE TRIGGER VOLTAGE WITH TEMPERATURE FOR 2N2322-29 (C5 SERIES) ONLY

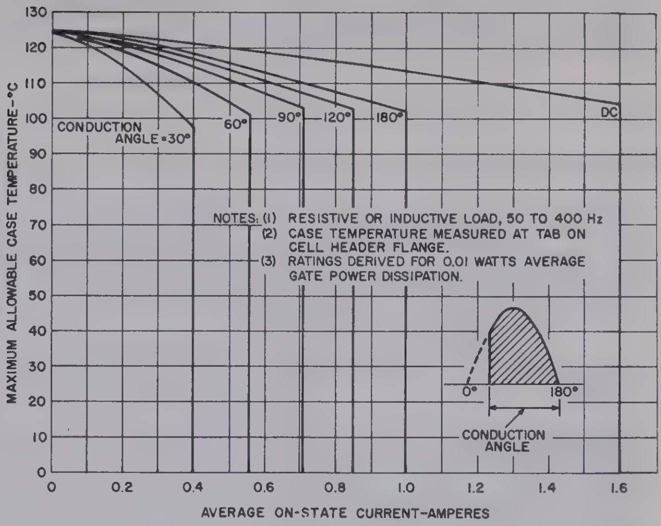


17. MAXIMUM TRANSIENT THERMAL IMPEDANCE (DIAMOND BASE)

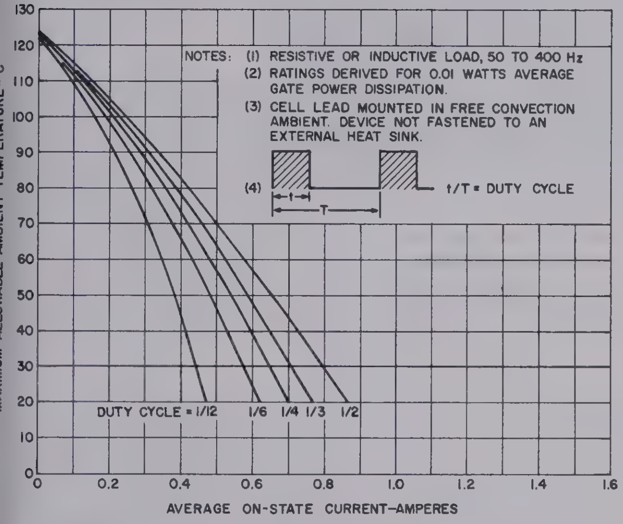
C5 Series



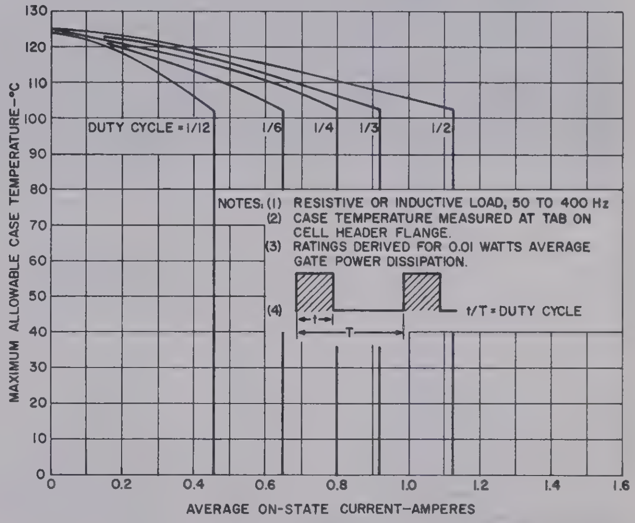
8. MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR HALF WAVE RECTIFIED SINE WAVE OF CURRENT (DIAMOND BASE)



19. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR HALF WAVE RECTIFIED SINE WAVE OF CURRENT (DIAMOND BASE)



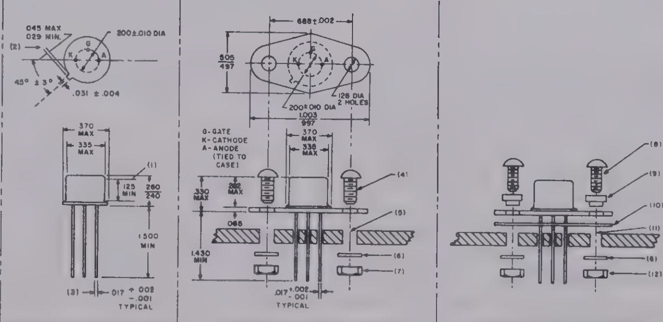
0. MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM (DIAMOND BASE)



21. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM (DIAMOND BASE)

OUTLINE DRAWING

(1) This zone is controlled for automatic handling. The variation in actual diameter within this zone shall not exceed .010.
(2) Measured from max. diameter of the actual device.
(3) The specified lead diameter applies in the zone between .050 and .250 from the base seat. Between .250 and 1.5 maximum of .021 diameter is held. Outside of these the lead diameter is not controlled. Leads may be inserted, without damage in .031 holes while device enters .371 hole concentric with lead hole circle
(4) #4-40 screw, st'n steel ` ,," long
(5) .120 hole (#31 drill)
(6) Int tooth lockwasher, st'n steel
(7) #4-40 nut, st'n steel
(8) #2-56 screw, st'n steel ⅜" long
(9) Shoulder washer, vulcanized fiber
(10) Mica insulator, .003 thick
(11) .0935 hole (#42 drill)
(12) #2-56 nut, st'n steel
All dimensions in inches


.045 MAX
.029 MIN.
.200±.010 DIA
(2)
G
K
A
45° ± 3°
.031 ± .004
.370 MAX
.335 MAX
(1)
.125 MIN
.260
.240
1.500 MIN
(3)
.017 + .002 − .001 TYPICAL
.688±.002
.505
.497
.128 DIA 2 HOLES
.200±.010 DIA
1.003
.997
G-GATE
K-CATHODE
A-ANODE (TIED TO CASE)
.370 MAX
.338 MAX
.330 MAX
.262 MAX
.065
1.430 MIN
(4)
(5)
(6)
(7)
.017 +.002 −.001 TYPICAL
(8)
(9)
(10)
(11)
(6)
(12)

CONFORMS TO JEDEC TO-5 OUTLINE

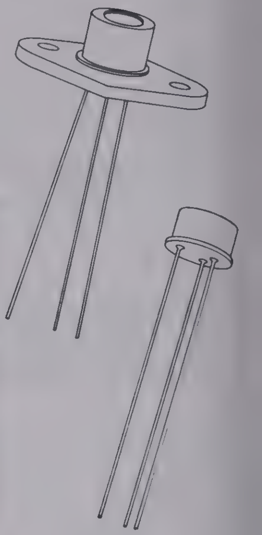
DIAMOND BASE STANDARD MOUNTING

DIAMOND BASE INSULATED MOUNTING

SCR

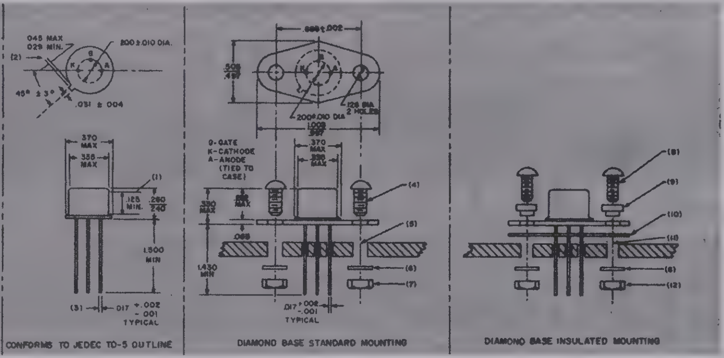
C6,C611

For High Volume Light Industrial, Computer, and Consumer Applications
- **Low Cost**
- **All-diffused for Proved Reliability**
- **Popular Voltage Range—up to 200V**
- **Sensitive Gate (1 ma to Trigger)**
- **Standard TO-5 Package (C6) for Convenient Mounting**
- **Diamond Flange Option (C611) Simplifies Heat Dissipation**



OUTLINE DRAWING

(1) This zone is controlled for automatic handling. The variation in actual diameter within this zone shall not exceed .010.
(2) Measured from max. diameter of the actual device.
(3) The specified lead diameter applies in the zone between 050 and 250 from the base seat. Between .250 and 1 5 maximum of .021 diameter is held. Outside of these the lead diameter is not controlled Leads may be inserted, without damage in .031 holes while device enters .371 hole concentric with lead hole circle.
(4) #4-40 screw, st'n steel ˋ˴" long
(5) .120 hole (#31 drill)
(6) Int tooth lockwasher, st'n steel
(7) #4-40 nut, st'n steel
(8) #2-56 screw, st'n steel ⅜" long
(9) Shoulder washer, vulcanized fiber
(10) Mica insulator, .003 thick
(11) .0935 hole (#42 drill)
(12) #2-56 nut, st'n steel
All dimensions in inches


045 MAX
029 MIN.
200±.010 DIA.
(2)
G
K
A
45° ± 3°
.031 ± .004
370 MAX
356 MAX
(1)
.125 MIN.
.260
.240
1.500 MIN
(3)
.017 +.002 -.001 TYPICAL
CONFORMS TO JEDEC TO-5 OUTLINE
±.002
.505
.495
.200±.010 DIA
.128 DIA 2 HOLES
G-GATE
K-CATHODE
A-ANODE (TIED TO CASE)
.370 MAX
MAX
(4)
(5)
(6)
(7)
1.430 MIN
.017 +.002 -.001 TYPICAL
DIAMOND BASE STANDARD MOUNTING
(8)
(9)
(10)
(11)
(12)
DIAMOND BASE INSULATED MOUNTING

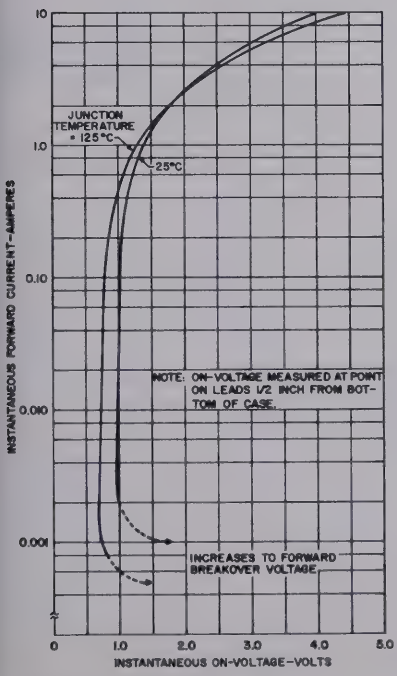
Types	Peak Forward Blocking Voltage, V_{FXM} $T_J = -40°C$ to $+125°C$ $R_{GK} = 1000$ OHMS	Working and Repetitive Peak Reverse Voltage V_{ROM}(wkg) and V_{ROM}(rep) $T_J = -40°C$ to $+125°C$	Non-Repetitive Peak Reverse Voltage, V_{ROM}(non-rep) (<5 Millisec.) $T_J = -40°C$ to $+125°C$
C6U, C611U	25 Volts	25 Volts	40 Volts
C6F, C611F	50 Volts	50 Volts	75 Volts
C6A, C611A	100 Volts	100 Volts	150 Volts
C6G, C611G	150 Volts	150 Volts	225 Volts
C6B, C611B	200 Volts	200 Volts	300 Volts

MAXIMUM ALLOWABLE RATINGS

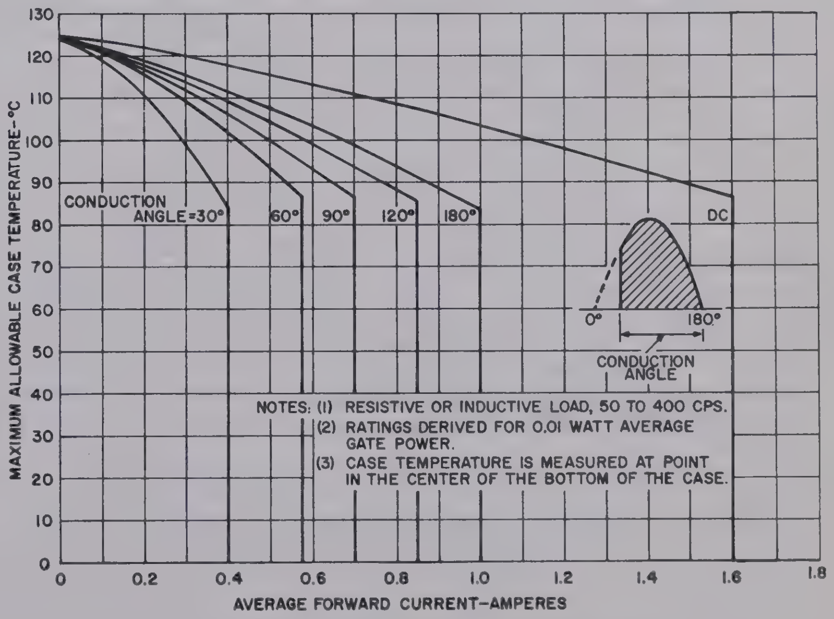
Peak Forward Voltage, PFV	300 Volts
RMS Forward Current, On-state (independent of conduction angle)	1.6 Amperes
Average Forward Current, On-state	Depends on conduction angle (See Charts)
Peak One Cycle Surge Forward (Non-repetitive) Current, I_{FM} (surge)	10 Amperes
Peak Gate Power, P_{GM}	0.1 Watt
Average Gate Power, $P_{G(AV)}$	0.01 Watt
Peak Gate Current, I_{GFM}	0.1 Ampere
Peak Gate Voltage, Forward & Reverse, V_{GFM} & V_{GRM}	6 Volts
Storage Temperature, T_{stg}	—40°C to +150°C
Operating Temperature	—40°C to +125°C
Peak non-recurrent surge forward current during turn-on time interval (Current rise time $= 5.0$ μsec Minimum).	40 Amperes

CHARACTERISTICS

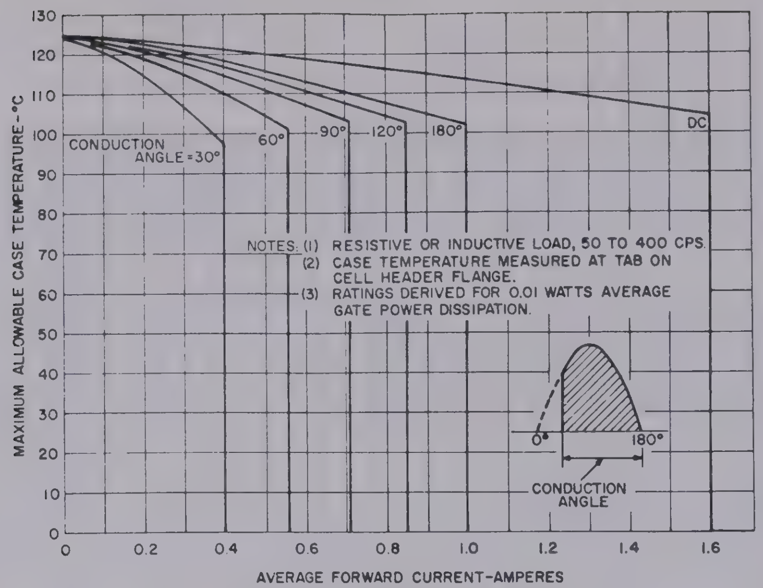
TEST	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Forward Breakover Voltage	$V_{(BR)FX}$				Volts	$T_J = -40°C$ to $+125°C$ $R_{GK} = 1000$ ohms Sinusoidal Waveform, 50 to 400 CPS
C6U, C611U		25	....	....		
C6F, C611F		50	....	....		
C6A, C611A		100	....	....		
C6G, C611G		150	....	....		
C6B, C611B		200	....	....		
Reverse or Forward Blocking Current	I_{RX} or I_{FX}					$V_{RX} = V_{FX} =$ Rated V_{ROM}(rep) Value
		....	2.0	10.0	μAdc	$T_J = 25°C$, $R_{GK} = 1000$ ohms
		....	40	100	μAdc	$T_J = 125°C$, $R_{GK} = 1000$ ohms
Gate Trigger Current	I_{GT}	....	0.2	1.0	mAdc	$T_J = 25°C$, $V_{FX} = 6$Vdc, $R_L = 100$ ohms
Gate Trigger Voltage	V_{GT}	0.35	0.5	0.8	Vdc	$R_L = 100$ ohms, $R_G = 1000$ ohms $T_J = 25°C$, $V_{FX} = 6$Vdc
		....	0.7	1.0	Vdc	$T_J = -40°C$, $V_{FX} = 6$Vdc
		0.1	0.25	0.5	Vdc	$T_J = 125°C$, $V_{FX} =$ Rated V_{FXM} Value.
Peak On-Voltage	V_{FM}	....	1.2	1.4	V	$T_J = 25°C$, $I_{FM} = 1.0$A, Single Half Sine Wave Pulse, 2.0 Millisec. Wide
Holding Current	I_{HX}	....	1.0	5.0	mAdc	$R_{GK} = 1000$ ohms $T_J = 25°C$, $R_L = 10$K ohms
		0.15	0.4	....	mAdc	$T_J = 125°C$, $R_L = 50$K ohms
Turn-On Time	$t_d + t_r$	....	1.4	....	μsec	$T_J = 25°C$, $I_F = 1.0$A, $V_{FX} =$ Rated V_{FXM} Value. Supply: 6 Volt Open Circuit, 330 ohm Load Line, 0.1 μsec Rise Time.
Circuit-Commutated Turn-off Time	t_{off}	....	40	....	μsec	$T_J = 125°C$, $I_{FM} = 1.0$A, I_R (Reccvery) $= 1.0$A, Reapplied $V_{FXM} =$ Rated V_{FXM} Value, Rate of Rise of Reapplied $V_{FXM} =$ 20 Volts per μsec, $R_{GK} = 100$ ohms.
Thermal Resistance, C6, Junction to Ambient	θ_{J-A}	....	....	160	°C/watt	Steady State
C611, Junction to Case	θ_{J-C}	....	....	10	°C/watt	Steady State



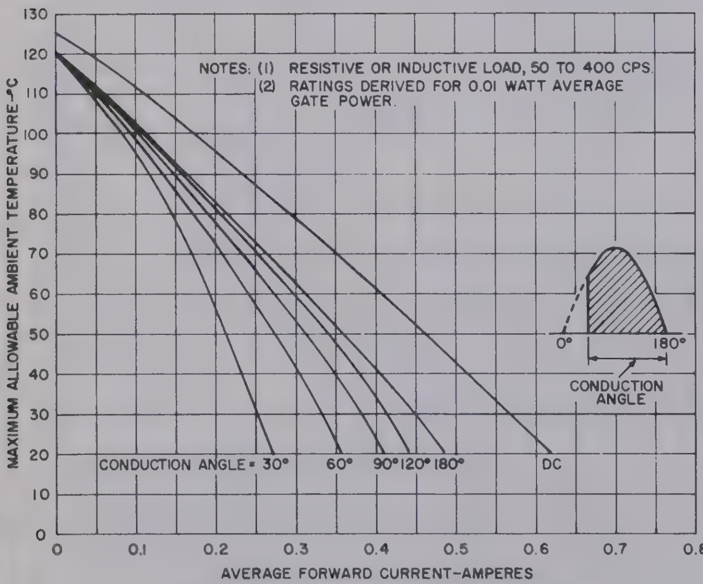
AXIMUM FORWARD CHARACTERISTICS—ON-STATE



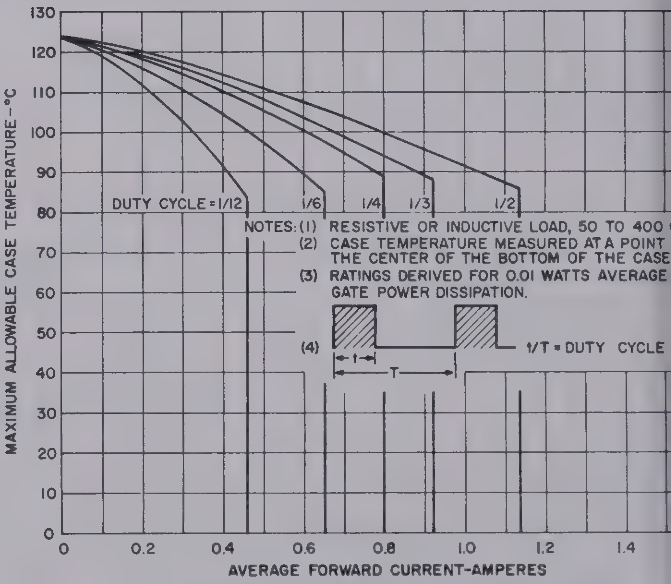
2. C6—MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



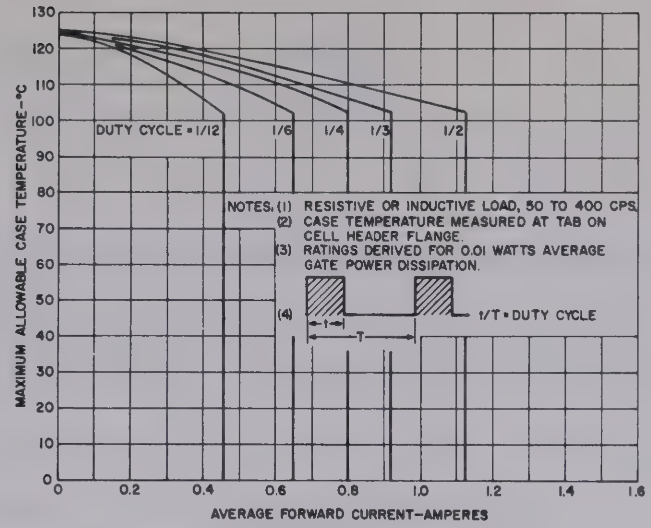
3. C611—MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



4. C6—MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM

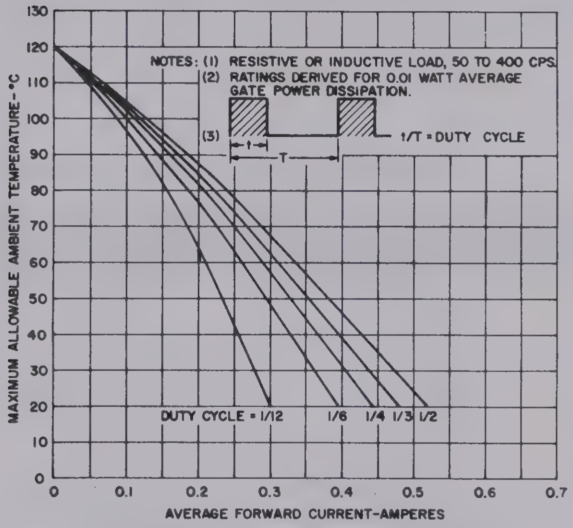


5. C6—MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



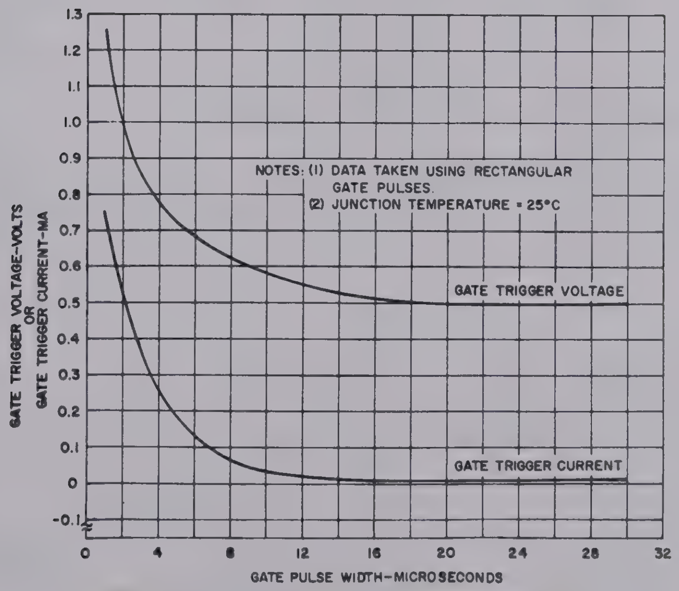
NOTES: (1) RESISTIVE OR INDUCTIVE LOAD, 50 TO 400 CPS.
(2) CASE TEMPERATURE MEASURED AT TAB ON CELL HEADER FLANGE.
(3) RATINGS DERIVED FOR 0.01 WATTS AVERAGE GATE POWER DISSIPATION.
(4)

6. C611—MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



NOTES: (1) RESISTIVE OR INDUCTIVE LOAD, 50 TO 400 CPS.
(2) RATINGS DERIVED FOR 0.01 WATT AVERAGE GATE POWER DISSIPATION.
(3)

7. C6—MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



NOTES: (1) DATA TAKEN USING RECTANGULAR GATE PULSES.
(2) JUNCTION TEMPERATURE = 25°C

8. TYPICAL VARIATION OF GATE TRIGGER VOLTAGE AND CURRENT WITH GATE PULSE WIDTH

SCR

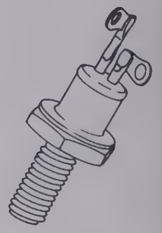
C10 SERIES
2N1770A-2N1777A

The General Electric C10 Series (2N1770A-2N1777A) Silicon Controlled Rectifier is a reverse blocking triode thyristor semiconductor for use in low power switching and phase control applications requiring blocking voltages up to 400 volts, and RMS load currents up to 7.4 amperes.

This series device is designed to meet MIL-S-19500/168 , and has full blocking voltage ratings from −65°C to +150°C.

The following G. E. Co., low-current SCR types are also available in the same package outline:

C11	(2N1770-2N1778, 2N2619)	(Pub. #150.21)—$T_J = 125°C$, up to 600V PRV
C15		(Pub. #150.22)—$T_J = 105°C$, up to 600V PRV



MAXIMUM ALLOWABLE RATINGS

TYPE	PEAK FORWARD BLOCKING VOLTAGE, V_{FOM} $T_C = -65°C$ to $+150°C$	REPETITIVE PEAK REVERSE VOLTAGE, V_{ROM} (rep)(1) $T_C = -65°C$ to $+150°C$	NON-REPETITIVE PEAK REVERSE VOLTAGE (<5.0 MILLISEC.), V_{ROM} (non-rep) $T_C = -65°C$ to $+150°C$
C10U (2N1770A)	25 Volts*	25 Volts*	35 Volts*
C10F (2N1771A)	50 Volts*	50 Volts*	75 Volts*
C10A (2N1772A)	100 Volts*	100 Volts*	150 Volts*
C10G (2N1773A)	150 Volts*	150 Volts*	225 Volts*
C10B (2N1774A)	200 Volts*	200 Volts*	300 Volts*
C10H (2N1775A)	250 Volts*	250 Volts*	350 Volts*
C10C (2N1776A)	300 Volts*	300 Volts*	400 Volts*
C10D (2N1777A)	400 volts*	400 Volts*	500 Volts*

(1) Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for whi maximum V_{FOM} and V_{ROM} ratings apply = 18°C per watt.

Peak Forward Voltage, PFV	480 volt
RMS Forward Current, On-State	7.4 amperes (all conduction angles)
Average Forward Current, On-State, Half Sine Wave, I_O	4.7 amperes at $T_C = 105°$
Average Forward Current, On-State	Depends on conduction angle (see Chart 3, 5 and 7)
Peak One-cycle Surge Forward Current, I_{FM} (surge)	60 ampere
I^2t (for fusing)	Calculate from Chart
Turn-On Current Limit	See Chart 1
Peak Gate Power Dissipation, P_{GM}	5 watt
Average Gate Power Dissipation, $P_{G\ (AV)}$	0.5 watt
Peak Gate Current, I_{GFM}	2 ampere
Peak Gate Voltage, Forward and Reverse, V_{GFM} and V_{GRM}	10 volt
Storage Temperature, T_{stg}	−65°C to +150°
Operating Temperature, T_J	−65°C to +150°
Stud Torque	15 lb-in (17 kg-cm)

*Indicates data included on JEDEC type number registration.

CHARACTERISTICS

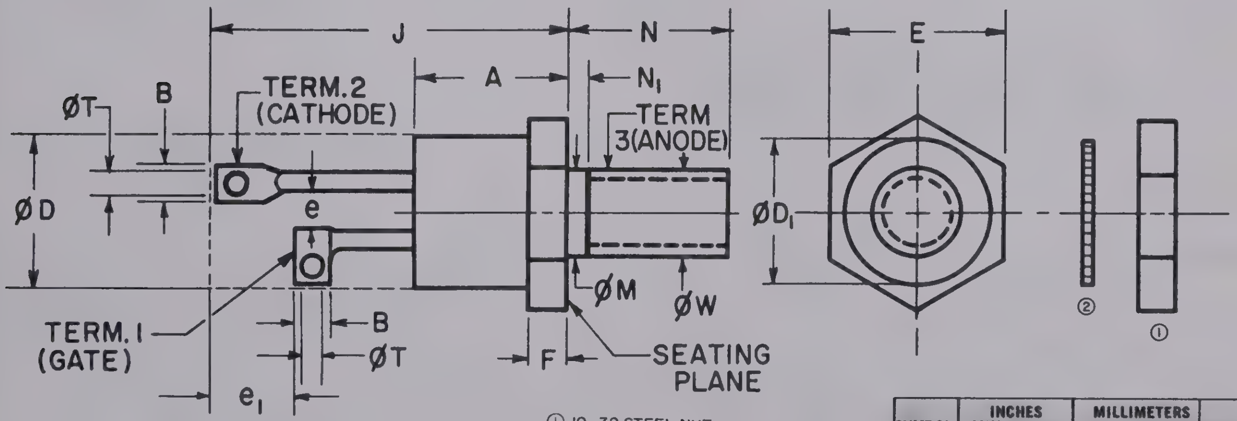
TEST	SYMBOL	MIN.	MAX.	UNITS	TEST CONDITIONS
PEAK REVERSE OR FORWARD BLOCKING CURRENT†	I_{ROM} or I_{FOM}			mA	$T_C = -65°C$ to $+150°C$
C10U (2N1770A)		——	9.0		$V_{ROM} = V_{FOM} = 25V$ Peak
C10F (2N1771A)		——	9.0		$V_{ROM} = V_{FOM} = 50V$ Peak
C10A (2N1772A)		——	9.0		$V_{ROM} = V_{FOM} = 100V$ Peak
C10G (2N1773A)		——	8.0		$V_{ROM} = V_{FOM} = 150V$ Peak
C10B (2N1774A)		——	6.0		$V_{ROM} = V_{FOM} = 200V$ Peak
C10H (2N1775A)		——	5.0		$V_{ROM} = V_{FOM} = 250V$ Peak
C10C (2N1776A)		——	4.0		$V_{ROM} = V_{FOM} = 300V$ Peak
C10D (2N1777A)		——	2.0		$V_{ROM} = V_{FOM} = 400V$ Peak
FULL CYCLE AVG. REVERSE OR FORWARD BLOCKING CURRENT†	$I_{RX\ (AV)}$ or $I_{FX\ (AV)}$			mA	$T_C = +105°C$, $I_O = 4.7A$ 180° Conduction Angle
C10U (2N1770A)		——	4.5*		$V_{RXM} = V_{FXM} = 25V$ Peak
C10F (2N1771A)		——	4.5*		$V_{RXM} = V_{FXM} = 50V$ Peak
C10A (2N1772A)		——	4.5*		$V_{RXM} = V_{FXM} = 100V$ Peak
C10G (2N1773A)		——	4.0*		$V_{RXM} = V_{FXM} = 150V$ Peak
C10B (2N1774A)		——	3.0*		$V_{RXM} = V_{FXM} = 200V$ Peak
C10H (2N1775A)		——	2.5*		$V_{RXM} = V_{FXM} = 250V$ Peak
C10C (2N1776A)		——	2.0*		$V_{RXM} = V_{FXM} = 300V$ Peak
C10D (2N1777A)		——	1.0*		$V_{RXM} = V_{FXM} = 400V$ Peak
GATE TRIGGER CURRENT	I_{GT}	——	15	mAdc	$T_C = +25°C$, $V_{FX} = 12$ Vdc, $R_L = 250$ ohms
		——	30*	mAdc	$T_C = -65°C$, $V_{FX} = 12$ Vdc, $R_L = 250$ ohms
GATE TRIGGER VOLTAGE	V_{GT}	——	2.0*	Vdc	$T_C = -65°C$ to $+150°C$, $V_{FX} = 12$ Vdc, $R_L = 250$ ohms
		0.2*	——	Vdc	$T_C = +150°C$, $V_{FXM} =$ Rated V_{FOM}, $R_L = 250$ ohms
PEAK ON-VOLTAGE	V_{FM}	——	1.85	V	$T_C = +25°C$, $I_{FM} = 15A$ Peak, 1 millisecond wide pulse. Duty cycle $\leqq 1\%$.
HOLDING CURRENT	I_{HO}	——	25	mAdc	$T_C = +25°C$, Anode supply = 24 Vdc, Gate Supply = 7V, 20 ohms. Initial forward current pulse = 0.5A, 0.1 millisecond to 10 milliseconds wide.
EFFECTIVE THERMAL RESISTANCE (DC)	θ_{J-C}	——	3.1	°C/watt	Junction to case.

†Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for which maximum V_{FOM} and V_{ROM} ratings apply equals 18°C/watt.

*Indicates data included on JEDEC type number registration.

OUTLINE DRAWING

(Complies with JEDEC registered TO-64 outline)



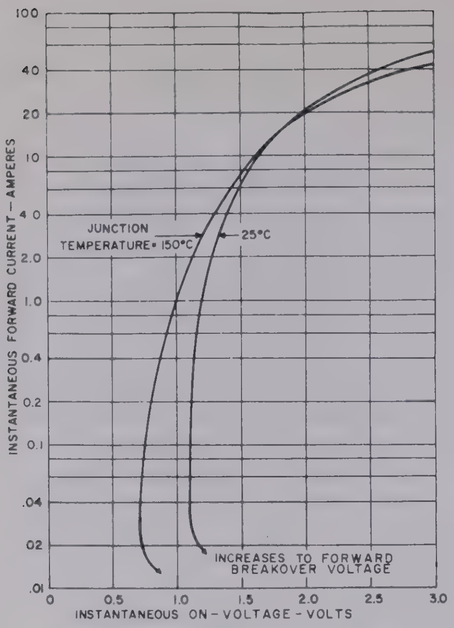
① 10-32 STEEL NUT CADMIUM PLATED

② LOCKWASHER, CADMIUM PLATED STEEL

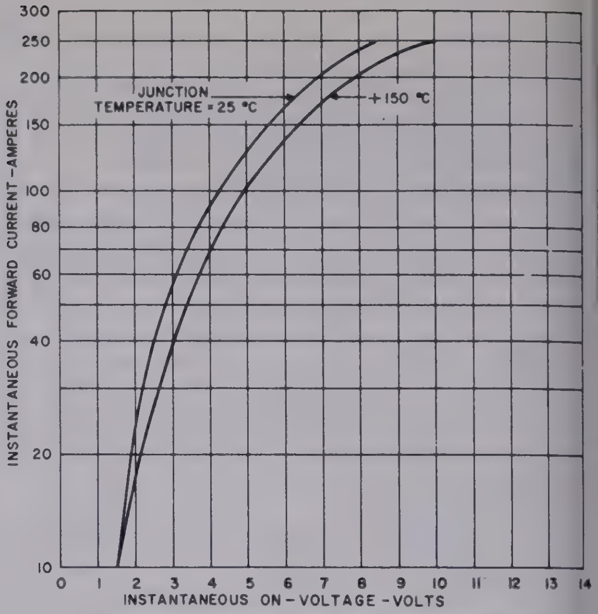
NOTES:

(1) Contour and orientation of fixed terminal lugs are optional.
(2) The outline contour (with exception of hexagon) is optional within zone defined by ϕD and J.
(3) Minimum diameter of seating plane.
(4) A chamfer (or undercut) on one or both ends of hexagonal portion is optional.
(5) Minimum difference in terminal lengths to establish datum line for numbering terminals.
(6) Pitch diameter—thread 10-32 NF-2A (Coated). Reference (Screw Thread Standards for Federal Services 1957) Handbook 1957 H28.
(7) Minimum spacing between terminals.
(8) Insulating kit available upon request.

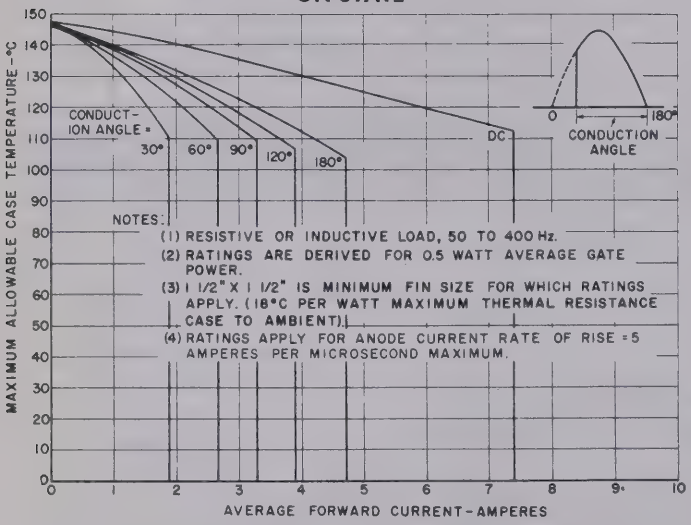
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	.300	.400	7.62	10.16	
B	.080	.136	2.03	3.45	1
ϕD		.424		10.77	2
ϕD₁	.400		10.16		3, 4
E	.424	.437	10.77	11.10	
e	.013		.330		7
e₁	.060		1.52		5
F	.060	.175	1.52	4.45	4
J	.700	.855	17.78	21.72	2
ϕM	.163	.189	4.14	4.80	
N	.400	.453	10.16	11.51	
N₁		.078		1.98	
ϕT	.040	.075	1.02	1.91	
ϕW	.1658	.1697	4.212	4.310	6



1 MAXIMUM FORWARD CHARACTERISTICS— ON-STATE

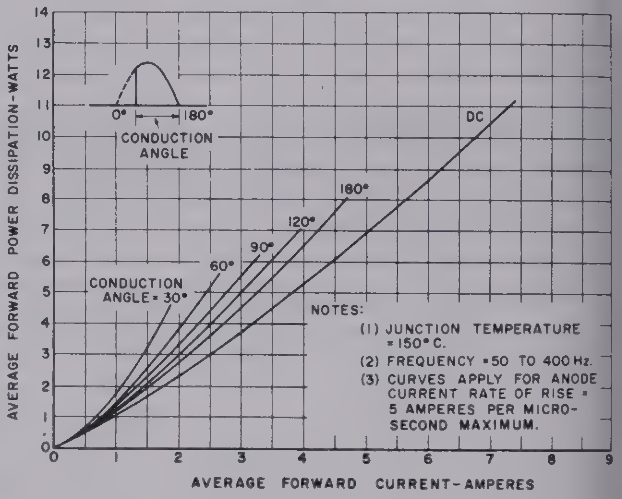


2 MAXIMUM FORWARD CHARACTERISTICS, HIGH CURRENT LEVEL—ON-STATE



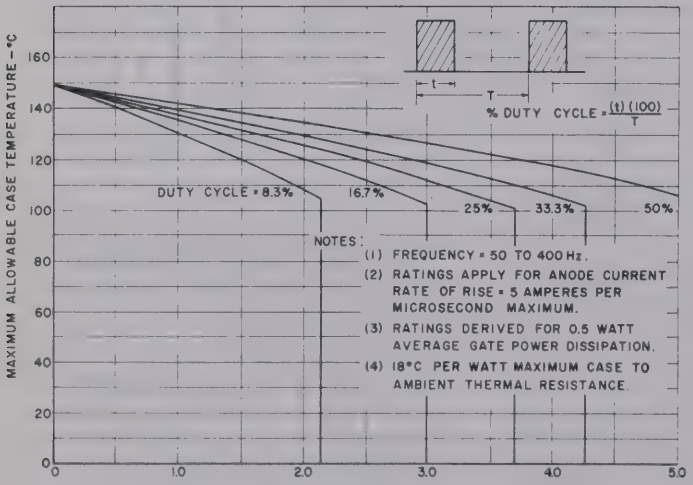
NOTES:
(1) RESISTIVE OR INDUCTIVE LOAD, 50 TO 400 Hz.
(2) RATINGS ARE DERIVED FOR 0.5 WATT AVERAGE GATE POWER.
(3) 1 1/2" X 1 1/2" IS MINIMUM FIN SIZE FOR WHICH RATINGS APPLY. (18°C PER WATT MAXIMUM THERMAL RESISTANCE CASE TO AMBIENT).
(4) RATINGS APPLY FOR ANODE CURRENT RATE OF RISE = 5 AMPERES PER MICROSECOND MAXIMUM.

3 MAXIMUM ALLOWABLE CASE TEMPERATURE FOR HALF WAVE RECTIFIED SINE WAVE OF CURRENT



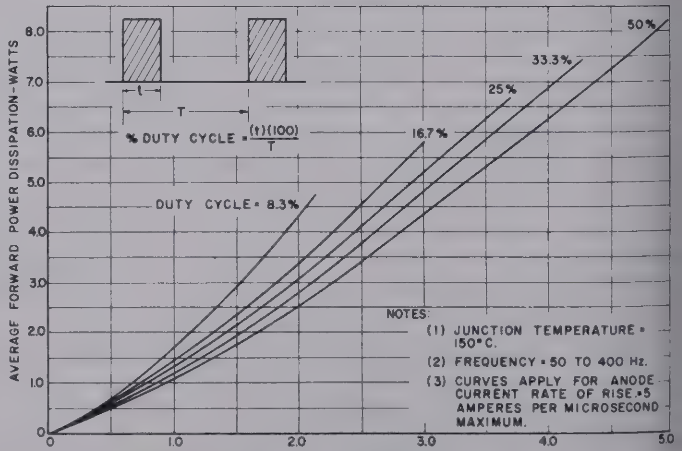
NOTES:
(1) JUNCTION TEMPERATURE = 150° C.
(2) FREQUENCY = 50 TO 400 Hz.
(3) CURVES APPLY FOR ANODE CURRENT RATE OF RISE = 5 AMPERES PER MICROSECOND MAXIMUM.

4 FORWARD POWER DISSIPATION FOR HALF WAVE RECTIFIED SINE WAVE OF CURRENT



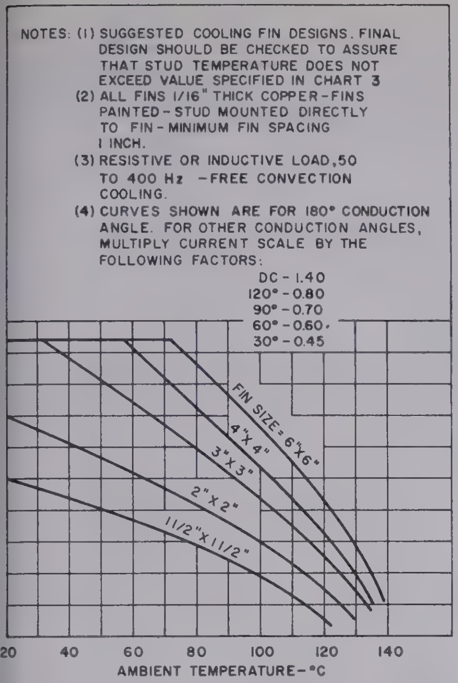
NOTES:
(1) FREQUENCY = 50 TO 400 Hz.
(2) RATINGS APPLY FOR ANODE CURRENT RATE OF RISE = 5 AMPERES PER MICROSECOND MAXIMUM.
(3) RATINGS DERIVED FOR 0.5 WATT AVERAGE GATE POWER DISSIPATION.
(4) 18°C PER WATT MAXIMUM CASE TO AMBIENT THERMAL RESISTANCE.

5 MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



NOTES:
(1) JUNCTION TEMPERATURE = 150° C.
(2) FREQUENCY = 50 TO 400 Hz.
(3) CURVES APPLY FOR ANODE CURRENT RATE OF RISE = 5 AMPERES PER MICROSECOND MAXIMUM.

6 FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM


NOTES: (1) SUGGESTED COOLING FIN DESIGNS. FINAL DESIGN SHOULD BE CHECKED TO ASSURE THAT STUD TEMPERATURE DOES NOT EXCEED VALUE SPECIFIED IN CHART 3

(2) ALL FINS 1/16" THICK COPPER-FINS PAINTED-STUD MOUNTED DIRECTLY TO FIN-MINIMUM FIN SPACING 1 INCH.

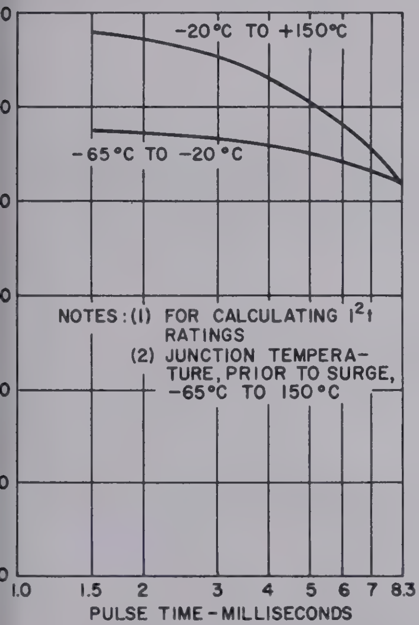
(3) RESISTIVE OR INDUCTIVE LOAD, 50 TO 400 Hz -FREE CONVECTION COOLING.

(4) CURVES SHOWN ARE FOR 180° CONDUCTION ANGLE. FOR OTHER CONDUCTION ANGLES, MULTIPLY CURRENT SCALE BY THE FOLLOWING FACTORS:

DC - 1.40
120° - 0.80
90° - 0.70
60° - 0.60
30° - 0.45

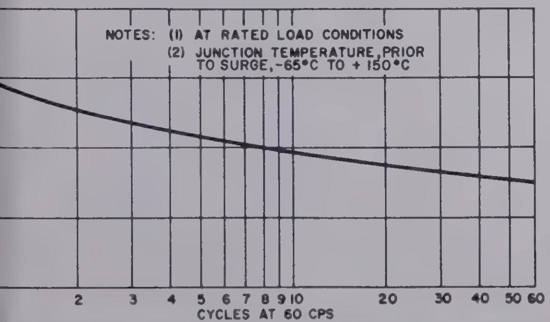
FIN SIZE = 6"X6"
4"X4"
3"X3"
2"X2"
11/2"X11/2"
20
40
60
80
100
120
140
AMBIENT TEMPERATURE-°C

AXIMUM FORWARD CURRENT VS. AMBIENT TEMPERATURE FOR VARIOUS FIN SIZES


NOTES: (1) FOR CALCULATING I^2t RATINGS

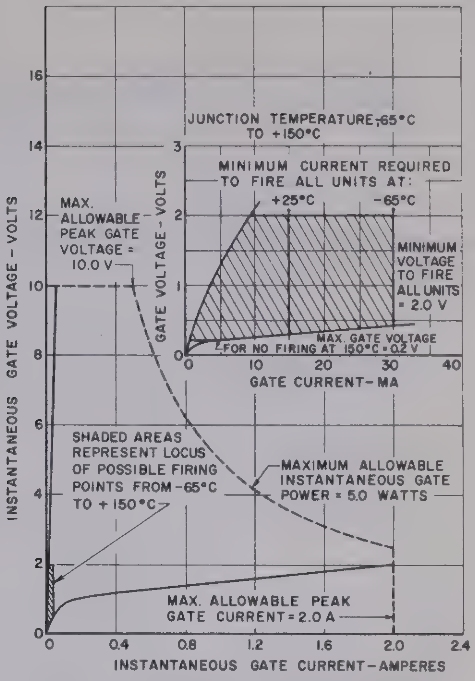
(2) JUNCTION TEMPERATURE, PRIOR TO SURGE, -65°C TO 150°C

MAXIMUM ALLOWABLE NON-RECURRENT SUB-CYCLE SURGE CURRENT RATING

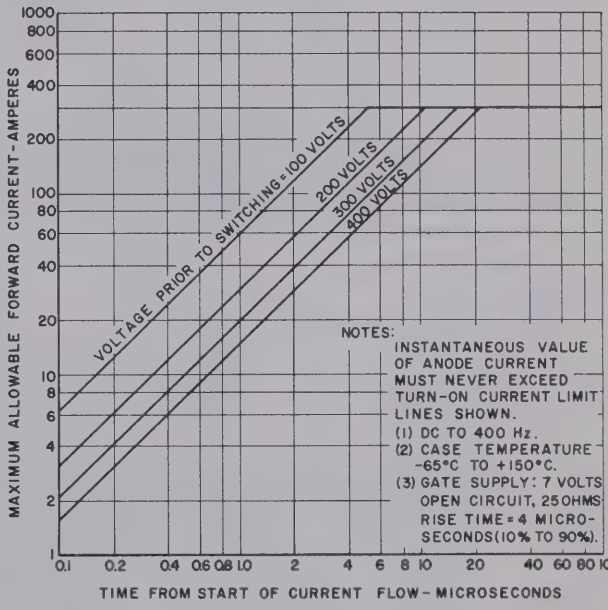

NOTES: (1) AT RATED LOAD CONDITIONS

(2) JUNCTION TEMPERATURE, PRIOR TO SURGE, -65°C TO + 150°C

1 MAXIMUM ALLOWABLE NON-RECURRENT PEAK SURGE FORWARD CURRENT



8 TRIGGERING CHARACTERISTICS


NOTES:

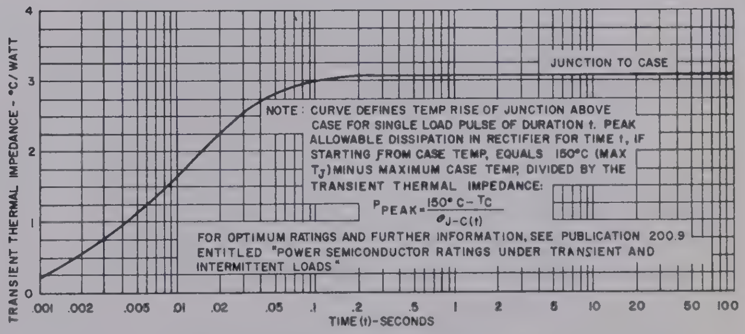
INSTANTANEOUS VALUE OF ANODE CURRENT MUST NEVER EXCEED TURN-ON CURRENT LIMIT LINES SHOWN.

(1) DC TO 400 Hz.

(2) CASE TEMPERATURE -65°C TO +150°C.

(3) GATE SUPPLY: 7 VOLTS OPEN CIRCUIT, 25 OHMS RISE TIME = 4 MICROSECONDS (10% TO 90%).

10 TURN-ON CURRENT LIMIT


NOTE: CURVE DEFINES TEMP RISE OF JUNCTION ABOVE CASE FOR SINGLE LOAD PULSE OF DURATION t. PEAK ALLOWABLE DISSIPATION IN RECTIFIER FOR TIME t, IF STARTING FROM CASE TEMP, EQUALS 150°C (MAX T_J) MINUS MAXIMUM CASE TEMP, DIVIDED BY THE TRANSIENT THERMAL IMPEDANCE:

$$P_{PEAK} = \frac{150° C - T_C}{\theta_{J-C(t)}}$$

FOR OPTIMUM RATINGS AND FURTHER INFORMATION, SEE PUBLICATION 200.9 ENTITLED "POWER SEMICONDUCTOR RATINGS UNDER TRANSIENT AND INTERMITTENT LOADS"

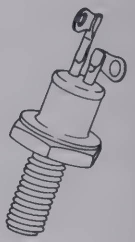
TRANSIENT THERMAL IMPEDANCE - °C/WATT
0
1
2
3
4
JUNCTION TO CASE
.001
.002
.005
.01
.02
.05
.1
.2
.5
1
2
5
10
20
50
100
TIME (t)-SECONDS

12 MAXIMUM TRANSIENT THERMAL IMPEDANCE

SCR

C11 SERIES
2N1770-78,
2N2619

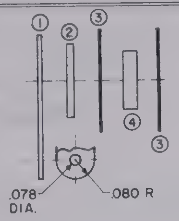
The C11 Silicon Controlled Rectifier is a three junction semiconductor device for use in low power switching and control applications requiring blocking voltages up to 600 volts and RMS load currents up to 7.4 amperes.



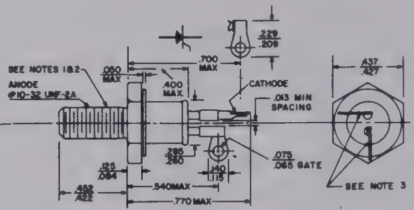
- Broad Voltage Range (Up to 600V)
- Long Electical Creepage Path
- Over Three Years of Successful Field Experience
- No Gate Bias Required
- High Gate Sensitivity

① COPPER TERMINAL, .016 THICK, TIN PLATED
② BRASS WASHER, .035 THICK NICKEL PLATED
③ MICA WASHERS, TWO, .625 O.D., .204 I.D., .005 THICK
④ TEFLON WASHER, .270 O.D. .204 I.D., .050 THICK
* AVAILABLE UPON REQUEST

INSULATING HARDWARE KIT*



① 10-32 STEEL NUT CADMIUM PLATED
② LOCKWASHER, CADMIUM PLATED STEEL



NOTES · 1. COMPLETE THREADS EXTEND TO WITHIN 2-1/2 THREADS OF HEAD
2. DIAMETER OF UNTHREADED PORTION .190 MAX.
3. ANGULAR ORIENTATION OF THESE TERMINALS IS UNDEFINED.
4. CASE IS ANODE CONNECTION.
5. ALL DIMENSIONS IN INCHES.

Type	Minimum Forward Breakover Voltage (V_{BO})† $T_J = -65°C$ to $+125°C$	Repetitive Peak Reverse Voltage (PRV)† $T_J = -65°C$ to $+125°C$	Transient Peak Reverse Voltage (Non-recurrent < 5 Millisec.)† $T_J = -65°C$ to $+125°C$
C11U (2N1770)	25 Volts*	25 Volts*	40 Volts*
C11F (2N1771)	50 Volts*	50 Volts*	75 Volts*
C11A (2N1772)	100 Volts*	100 Volts*	150 Volts*
C11G (2N1773)	150 Volts*	150 Volts*	225 Volts*
C11B (2N1774)	200 Volts*	200 Volts*	300 Volts*
C11H (2N1775)	250 Volts*	250 Volts*	350 Volts*
C11C (2N1776)	300 Volts*	300 Volts*	400 Volts*
C11D (2N1777)	400 Volts*	400 Volts*	500 Volts*
C11E (2N1778)	500 Volts*	500 Volts*	600 Volts*
C11M (2N2619)	600 Volts*	600 Volts*	720 Volts*

†Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for which maximum PRV ratings apply equals 18°C/watt.

MAXIMUM ALLOWABLE RATINGS

Repetitive Peak Forward Blocking Voltage (PFV)	(C11U thru C11D)	480	Volts
	(C11E and C11M)	720	Volts
RMS Forward Current	(All conduction angles)	7.4	Amperes
Average Forward Current (I_O)	4.7 Amperes* at 60°C Case (Half Wave Rectified) For other operating conditions see Chart 3.		
Peak One Cycle Non-recurrent Surge Current (i_{surge})		60	Amperes*
Peak Surge Current During Turn-on Time Interval		See Chart 7	
I^2t (for fusing)		Calculate from Chart 8	
Peak Gate Power (p_G)		5	Watts*
Average Gate Power (P_G)		0.5	Watt*
Peak Gate Current (i_G)		2.0	Amperes*
Peak Gate Voltage (v_G) (Forward and Reverse)		10	Volts*
Operating Temperature		−65°C to +125°C*	
Storage Temperature		−65°C to +150°C*	
Stud Torque		15	inch-pounds

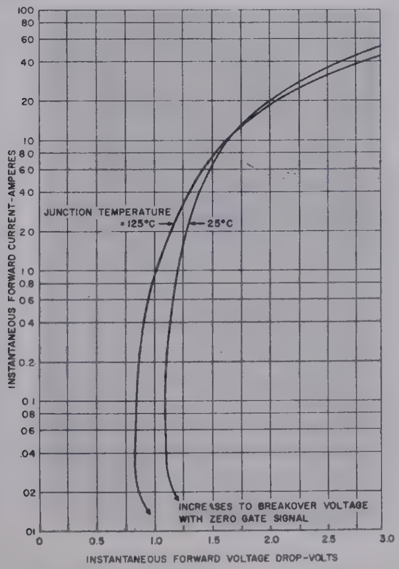
*Indicates data included on JEDEC type number registration.

CHARACTERISTICS

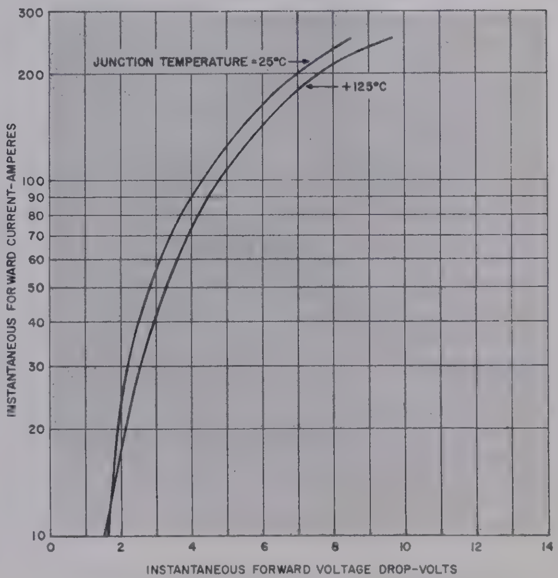
Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Peak Reverse and Forward Blocking Current†	i_R and i_S					$T_J = 125°C$, Gate Open
C11U (2N1770)		——	4.5	9.0	ma	$v_{AC} = v_{CA} =$ 25 Volts Peak
C11F (2N1771)		——	4.5	9.0	ma	50
C11A (2N1772)		——	4.5	9.0	ma	100
C11G (2N1773)		——	4.0	8.0	ma	150
C11B (2N1774)		——	3.0	6.0	ma	200
C11H (2N1775)		——	2.5	5.0	ma	250
C11C (2N1776)		——	1.5	4.0	ma	300
C11D (2N1777)		——	1.0	2.0	ma	400
C11E (2N1778)		——	1.0	2.0	ma	500
C11M (2N2619)		——	1.0	2.0	ma	600
Full Cycle Avg. Reverse and Forward Blocking Current†	$I_{R(AV)}$ and $I_{S(AV)}$					$T_C = 60°C$, $I_O = 4.7A$, half sine wave 180° Conduction Angle
C11U (2N1770)		——	2.3	4.5*	mAdc	$v_{AC} = v_{CA} =$ 25 Volts Peak
C11F (2N1771)		——	2.3	4.5*	mAdc	50
C11A (2N1772)		——	2.3	4.5*	mAdc	100
C11G (2N1773)		——	2.0	4.0*	mAdc	150
C11B (2N1774)		——	1.5	3.0*	mAdc	200
C11H (2N1775)		——	1.3	2.5*	mAdc	250
C11C (2N1776)		——	0.8	2.0*	mAdc	300
C11D (2N1777)		——	0.5	1.0*	mAdc	400
C11E (2N1778)		——	0.5	1.0*	mAdc	500
C11M (2N2619)		——	0.5	1.0*	mAdc	600
Gate Current to Fire	I_{GF}	——	10	15	mAdc	$V_{AC} = 12$Vdc, $T_J = 25°C$, $R_L = 250$ ohms
		——	20	30*	mAdc	$V_{AC} = 12$Vdc, $T_J = -65°C$, $R_L = 250$ ohms
		——	4	8	mAdc	$V_{AC} = 12$Vdc, $T_J = 125°C$, $R_L = 250$ ohms
Gate Voltage to Fire	V_{GF}	——	1.3	2.0*	Vdc	$V_{AC} = 12$ Vdc, $T_J = -65°$ to $+ 125°C$, $R_L = 250$ ohms
		0.3*	0.7	——	Vdc	$v_{AC} =$ Rated, $T_J = 125°C$, $R_L = 250$ ohms
Peak Forward Voltage Drop	v_F	——	1.6	1.85	v	$T_J = 25°C$, $i_F = 15$ a (single sinusoidal pulse, 4 ms wide)
Holding Current	I_H	——	8.0	——	mAdc	Anode Supply = 6 Vdc, $T_J = 25°C$
Turn-on Time	$t_d + t_r$	——	1.0	——	μsec	$T_J = 25°C$, $i_F = 10$ a, $v_{AC} =$ Rated Gate Supply: 7 volt open circuit, 20 ohm, 0.1 μsec max. rise time.
Turn-off Time	t_{off}	——	15	——	μsec	$T_J = 125°C$, $i_F = 5$ a, $i_R = 5$ a v_{AC} (Reapplied) = Rated. Rate of Rise of Reapplied Forward Blocking Voltage = 20 volts per microsecond maximum.
Thermal Resistance	θ_{J-C}	——	1.5	3.1	°C/Watt	Junction to Case.

†Values apply for zero or negative gate voltage. Maximum case to ambient thermal resistance for which maximum PRV ratings apply = 18°C per watt.

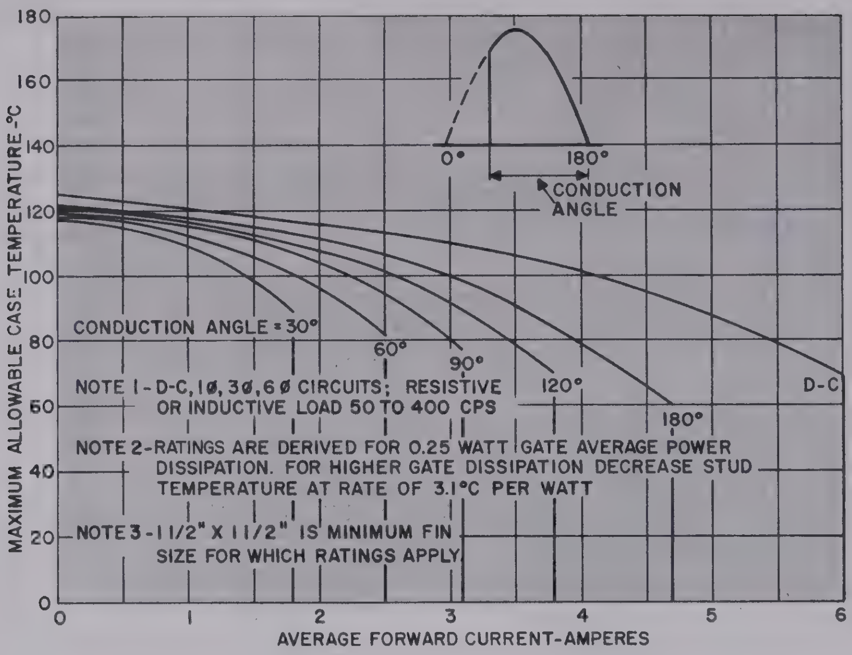
*Indicates data included on JEDEC type number registration.



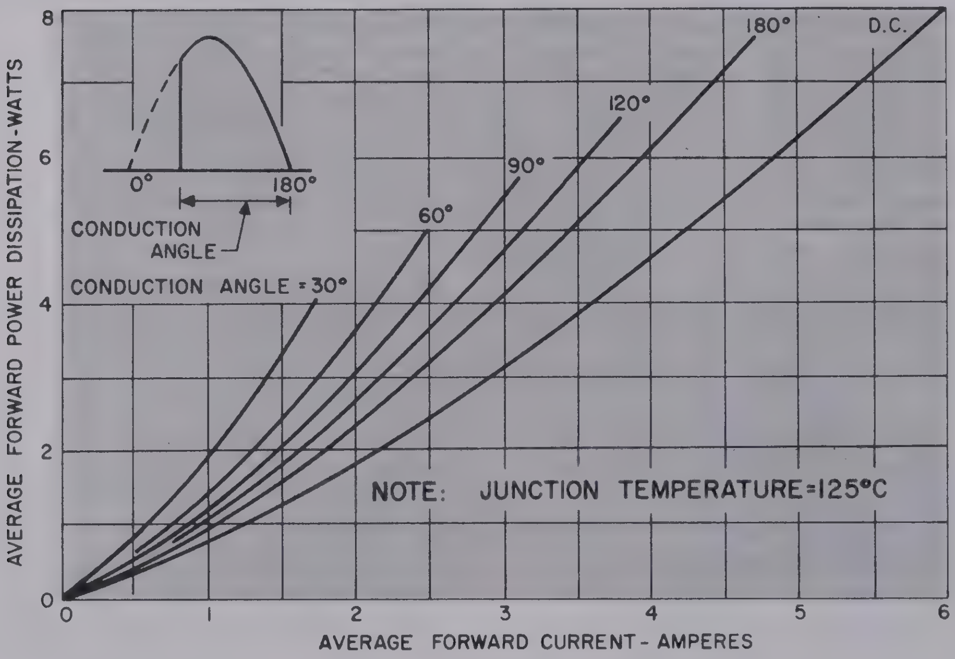
1. MAXIMUM FORWARD CHARACTERISTICS
CONDUCTING STATE



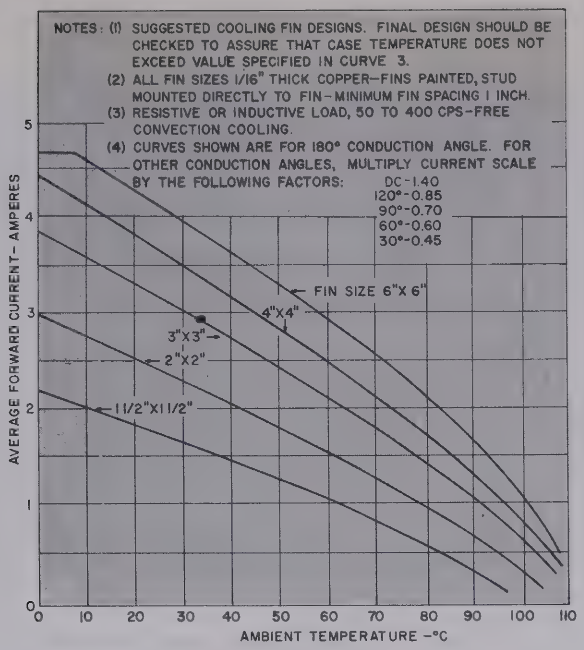
2. MAXIMUM FORWARD CHARACTERISTICS
HIGH CURRENT LEVEL — CONDUCTING STATE



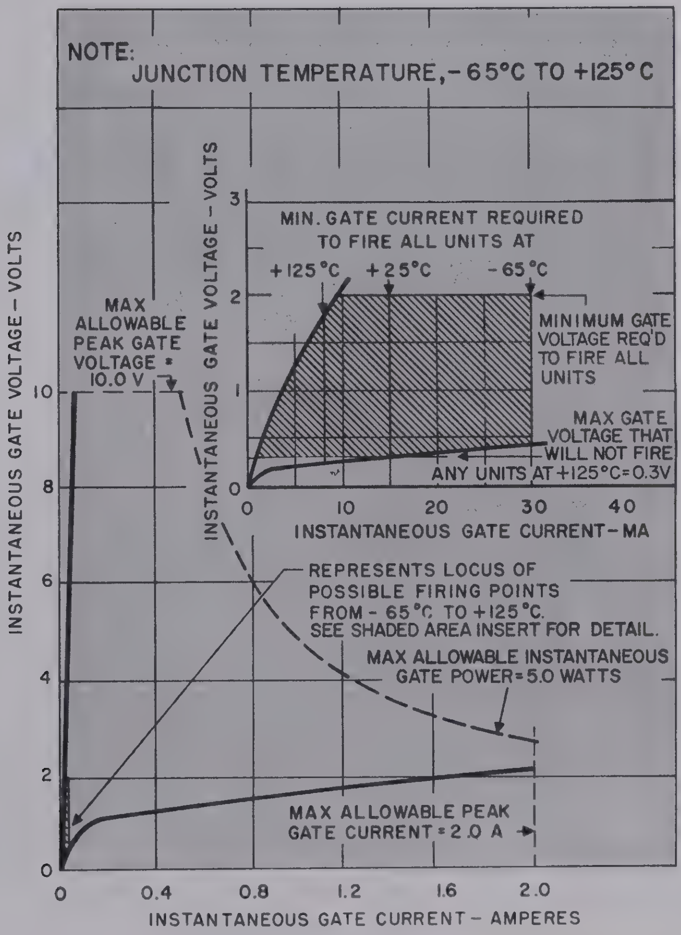
3. MAXIMUM ALLOWABLE CASE TEMPERATURE



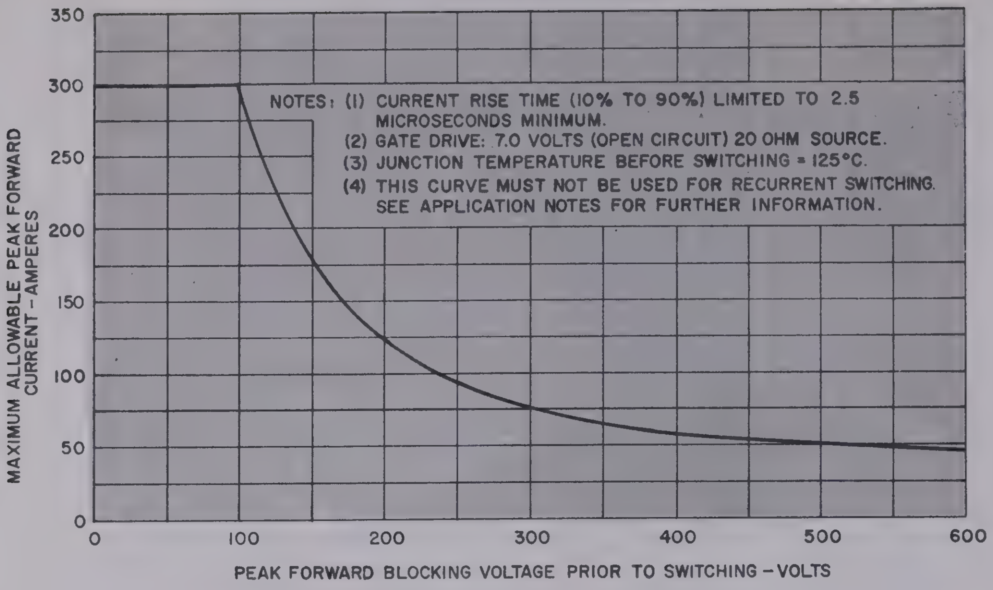
4. FORWARD POWER DISSIPATION



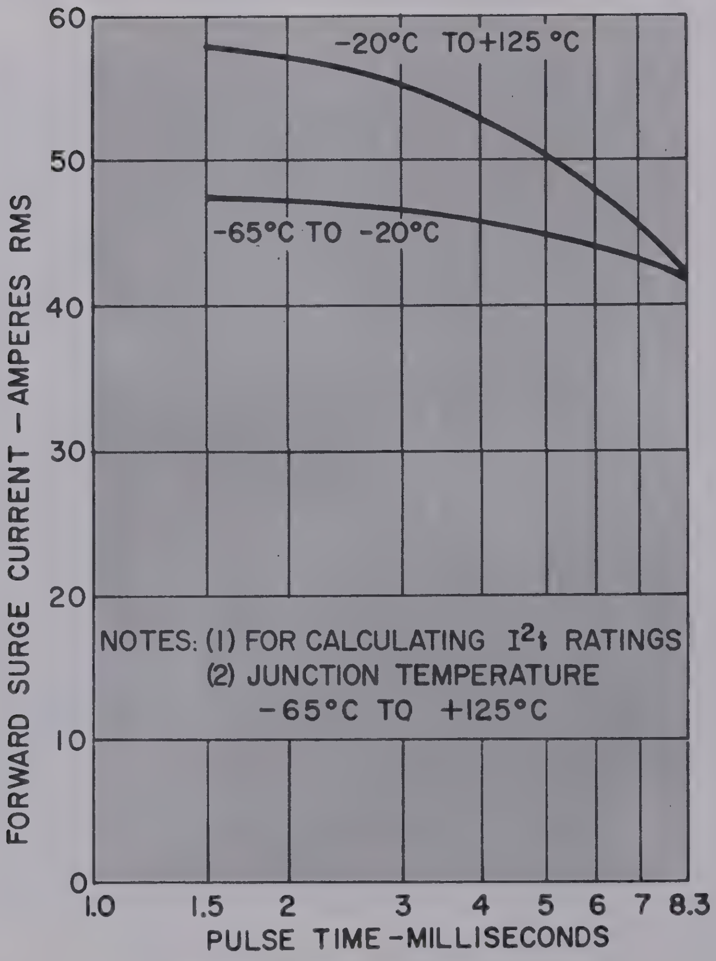
5. MAXIMUM FORWARD CURRENT VS. AMBIENT TEMPERATURE FOR VARIOUS FIN SIZES



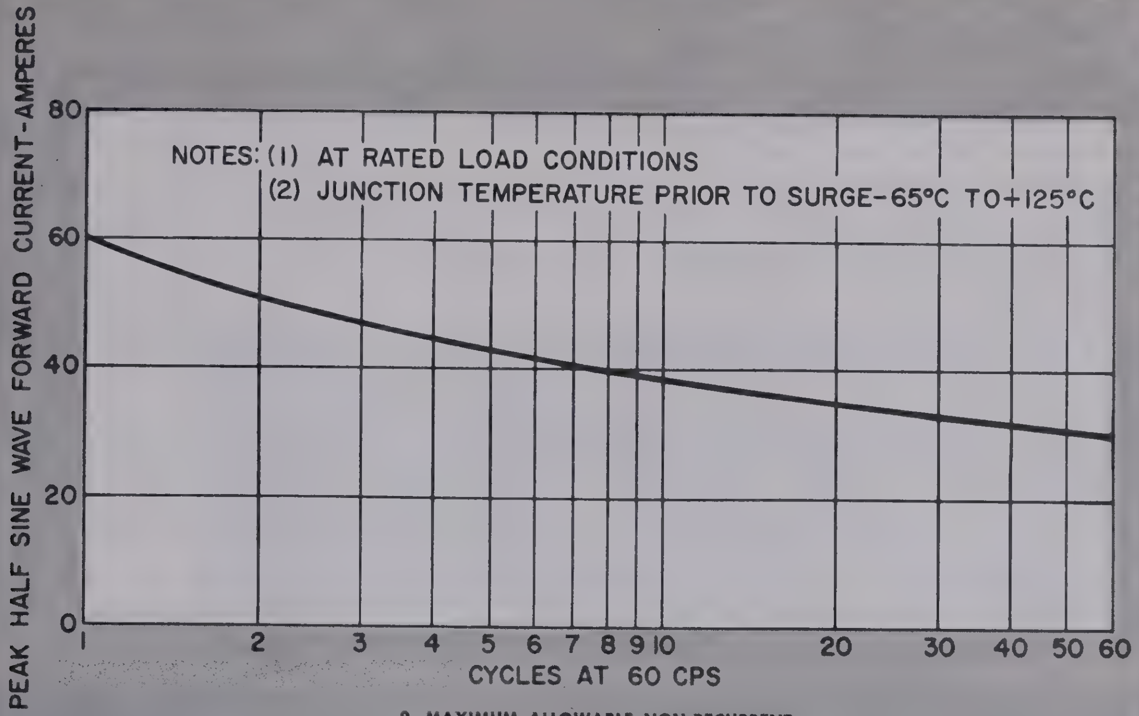
6. FIRING CHARACTERISTICS



7. PEAK NON-RECURRENT SURGE CURRENT DURING TURN-ON TIME INTERVAL

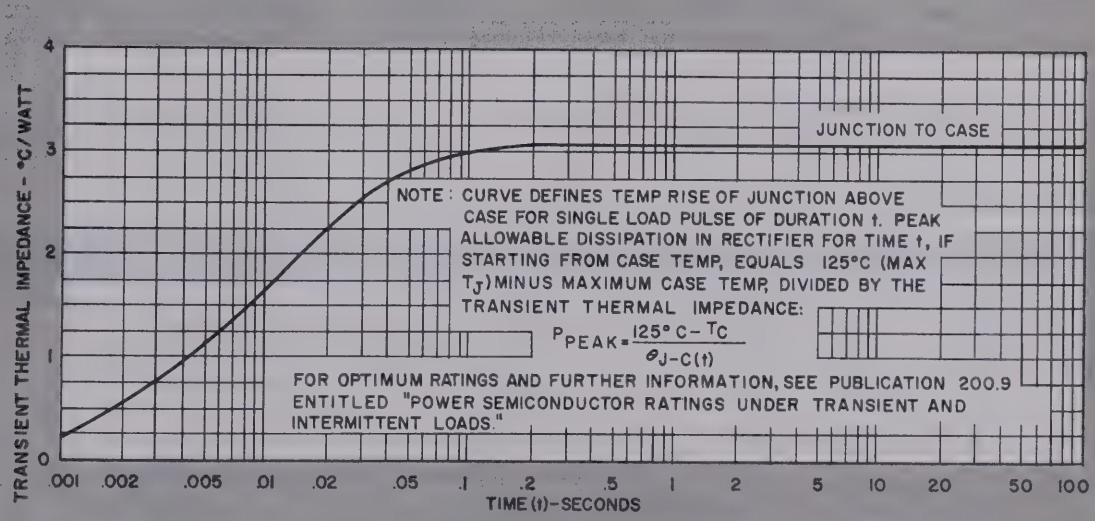


8. MAXIMUM ALLOWABLE NON-RECURRENT SUB-CYCLE SURGE CURRENT RATING



NOTES: (1) AT RATED LOAD CONDITIONS
(2) JUNCTION TEMPERATURE PRIOR TO SURGE-65°C TO+125°C

9. MAXIMUM ALLOWABLE NON-RECURRENT SURGE CURRENT RATING



NOTE: CURVE DEFINES TEMP RISE OF JUNCTION ABOVE CASE FOR SINGLE LOAD PULSE OF DURATION t. PEAK ALLOWABLE DISSIPATION IN RECTIFIER FOR TIME t, IF STARTING FROM CASE TEMP, EQUALS 125°C (MAX T_J) MINUS MAXIMUM CASE TEMP, DIVIDED BY THE TRANSIENT THERMAL IMPEDANCE:

$$P_{PEAK} = \frac{125° C - T_C}{\theta_{J-C(t)}}$$

FOR OPTIMUM RATINGS AND FURTHER INFORMATION, SEE PUBLICATION 200.9 ENTITLED "POWER SEMICONDUCTOR RATINGS UNDER TRANSIENT AND INTERMITTENT LOADS."

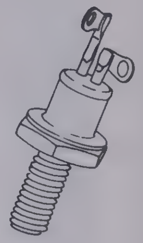
10. MAXIMUM TRANSIENT THERMAL RESISTANCE

SCR

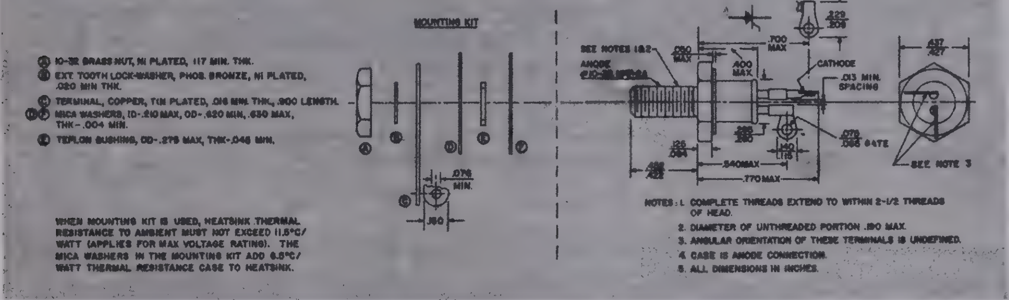
C12 SERIES

7.4A RMS HIGH SPEED TYPE

FEATURES:
- Specially Designed for Inverter, Pulse Modulator, Chopper, Cycloconverter, and Other High Frequency Applications.
- Insured Turn-off Time of Less Than 12 usec.
- Same Top Features of General Electric's Proved, Dependable C11 Series (2N1770-77)
- Wide Voltage Range—Up to 400V.



OUTLINE DRAWING


MOUNTING KIT
Ⓐ 10-32 BRASS NUT, NI PLATED, .117 MIN. THK.
Ⓑ EXT. TOOTH LOCK-WASHER, PHOS. BRONZE, NI PLATED, .020 MIN THK.
Ⓒ TERMINAL, COPPER, TIN PLATED, .016 MIN. THK., .900 LENGTH.
ⒹⒻ MICA WASHERS, ID-.210 MAX, OD-.620 MIN, .630 MAX, THK-.004 MIN.
Ⓔ TEFLON BUSHING, OD-.275 MAX, THK-.046 MIN.
Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ Ⓕ
.076 MIN.
.180
WHEN MOUNTING KIT IS USED, HEATSINK THERMAL RESISTANCE TO AMBIENT MUST NOT EXCEED 11.5°C/WATT (APPLIES FOR MAX VOLTAGE RATING). THE MICA WASHERS IN THE MOUNTING KIT ADD 6.5°C/WATT THERMAL RESISTANCE CASE TO HEATSINK.
SEE NOTES 1&2
ANODE
.050 MAX
.700 MAX
.400 MAX
.229
.209
CATHODE
.013 MIN. SPACING
.437
.427
.076
.066 GATE
.140
.115
.125
.540MAX
.770MAX
SEE NOTE 3
NOTES: 1. COMPLETE THREADS EXTEND TO WITHIN 2-1/2 THREADS OF HEAD.
2. DIAMETER OF UNTHREADED PORTION .190 MAX.
3. ANGULAR ORIENTATION OF THESE TERMINALS IS UNDEFINED.
4. CASE IS ANODE CONNECTION.
5. ALL DIMENSIONS IN INCHES.

TYPE	MINIMUM FORWARD BREAKOVER VOLTAGE $V_{(BR)FO}$* $T_J = -65°C$ to $+125°C$	REPETITIVE PEAK REVERSE VOLTAGE V_{ROM}(rep)* $T_J = -65°C$ to $+125°C$	NON-REPETITIVE PEAK REVERSE VOLTAGE (<5.0 MILLISEC.) V_{ROM}(non-rep)* $T_J = -65°C$ to $+125°C$
C12U	25 Volts	25 Volts	40 Volts
C12F	50 Volts	50 Volts	75 Volts
C12A	100 Volts	100 Volts	150 Volts
C12G	150 Volts	150 Volts	225 Volts
C12B	200 Volts	200 Volts	300 Volts
C12H	250 Volts	250 Volts	350 Volts
C12C	300 Volts	300 Volts	400 Volts
C12D	400 Volts	400 Volts	500 Volts

*Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for which maximum V_{ROM} (rep) ratings apply equals 18°C watt.

MAXIMUM ALLOWABLE RATINGS All maximum allowable ratings for C11 SCR apply with the following addition:
Peak Reverse Recovery Current, I_R (recovery) .... 15 amperes

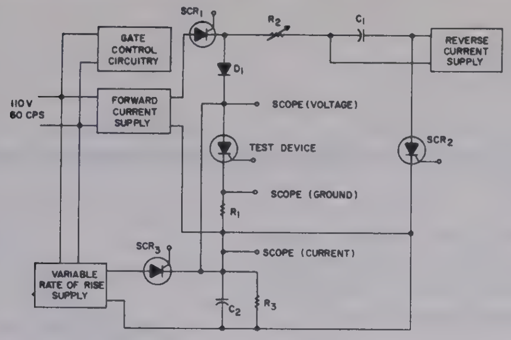
CHARACTERISTICS All characteristics for C11 SCR's apply with the following addition:

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Circuit-Commutated Turn-off Time	t_{off}	—	8	12	μsec	(Refer to Chart 1.) Peak forward current, on-state (I_{FM}) = 5 A.† Peak reverse recovery current I_R(recovery) = 10 A. Peak reverse voltage (V_{RXM}) = rated voltage Reverse voltage (V_{RX}) = 10 V.†† Switching (repetition rate) = 60 pps Rate of rise of re-applied forward blocking voltage (dv/dt) = 20 V/μsec Peak forward blocking voltage (V_{FXM}) = rated voltage Duty Cycle (percent on-time) = .5% Junction temperature = +125°C

†When an SCR is switched into a high anode current, localized junction heating occurs. For reliable operation, the rate of rise of the anode current should be minimized. For further information, consult Application Note 200.28 entitled "The Rating of SCR's When Switching Into High Currents."

††Increasing the magnitude of reverse voltage immediately prior to the reapplication of forward blocking voltage decreases circuit-commutated turn-off time.

SIMPLIFIED CIRCUIT-COMMUTATED TURN-OFF TIME TEST CIRCUIT


SCR1
R2
C1
GATE CONTROL CIRCUITRY
REVERSE CURRENT SUPPLY
D1
110 V 60 CPS
FORWARD CURRENT SUPPLY
SCOPE (VOLTAGE)
TEST DEVICE
SCR2
SCOPE (GROUND)
R1
SCR3
SCOPE (CURRENT)
VARIABLE RATE OF RISE SUPPLY
C2
R3

R1 = Non-Inductive Current Viewing Resistor
R2 = Reverse Current Adjusting Resistor
D1 = Rectifier Diode selected for Reverse Recovery Time longer than Reverse Recovery time of test device, but shorter than Turn-off Time of test device.

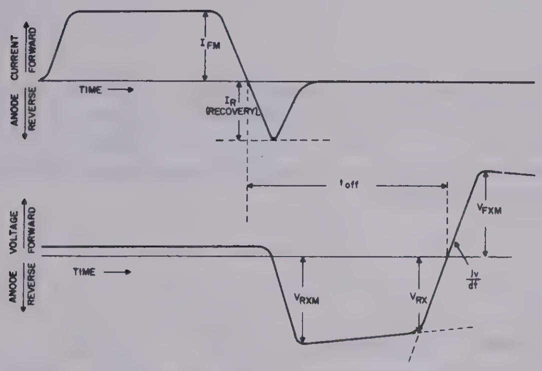
SCR TRIGGERING SEQUENCE

At t = 0, Test Device and SCR1
At t = 50 μsec, SCR2
At t ≧ 50 μsec, SCR3

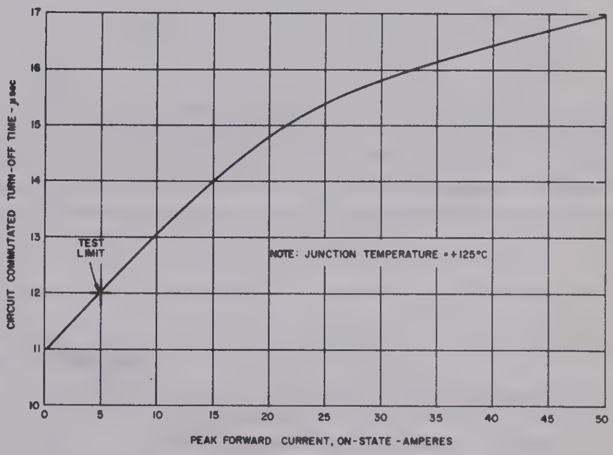
This circuit may be used to determine the circuit-commutated turn-off time of the test SCR. It operates in the following manner:

A specified (see Test Conditions, page 1) forward conduction current is passed through the device for a short period of time. The anode circuit is then driven negative, causing reverse current to flow. After sufficient stored charge has recombined or has been swept out of the base regions, the anode to cathode potential will begin to go negative with a corresponding decrease in reverse current. Forward voltage is then applied to the anode of the device and the device has fully recovered when it regains its ability to block the reapplied forward voltage at a specified rate of voltage rise.

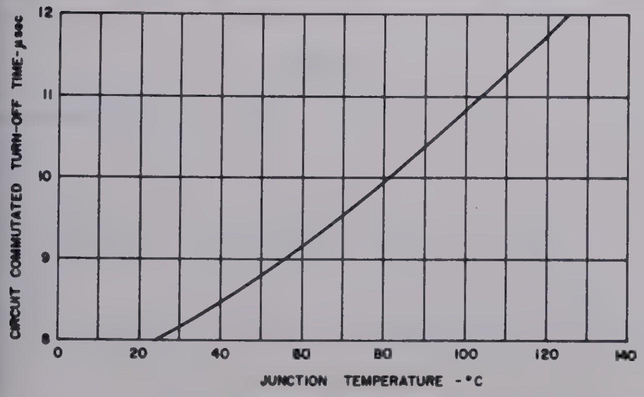
For further information, see Application Note 200.15 entitled, "Turn-Off Time Characterization and Measurement of Silicon Controlled Rectifiers."


ANODE CURRENT
FORWARD
REVERSE
TIME
I FM
I R (RECOVERY)
t off
ANODE VOLTAGE
FORWARD
REVERSE
TIME
V FXM
V RXM
V RX
dv/dt

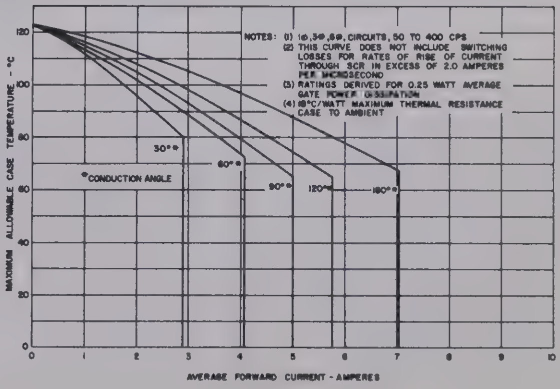
1. CIRCUIT-COMMUTATED TURN-OFF TIME WAVEFORMS



2. MAXIMUM CIRCUIT COMMUTATED TURN-OFF TIME VS PEAK FORWARD CURRENT, ON-STATE



3. MAXIMUM CIRCUIT-COMMUTATED TURN-OFF TIME VS JUNCTION TEMPERATURE

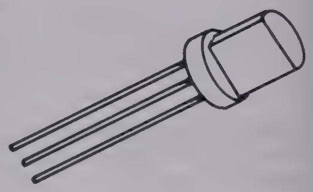


4. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM

SCR

C13

The General Electric C13 Complementary Silicon Controlled Rectifier (CSCR) is a three-terminal, planar-passivated PNPN device in the standard, low-cost plastic TO-98 JEDEC package. As CSCR's, the C13F and the C13Y offer greater flexibility in circuit design through the use of the anode gate. The three leads are designatd as anode, anode gate and cathode.

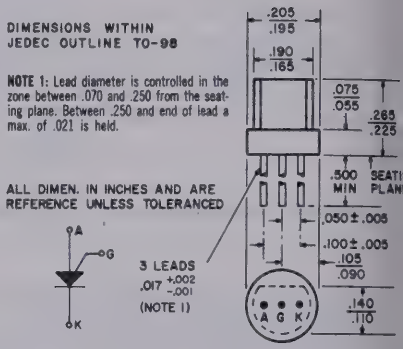


Outstanding Features

- Planar Passivated Structure
- Low Leakage Current
- Low Triggering Current
- Low Forward Voltage Drop
- Low Cost
- High Gate Breakdown Voltage

Applications

- Automotive Switching
- SCR Triggering
- Ring Counters
- Level Detectors
- Fuse Circuits
- Miniature Lamp Drivers
- Low Level Logic
- Memory Circuits


DIMENSIONS WITHIN JEDEC OUTLINE TO-98

NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

The C13 CSCR operates similarly to the conventional SCR. The major difference is that the device is turned on by forward biasi the junction between the anode and the anode gate. The voltage on the anode gate is made negative with respect to the voltage on t anode. "Conventional" SCR's are turned on by injecting current into the lower p-base (cathode gate), while those that are turn on through the upper n-base (anode gate) are called "complementary" SCR's. A four-terminal, Silicon Controlled Switch (SCS) h connections to both bases and either, or both, bases may be used to initiate switching.

MAXIMUM ALLOWABLE RATINGS

Types	Peak Forward Blocking Voltage, V_{DWM} (R_{GA} = 1K)	Working and Repetitive Peak Reverse Voltage, V_{RWM} & V_{RRM} (Open Gate)	Non-Repetitive Peak Reverse Voltage, V_{RSM} (Open Gate)
C13Y	30 volts	30 volts	30 volts
C13F	50 volts	50 volts	50 volts

*Reverse Blocking Voltage, V_{RM} (Finite gate resistance)	5 Vol
Continuous Forward Current, I_{TM}	250 Milliamper
Peak Forward Current, I_{TRM} (10 μsec., 1% Duty Cycle, 100°C)	3 Amper
Peak Forward Current, I_{TRM} (100 μsec., 1% Duty Cycle, 100°C)	1 Ampe
Peak Forward Surge Current, I_{TSM} (non-repetitive, 5 μsec., 25°C)	10 Amper
Peak Forward Gate Current, I_{GM}	50 Milliamper
Peak Reverse Gate Current, I_{GM}	50 Milliamper
Peak Reverse Gate Voltage, V_{GM}	30 Vol
Average Gate Power Dissipation, $P_{G(AV)}$	10 Milliwat
Storage Temperature, T_{STG}	−65°C to +150
Operating Temperature	−55°C to +100
Total Power, P_T (Derate linearly to 0 at 100°C)	450 m

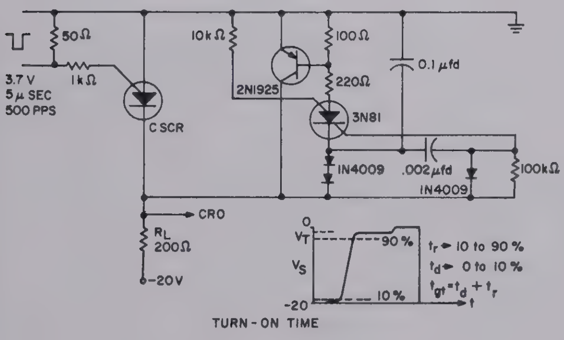
*When used on AC operation with finite gate resistance, a diode must be added in series with the cathode to absorb the reverse voltage.

CHARACTERISTICS

(at 25°C, unless otherwise noted)

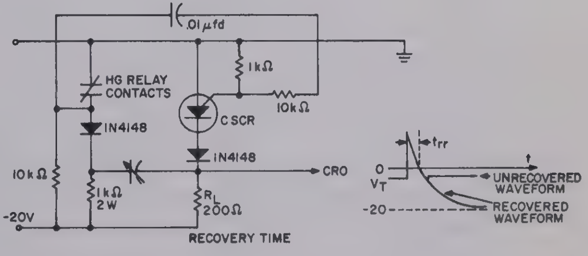
Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Forward Blocking Current	I_D	—	.01	0.10	μA	V_D = rated, R_G = 1K
		—	0.10	100		V_D = rated, R_G = 1K, T_A = 100°C
Reverse Blocking urrent	I_R	—	.001	0.10		V_R = rated, Open Gate
		—	.10	100		V_R = rated, Open Gate, T_A = 100°C
ate Trigger urrent*	I_{GT}	—	.05	—		V_D = 6 volts, R_L = 100 ohms
		—	2.0	20		V_D = 6 volts, R_L = 100 ohms, T_A = −55°C
ate Trigger oltage**	V_{GT}	—	0.45	0.60	Volts	V_D= 6 volts, R_L = 100 ohms
		—	0.25	0.40		V_D= 6 volts, R_L = 100 ohms, T_A = 100°C
orward oltage rop	V_T	—	1.4	1.8		I_T = 250mA
		—	1.4	—		I_T = 250 mA, T_A = 100°C
olding urrent	I_H	—	0.70	—	mA	R_G = 1K
		—	0.42	—		R_G = 1K, T_A = 100°C
urn-On ime	t_{gt}	—	—	0.10	μsec	see Circuit A
ecovery ime	t_{rr}	—	—	10		see Circuit B

T measured using current source. **V_{GT} measured using voltage source.



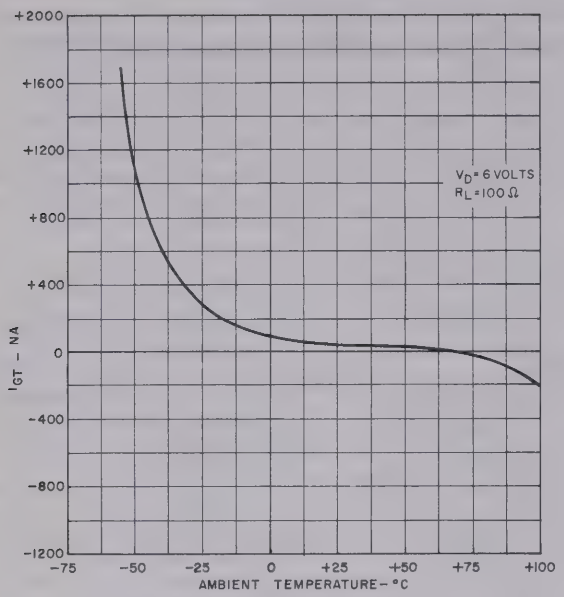
50Ω
3.7 V
5 µ SEC
500 PPS
1kΩ
C SCR
10kΩ
2N1925
100Ω
220Ω
3N81
0.1 µfd
IN4009
.002µfd
IN4009
100kΩ
CRO
R_L
200Ω
−20V
0
V_T
V_S
90 %
10 %
-20
t
t_r → 10 to 90 %
t_d → 0 to 10 %
t_{gt} = t_d + t_r
TURN - ON TIME

CIRCUIT A

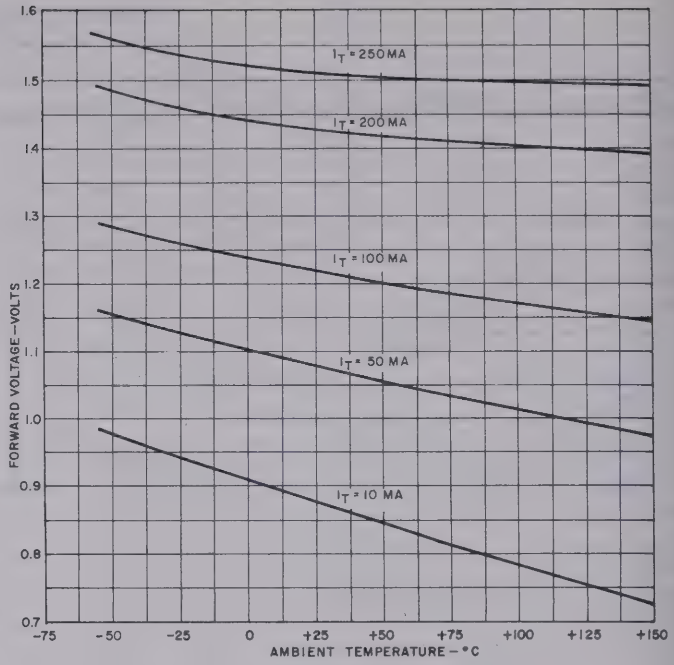


.01 µfd
1kΩ
HG RELAY CONTACTS
10kΩ
C SCR
IN4148
IN4148
CRO
10kΩ
1kΩ 2W
R_L 200Ω
-20V
RECOVERY TIME
t_{rr}
t
0
V_T
-20
UNRECOVERED WAVEFORM
RECOVERED WAVEFORM

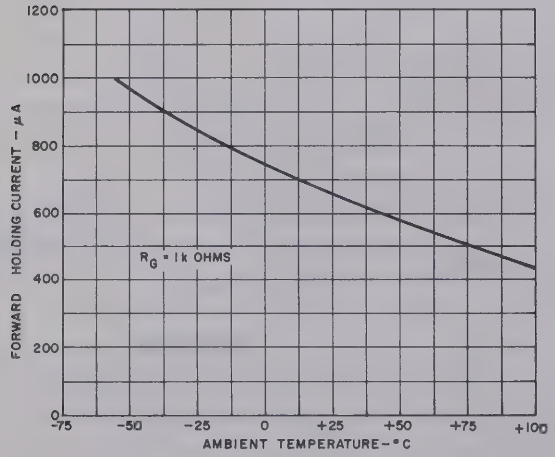
CIRCUIT B



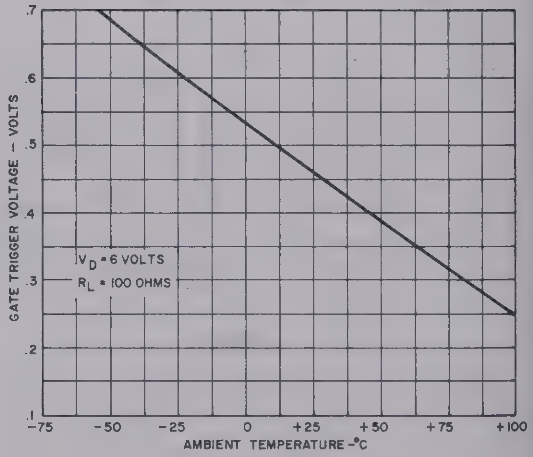
1. **TYPICAL GATE TRIGGER CURRENT vs. AMBIENT TEMPERATURE**



2. **TYPICAL FORWARD BLOCKING VOLTAGE AND ANODE CURRENT vs. AMBIENT TEMPERATURE**

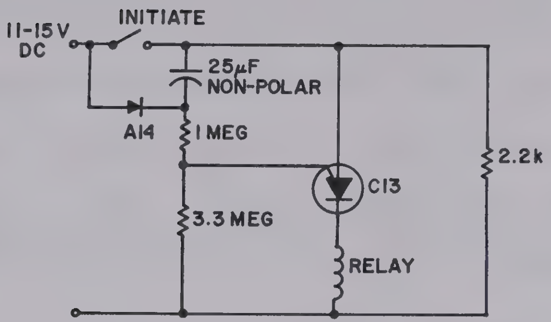


3. **TYPICAL FORWARD HOLDING CURRENT vs. AMBIENT TEMPERATURE**



4. **TYPICAL GATE TRIGGER VOLTAGE vs. AMBIENT TEMPERATURE**

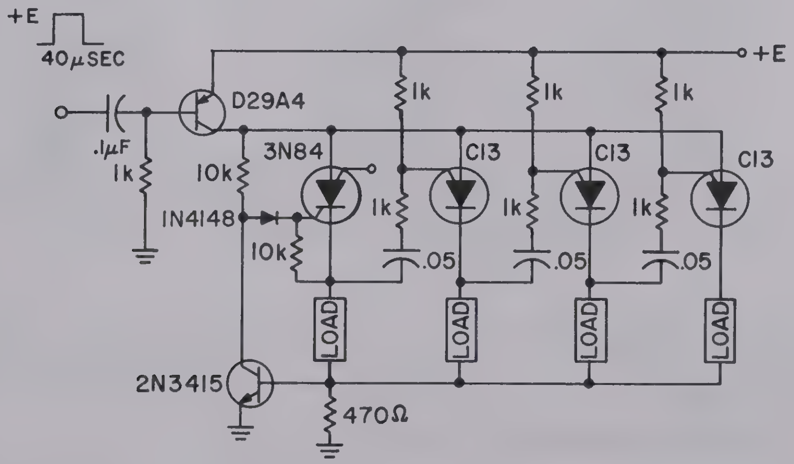
APPLICATIONS


INITIATE
11-15V DC
25μF NON-POLAR
A14
1 MEG
2.2k
C13
3.3 MEG
RELAY

TIME DELAY 40-60 SECS WITH COMPONENTS SHOWN

C13 DOUBLES AS TIMING THRESHOLD AND LOAD DRIVER

s circuit is an interesting twist in timers. Here the C13 is used as both the sensitive timing element *and* the load driver. Power is lied to the circuit with the initiate switch open circuited. The 25μF capacitor charges through the A14 diode and 2.2K resistor to supply voltage. When the initiate switch is closed, the "low" side of the capacitor is suddenly raised to +12. This raises the diode e of the capacitor to approximately +24. The capacitor immediately begins discharging through the 1 meg in series with 3.3 megs. entually, the C13 gate becomes forward biased and the device turns on thereby applying power to the relay. The delay is virtually ependent of supply voltage.


+E
40μSEC
.1μF
1k
D29A4
+E
1k
1k
1k
10k
3N84
C13
C13
C13
1N4148
10k
1k
1k
1k
.05
.05
.05
LOAD
LOAD
LOAD
LOAD
2N3415
470Ω

LOW COST RING COUNTER

's can also be used for ordinary thyristor applications. This ring counter makes an efficient, low cost circuit featuring automatic etting via the first stage 3N84. As many stages as desired may be cascaded.

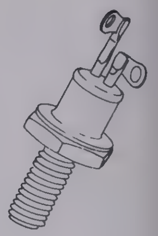
SCR

C15 SERIES

The General Electric C15 Series Silicon Controlled Rectifier is a reverse blocking triode thyristor semiconductor device for use in power switching and phase control applications requiring blocking voltages up to 600 volts, and RMS load currents up to 8.0 amperes.

This series device is particularly suitable for high-volume, consumer/industrial applications.

The following G. E. Co., low-current SCR types are also available in the same package outline:



C10 (2N1770A-2N1777A) (Pub. #150.20)—$T_J = 150°C$, up to 400V PRV
(JAN Types 2N1770A-2N1777A to MIL-S-19500/168B also available)
C11 (2N1770-2N1778, 2N2619) (Pub. #150.21)—$T_J = 125°C$, up to 600V PRV

MAXIMUM ALLOWABLE RATINGS

TYPE	PEAK FORWARD BLOCKING VOLTAGE, V_{FOM} $T_C = -65°C$ to $+105°C$	PEAK FORWARD VOLTAGE, PFV $T_C = -65°C$ to $+105°C$	WORKING AND REPETITIVE PEAK REVERSE VOLTAGE V_{ROM} (wkg) and V_{ROM} (rep)$^{(1)}$ $T_C = -65°C$ to $+105°C$	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{ROM} (non-rep) (<5 Millisec.)$^{(1)}$ $T_C = -65°C$ to $+105°C$
C15U	25 volts	480 volts	25 volts	40 volts
C15F	50 volts	480 volts	50 volts	75 volts
C15A	100 volts	480 volts	100 volts	150 volts
C15G	150 volts	480 volts	150 volts	220 volts
C15B	200 volts	480 volts	200 volts	300 volts
C15C	300 volts	480 volts	300 volts	400 volts
C15D	400 volts	480 volts	400 volts	500 volts
C15E	500 volts	600 volts	500 volts	600 volts
C15M	600 volts	720 volts	600 volts	720 volts

(1) Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for whi maximum V_{FOM} and V_{ROM} ratings apply equals 18°C per watt.

RMS Forward Current, On-State	8.0 amperes (all conduction angle
Average Forward Current, On-State	3.0 amperes at 75°C case (half-wave rectifie 5.0 amperes at 75°C case (full-wave rectified (See Charts 3 and
Peak One Cycle Surge Forward Current, I_{FM} (surge)	60 amper
I^2t (for fusing)	(Calculate from Chart
Peak Gate Power Dissipation, P_{GM}	5 wat
Average Gate Power Dissipation, P_G (AV)	0.5 wat
Peak Reverse Gate Voltage, V_{GRM}	10 vol
Storage Temperature, T_{stg}	−65°C to +150°
Operating Temperature, T_J	−65°C to +105°
Stud Torque	15 lb-in (17 kg-cm

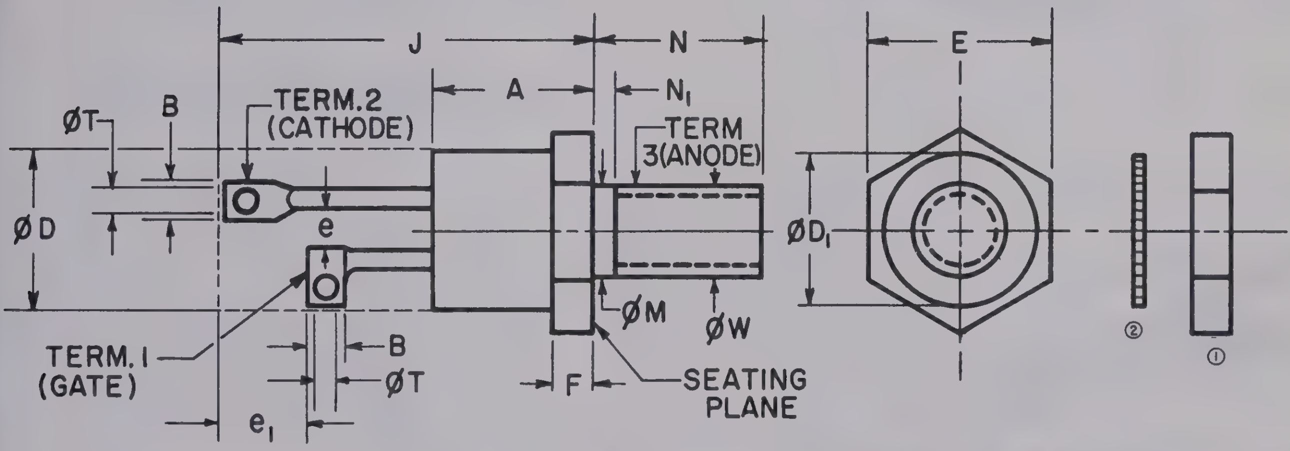
CHARACTERISTICS

TEST	SYMBOL	MIN.	MAX.	UNITS	TEST CONDITIONS
PEAK REVERSE OR FORWARD BLOCKING CURRENT(1)	I_{ROM} or I_{FOM}			mA	$T_C = -65°C$ to $+105°C$
C15U		——	9.0		$V_{ROM} = V_{FOM} =$ 25V Peak
C15F		——	9.0		$V_{ROM} = V_{FOM} =$ 50V Peak
C15A		——	9.0		$V_{ROM} = V_{FOM} =$ 100V Peak
C15G		——	8.0		$V_{ROM} = V_{FOM} =$ 150V Peak
C15B		——	6.0		$V_{ROM} = V_{FOM} =$ 200V Peak
C15C		——	4.0		$V_{ROM} = V_{FOM} =$ 300V Peak
C15D		——	2.0		$V_{ROM} = V_{FOM} =$ 400V Peak
C15E		——	2.0		$V_{ROM} = V_{FOM} =$ 500V Peak
C15M		——	2.0		$V_{ROM} = V_{FOM} =$ 600V Peak
GATE TRIGGER CURRENT	I_{GT}	——	25	mAdc	$T_C = +25°C$, $V_{FX} = 6$ Vdc, $R_L = 125$ ohms
		——	50	mAdc	$T_C = -65°C$, $V_{FX} = 6$ Vdc, $R_L = 125$ ohms
GATE TRIGGER VOLTAGE	V_{GT}	——	2.5	Vdc	$T_C = -65°C$ to $+105°$ C, $V_{FX} = 6$ Vdc, $R_L = 125$ ohms
		0.3	——	Vdc	$T_C = +105°C$, $V_{FXM} =$ Rated V_{FOM}, $R_L = 250$ ohms
PEAK ON-VOLTAGE	V_{FM}	——	1.85	V	$T_C = +25°C$, $I_{FM} = 15A$ Peak, 1 millisecond wide pulse. Duty cycle $\leqq 1\%$.
HOLDING CURRENT	I_{HO}	——	30	mA	$T_C = +25°C$, Anode supply = 24 Vdc, Gate Supply = 7V, 20 ohms. Initial forward current pulse = 0.5A, 0.1 millisecond to 10 milliseconds wide.
EFFECTIVE THERMAL RESISTANCE (DC)	θ_{J-C}	——	3.1	°C/watt	Junction to case.

(1)Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for which maximum V_{FOM} and V_{ROM} ratings apply equals 18°C/watt.

OUTLINE DRAWING

(Complies with JEDEC registered TO-64 outline)



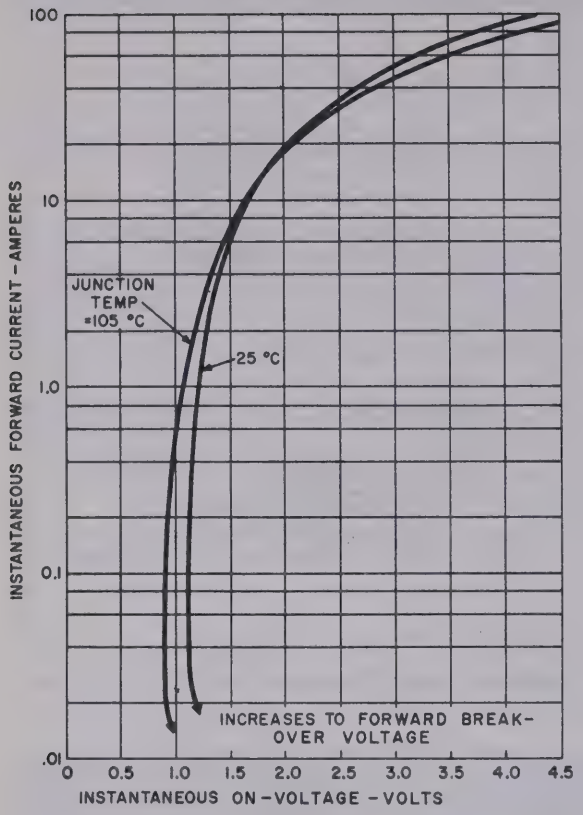
① 10-32 STEEL NUT CADMIUM PLATED

② LOCKWASHER, CADMIUM PLATED STEEL

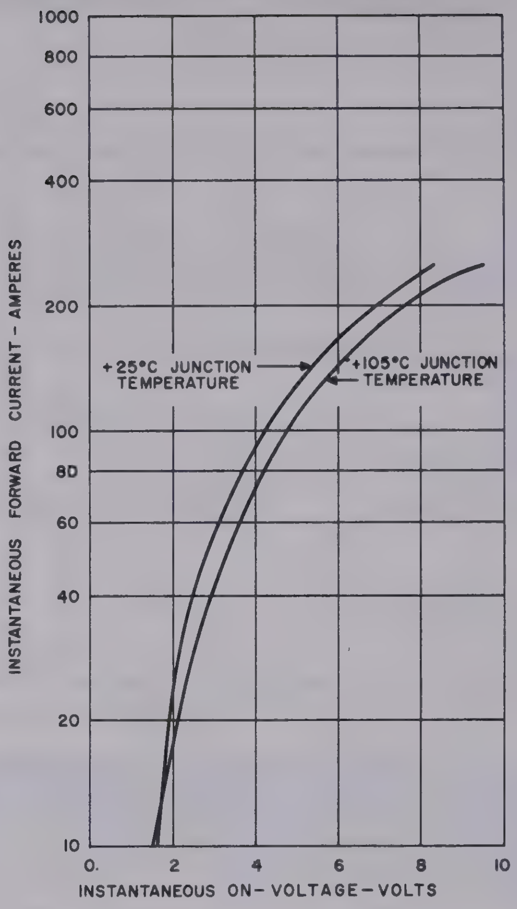
SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	.300	.400	7.62	10.16	
B	.080	.136	2.03	3.45	1
φD		.424		10.77	2
φD1	.400		10.16		3, 4
E	.424	.437	10.77	11.10	
e	.013		.330		7
e1	.060		1.52		5
F	.060	.175	1.52	4.45	4
J	.700	.855	17.78	21.72	2
φM	.163	.189	4.14	4.80	
N	.400	.453	10.16	11.51	
N1		.078		1.98	
φT	.040	.075	1.02	1.91	
φW	.1658	.1697	4.212	4.310	6

NOTES:

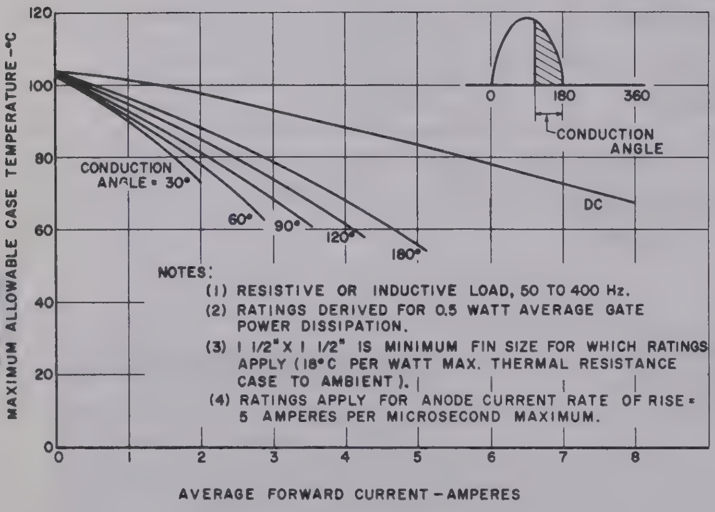
(1) Contour and orientation of fixed terminal lugs are optional.
(2) The outline contour (with exception of hexagon) is optional within zone defined by φD and J.
(3) Minimum diameter of seating plane.
(4) A chamfer (or undercut) on one or both ends of hexagonal portion is optional.
(5) Minimum difference in terminal lengths to establish datum line for numbering terminals.
(6) Pitch diameter—thread 10-32 NF-2A (Coated). Reference (Screw Thread Standards for Federal Services 1957) Handbook 1957 H28.
(7) Minimum spacing between terminals.
(8) Insulating kit available upon request.



1 MAXIMUM FORWARD CHARACTERISTICS—ON-STATE

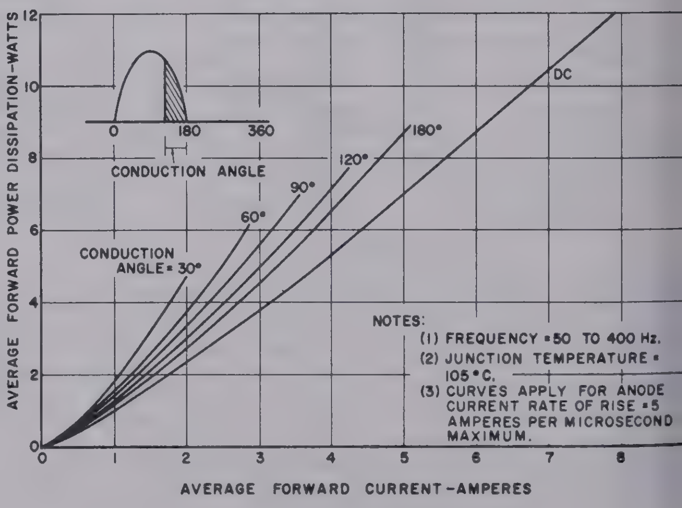


2 MAXIMUM FORWARD CHARACTERISTICS, HIGH CURRENT LEVEL—ON-STATE



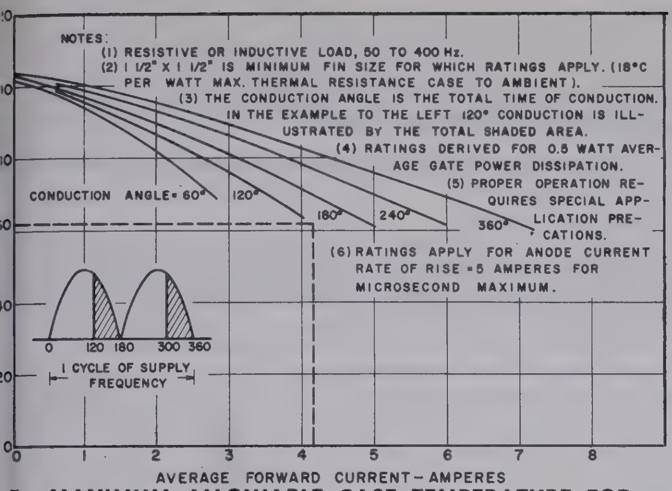
NOTES:
(1) RESISTIVE OR INDUCTIVE LOAD, 50 TO 400 Hz.
(2) RATINGS DERIVED FOR 0.5 WATT AVERAGE GATE POWER DISSIPATION.
(3) 1 1/2" X 1 1/2" IS MINIMUM FIN SIZE FOR WHICH RATINGS APPLY (18°C PER WATT MAX. THERMAL RESISTANCE CASE TO AMBIENT).
(4) RATINGS APPLY FOR ANODE CURRENT RATE OF RISE = 5 AMPERES PER MICROSECOND MAXIMUM.

3 MAXIMUM ALLOWABLE CASE TEMPERATURE FOR HALF WAVE RECTIFIED SINE WAVE OF CURRENT



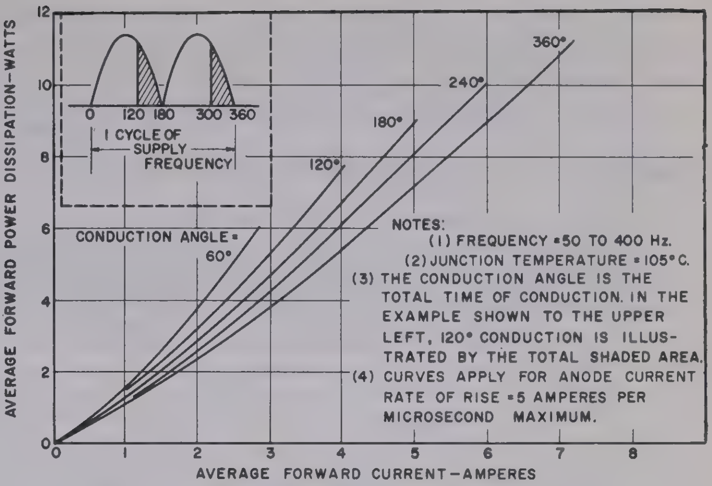
NOTES:
(1) FREQUENCY = 50 TO 400 Hz.
(2) JUNCTION TEMPERATURE = 105 °C.
(3) CURVES APPLY FOR ANODE CURRENT RATE OF RISE = 5 AMPERES PER MICROSECOND MAXIMUM.

4 FORWARD POWER DISSIPATION FOR HALF WAVE RECTIFIED SINE WAVE OF CURRENT



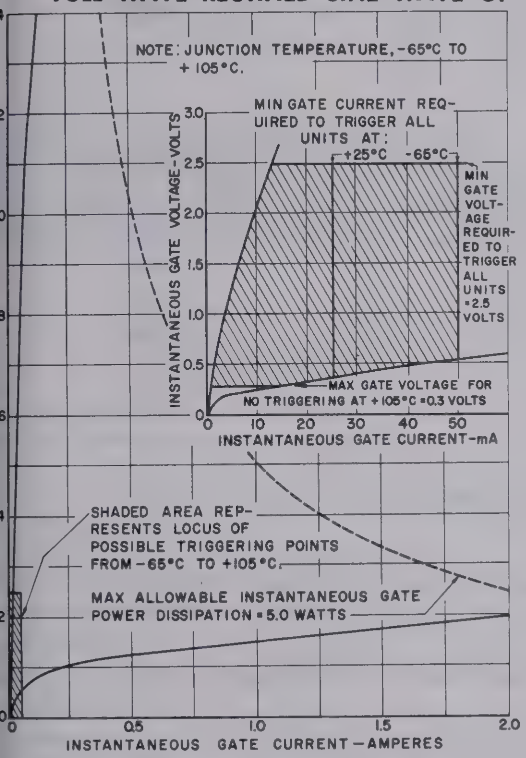
NOTES:
(1) RESISTIVE OR INDUCTIVE LOAD, 50 TO 400 Hz.
(2) 1 1/2" X 1 1/2" IS MINIMUM FIN SIZE FOR WHICH RATINGS APPLY. (18°C PER WATT MAX. THERMAL RESISTANCE CASE TO AMBIENT).
(3) THE CONDUCTION ANGLE IS THE TOTAL TIME OF CONDUCTION. IN THE EXAMPLE TO THE LEFT 120° CONDUCTION IS ILLUSTRATED BY THE TOTAL SHADED AREA.
(4) RATINGS DERIVED FOR 0.5 WATT AVERAGE GATE POWER DISSIPATION.
(5) PROPER OPERATION REQUIRES SPECIAL APPLICATION PRECATIONS.
(6) RATINGS APPLY FOR ANODE CURRENT RATE OF RISE = 5 AMPERES FOR MICROSECOND MAXIMUM.

5 MAXIMUM ALLOWABLE CASE TEMPERATURE FOR FULL WAVE RECTIFIED SINE WAVE OF CURRENT



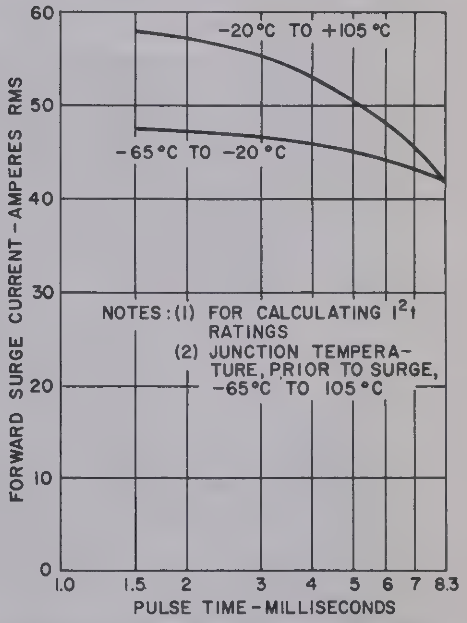
NOTES:
(1) FREQUENCY = 50 TO 400 Hz.
(2) JUNCTION TEMPERATURE = 105°C.
(3) THE CONDUCTION ANGLE IS THE TOTAL TIME OF CONDUCTION. IN THE EXAMPLE SHOWN TO THE UPPER LEFT, 120° CONDUCTION IS ILLUSTRATED BY THE TOTAL SHADED AREA.
(4) CURVES APPLY FOR ANODE CURRENT RATE OF RISE = 5 AMPERES PER MICROSECOND MAXIMUM.

6 FORWARD POWER DISSIPATION FOR FULL WAVE RECTIFIED SINE WAVE OF CURRENT



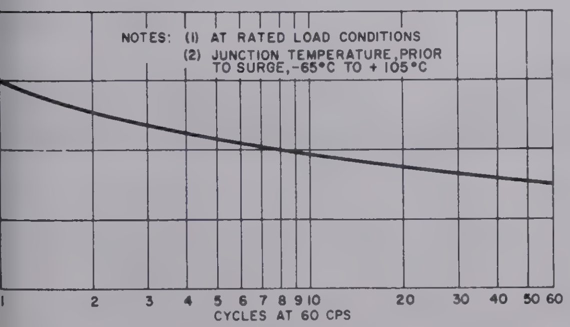
NOTE: JUNCTION TEMPERATURE, -65°C TO +105°C.

7 TRIGGERING CHARACTERISTICS



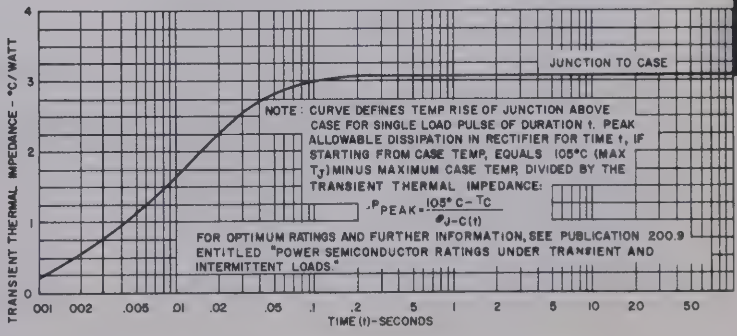
NOTES: (1) FOR CALCULATING I^2t RATINGS
(2) JUNCTION TEMPERATURE, PRIOR TO SURGE, -65°C TO 105°C

8 MAXIMUM ALLOWABLE NON-RECURRENT SUB-CYCLE SURGE CURRENT RATING



NOTES: (1) AT RATED LOAD CONDITIONS
(2) JUNCTION TEMPERATURE, PRIOR TO SURGE, -65°C TO +105°C

9 MAXIMUM ALLOWABLE NON-RECURRENT PEAK SURGE FORWARD CURRENT



NOTE: CURVE DEFINES TEMP RISE OF JUNCTION ABOVE CASE FOR SINGLE LOAD PULSE OF DURATION t. PEAK ALLOWABLE DISSIPATION IN RECTIFIER FOR TIME t, IF STARTING FROM CASE TEMP, EQUALS 105°C (MAX T_J) MINUS MAXIMUM CASE TEMP, DIVIDED BY THE TRANSIENT THERMAL IMPEDANCE:

$$P_{PEAK} = \frac{105°C - T_C}{\theta_{J-C(t)}}$$

FOR OPTIMUM RATINGS AND FURTHER INFORMATION, SEE PUBLICATION 200.9 ENTITLED "POWER SEMICONDUCTOR RATINGS UNDER TRANSIENT AND INTERMITTENT LOADS."

10 MAXIMUM TRANSIENT THERMAL IMPEDANCE

SCR

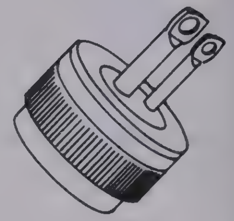
SERIES C20,C22

7.4 AMPS. RMS UP TO 400 PRV

FOR HIGH VOLUME, LIGHT INDUSTRIAL AND CONSUMER APPLICATIONS
The C22 Silicon Controlled Rectifier is a three junction semiconductor device for use in power switching and control applications requiring a blocking voltage of 400 volts or less and average load currents (full-wave retified) up to 6.0 ampers. The C22 is provided in the popular "Press Fit" cup housing to insure ease of installation in large volume applications. Low cost makes this device suitable for high volume consumer and Light Industrial applications.

The C20 is the same as the C22 except that it is mounted on a 9/16" hex and 1/4"-28 stud as an added convenience to those manufactures with production facilities more adaptable to "nut and bolt" type assembly.

An ideal, inexpensive trigger device for this Controlled Rectifier is a silicon Unijunction transistor such as type 2N2646.



- Flexibility of Mounting (Available in cup construction to solder, glue, or press fit, and as a stud device)
- One-Piece Terminals
- High Surge Current Capabilities
- Low Power Required for Triggering

Type	Minimum Forward Breakover Voltage $V_{(BR)FO}$† $T_J = -25°C$ to $+100°C$	Repetitive Peak Reverse Voltage V_{ROM}(rep)† $T_J = -25°C$ to $+100°C$	Non-repetitive Peak Reverse Voltage (5.0 millisec) V_{ROM}(non-rep)† $T_J = -25°C$ to $+100°C$
C20U, C22U	25 Volts	25 Volts	35 Volts
C20F, C22F	50 Volts	50 Volts	75 Volts
C20A, C22A	100 Volts	100 Volts	150 Volts
C20B, C22B	200 Volts	200 Volts	300 Volts
C20C, C22C	300 Volts	300 Volts	400 Volts
C20D, C22D	400 Volts	400 Volts	500 Volts

†Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for which maximum V_{ROM}(rep) ratings apply equals 18°C per watt.

MAXIMUM ALLOWABLE RATINGS

Repetitive Peak Forward Blocking Voltage, PFV	500 volts
RMS Forward Current, On State	7.4 Amperes (All conduction angles)
Average Forward Current, On State	3.0 Amperes at 80°C case (Half wave rectified sine wave) 6.0 Amperes at 80°C case (Full wave rectified sine wave)
Peak One-Cycle Surge Forward Current, I_{FM}(surge)	80 amperes
I^2t (for fusing)	27 Ampere² seconds (for times >1.5 milliseconds)
Peak Gate Power Dissipation, P_{GM}	5.0 watts
Average Gate Power Dissipation, $P_{G(AV)}$	0.5 watts
Peak Reverse Gate Voltage, V_{GRM}	5.0 volts
Storage Temperature, T_{stg}	−25°C to +100°
Operating Junction Temperature	−25°C to +100°
Stud Torque (C20 only)	25 inch pound

CHARACTERISTICS

Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Peak Reverse and Forward Blocking Current*	I_{ROM} and I_{FOM}					$T_J = 100°C$
C20U, C22U		—	1.0	10.0	ma	$V_{ROM} = V_{FOM} =$ 25 volts peak
C20F, C22F		—	1.0	10.0	ma	50 volts peak
C20A, C22A		—	1.0	7.0	ma	100 volts peak
C20B, C22B		—	1.0	3.5	ma	200 volts peak
C20C, C22C		—	1.0	2.3	ma	300 volts peak
C20D, C22D		—	1.0	1.7	ma	400 volts peak

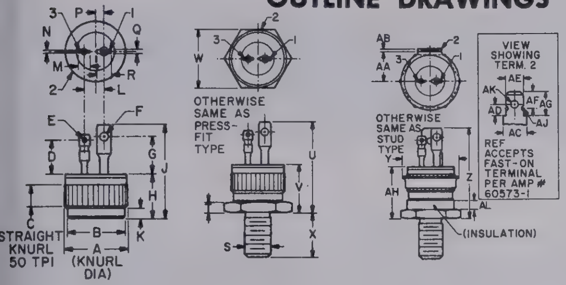
CHARACTERISTICS (Continued)

Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Gate Trigger Current†	I_{GT}	—	4.0	25.0†	mAdc	$T_J = 25°C$, $V_{FX} = 6$ Vdc, $R_L = 60$ ohms
		—	6.0	40.0	mAdc	$T_J = -25°C$, $V_{FX} = 6$ Vdc, $R_L = 60$ ohms
Gate Trigger Voltage	V_{GT}	—	0.8	1.5	Vdc	$T_J = 25°C$, $V_{FX} = 6$ Vdc, $R_L = 60$ ohms
		—	1.3	3.0	Vdc	$T_J = -25°C$, $V_{FX} = 6$ Vdc, $R_L = 60$ ohms
		0.2	0.5	—	Vdc	$T_J = 100°C$, V_{FXM} = rated, $R_L = 100$ ohms
Peak On Voltage	V_{FM}	—	1.50	1.85	V	$T_J = 25°C$, $I_{FM} = 10$ A peak, single half sine wave pulse, 2.0 millisec. wide
Holding Current	I_{HO}	—	10.0	30.0	mAdc	$T_J = 25°C$, anode supply = 24 Vdc

*Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for which maximum V_{ROM}(rep) ratings apply equals 18° per watt.

†Special selections of Gate Trigger Current down to 4.0 mAdc are available upon request.

OUTLINE DRAWINGS



PRESS-FIT **STUD** **ISOLATED STUD**

SYM	DECIMAL (INCHES) MIN.	DECIMAL (INCHES) MAX.	METRIC (MM) MIN.	METRIC (MM) MAX.
A	.501	.505	12.73	12.83
B	.467	.475	11.86	12.07
C	.177 REF.		4.50 REF.	
D	.260	.301	6.60	7.65
E	.035	.045	.89	1.14
F	.065	.075	1.65	1.41
G		.350		8.89
H	.340	.376	8.64	9.55
J		.782		19.86
K	.083	.097	2.11	2.46
L	.130	.180	3.30	4.57
M	.085	.115	2.16	2.92
N	.016	.023	.41	.58
P	.065 REF.		1.65 REF.	
Q	.028	.035	.71	.89
R	.110	.135	2.79	3.43
S	1/4-28 UNF2A		1/4-28 UNF2A	
T	.086	.098	2.18	2.49
U		.865		21.79
V		.475		12.07
W	.552	.562	14.02	14.27
X	.432	.442	10.97	11.23
Y	.580	.610	14.73	15.49
Z		.975		24.77
AA	.290	.330	7.37	8.38
AB	.017	.024	.43	.61
AC	.235	.265	5.97	6.73
AD	.115	.121	2.29	3.07
AE	.186	.189	4.72	4.80
AF	.170 REF.		4.32 REF	
AG	.245	.255	6.22	6.48
AH		.585		14.86
AJ	.025	R-REF.	.64	R-REF.
AK	.065	.070	1.65	1.78
AL	.100	.110	2.54	2.79

NOTES: (1)Case temperature is measured at the center of any hex flat or press-fit base.

(2)One ext. tooth lock washer and one nut (both steel, cad. plated) supplied with each stud and isolated stud unit.

(3)Insulation hardware for stud device consisting of terminal, 2 mica washers and one nlyon bushing available at extra cost upon request.

INSTALLATION

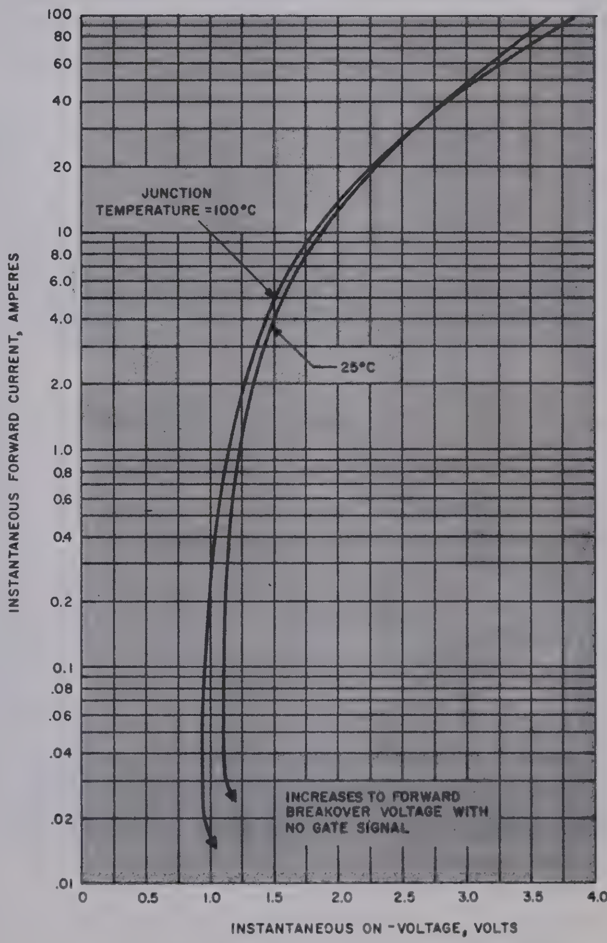
WHEN PRESS-FITTING THESE SCR'S INTO A HEATSINK, THE FOLLOWING SPECIFICATIONS AND RECOMMENDATIONS APPLY.

1. The heatsink materials may be copper, aluminum or steel. For maximum heat transfer and minimum corrosion problems, copper is recommended. The heatsink thickness, or amount of heatsink wall in contact with the SCR, should be ⅛ inch.
2. The hole diameter into which the SCR is pressed must be 0.4975 ± .001 inch. A slight chamfer on the hole should be used. This hole may be punched and reamed in a flat plate or extruded and sized in sheet metal.
3. The entire knurled section of the SCR should be in contact with the heatsink to insure maximum heat transfer. The SCR must not be inserted into a heatsink deeper than the knurl height.
4. The SCR insertion force must not exceed 800 pounds. If the insertion force approaches that value either the SCR is misaligned with the hole or the SCR-to-hole interference is excessive. The insertion force must be uniformly applied to the top face (terminal end) of the SCR within an annular ring which has an inside diameter not less than 0.370 inch and not larger than 0.390 inch; the outside diameter must not be less than 0.500 inch.
5. The thermal resistance between the SCR case and a copper heatsink will not exceed 0.5°C/W if the SCR is inserted in the manner described above.

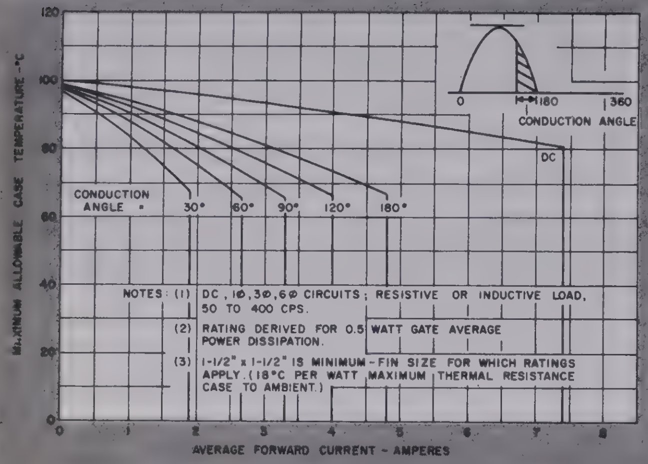
WARNING

Isolated stud products described in this specification sheet should be handled with care. The ceramic portion of these thyristors contains BERYLLIUM OXIDE as a major ingredient.

Do not crush, grind, or abrade these portions of the thyristors because the dust resulting from such action may be hazardous if inhaled.

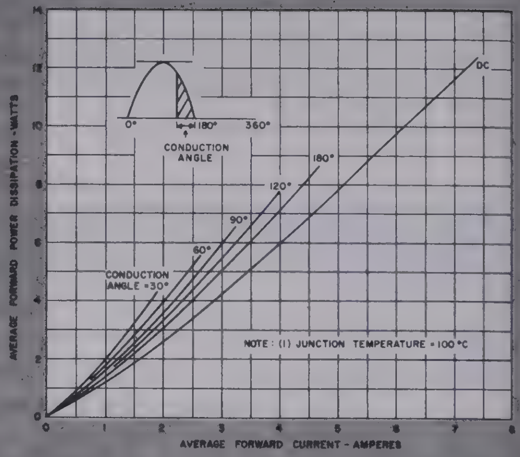


1. MAXIMUM FORWARD CHARACTERISTICS, ON-STATE



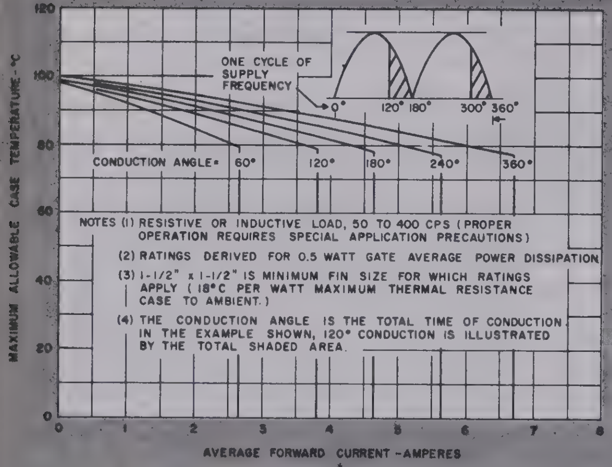
NOTES: (1) DC, 1Ø, 3Ø, 6Ø CIRCUITS; RESISTIVE OR INDUCTIVE LOAD, 50 TO 400 CPS.
(2) RATING DERIVED FOR 0.5 WATT GATE AVERAGE POWER DISSIPATION.
(3) 1-1/2" x 1-1/2" IS MINIMUM-FIN SIZE FOR WHICH RATINGS APPLY. (18°C PER WATT MAXIMUM THERMAL RESISTANCE CASE TO AMBIENT.)

2. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR HALF WAVE RECTIFIED SINE WAVE OF CURRENT



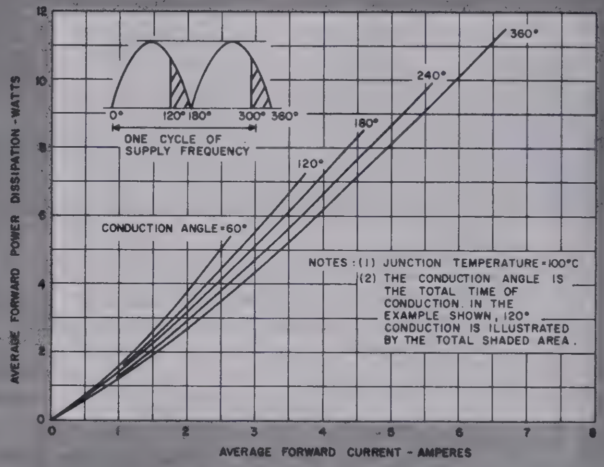
NOTE: (1) JUNCTION TEMPERATURE = 100 °C

3. MAXIMUM FORWARD POWER DISSIPATION FOR HALF WAVE RECTIFIED SINE WAVE OF CURRENT



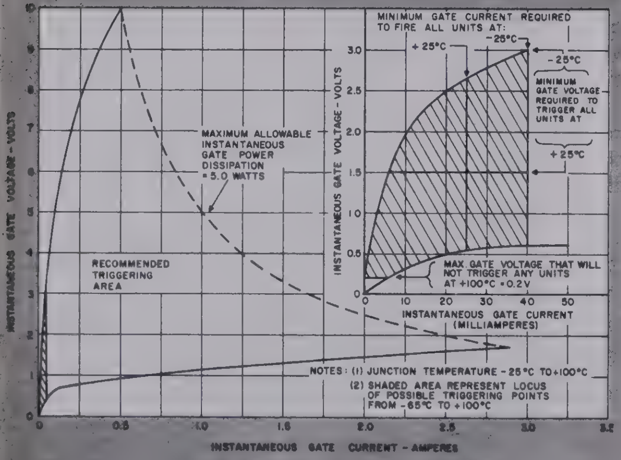
NOTES (1) RESISTIVE OR INDUCTIVE LOAD, 50 TO 400 CPS (PROPER OPERATION REQUIRES SPECIAL APPLICATION PRECAUTIONS)
(2) RATINGS DERIVED FOR 0.5 WATT GATE AVERAGE POWER DISSIPATION
(3) 1-1/2" x 1-1/2" IS MINIMUM FIN SIZE FOR WHICH RATINGS APPLY (18°C PER WATT MAXIMUM THERMAL RESISTANCE CASE TO AMBIENT.)
(4) THE CONDUCTION ANGLE IS THE TOTAL TIME OF CONDUCTION. IN THE EXAMPLE SHOWN, 120° CONDUCTION IS ILLUSTRATED BY THE TOTAL SHADED AREA.

4. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR FULL WAVE RECTIFIED SINE WAVE OF CURRENT



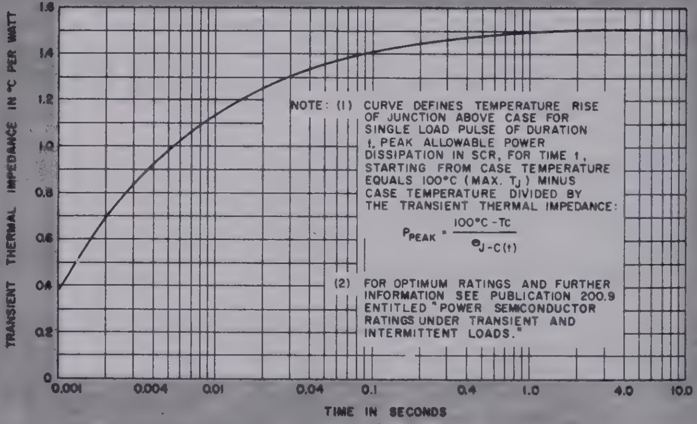
NOTES: (1) JUNCTION TEMPERATURE = 100°C
(2) THE CONDUCTION ANGLE IS THE TOTAL TIME OF CONDUCTION. IN THE EXAMPLE SHOWN, 120° CONDUCTION IS ILLUSTRATED BY THE TOTAL SHADED AREA.

5. MAXIMUM FORWARD POWER DISSIPATION FOR FULL WAVE RECTIFIED SINE WAVE OF CURRENT



NOTES: (1) JUNCTION TEMPERATURE -25°C TO +100°C
(2) SHADED AREA REPRESENT LOCUS OF POSSIBLE TRIGGERING POINTS FROM -65°C TO +100°C

6. GATE TRIGGERING CHARACTERISTICS



NOTE: (1) CURVE DEFINES TEMPERATURE RISE OF JUNCTION ABOVE CASE FOR SINGLE LOAD PULSE OF DURATION t, PEAK ALLOWABLE POWER DISSIPATION IN SCR, FOR TIME t, STARTING FROM CASE TEMPERATURE EQUALS 100°C (MAX. T_J) MINUS CASE TEMPERATURE DIVIDED BY THE TRANSIENT THERMAL IMPEDANCE:

$$P_{PEAK} = \frac{100°C - T_C}{\theta_{J-C(t)}}$$

(2) FOR OPTIMUM RATINGS AND FURTHER INFORMATION SEE PUBLICATION 200.9 ENTITLED "POWER SEMICONDUCTOR RATINGS UNDER TRANSIENT AND INTERMITTENT LOADS."

7. MAXIMUM TRANSIENT THERMAL IMPEDANCE, JUNCTION TO CASE

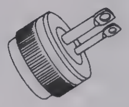
SCR

SERIES C30-33

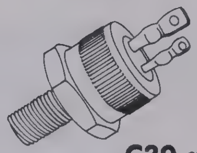
25 AMPS RMS up to 400 PRV

FOR HIGH VOLUME, LIGHT INDUSTRIAL AND CONSUMER APPLICATIONS
The C30 series with power switching capability to 10 KW is a new three junction diffued Silicon Controlled Rectifier designed for power switching and control circuits in high volume light industrial and consumer applications. The C31 series is basically the same device as the C30 except that these units are specially selected for gate current to trigger of 9 milliamperes maximum.

Available as either a press fit C32 and C33 or stud type C30 and C31, these SCR's are rated up to 25 amps RMS and 400 volts peak. With these ratings, package versatility, the low power required for gate triggering, and high surge capability, these SCR's are ideally suited for those applications requiring medium power devices at attractive prices. Special mounting variations for printed board work are available on request.



C32 and C33



C30 and C31

Type	Peak Forward Blocking Voltage†, V_{FOM} $T_J = -40°C$ to $+100°C$	Repetitive Peak Reverse Voltage†, V_{ROM}(rep) $T_J = -40°C$ to $+100°C$	Non-Repetitive Peak Reverse Voltage† ($<$5.0 Millisec) V_{ROM}(non-rep) $T_J = -40°C$ to $+100°C$
C30U, C32U C31U, C33U	25 Volts	25 Volts	35 Volts
C30F, C32F C31F, C33F	50 Volts	50 Volts	75 Volts
C30A, C32A C31A, C33A	100 Volts	100 Volts	150 Volts
C30B, C32B C31B, C33B	200 Volts	200 Volts	300 Volts
C30C, C32C C31C, C33C	300 Volts	300 Volts	400 Volts
C30D, C32D C31D, C33D	400 Volts	400 Volts	500 Volts

†Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for which maximum V_{ROM}(rep) ratings apply equals 18°C per watt.

MAXIMUM ALLOWABLE RATINGS

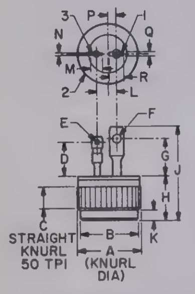
Peak Forward Voltage, PFV	500 volts
RMS Forward Current, On-State	25 amperes (all conduction angles)
Average Forward Current, On-State	13 amperes at 75°C case (half wave rectified sine wave) 19 amperes at 75°C case (full wave rectified sine wave)
Peak One Cycle Surge Forward Current, I_{FM}(surge)	250 amperes
I^2t (for fusing)	260 ampere^2 seconds (for times $\geqq$1.0 milliseconds)
Peak Gate Power Dissipation, P_{GM}	5.0 watts
Average Gate Power Dissipation, $P_{G(AV)}$	0.5 watts
Peak Reverse Gate Voltage, V_{GRM}	5.0 volts
Storage Temperature, T_{stg}	−40°C to +100°C
Operating Junction Temperature	−40°C to +100°C
Stud Torque (C30 and C31 only)	25 inch pounds

SERIES C30-33

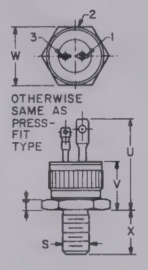
CHARACTERISTICS

Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Peak Reverse and Forward Blocking Current*	I_{ROM} and I_{FOM}					$T_J = +100°C$
C30U, C32U C31U, C33U		—	1.0	10.0	mA	$V_{ROM} = V_{FOM} = 25$ Volts Peak
C30F, C32F C31F, C33F		—	1.0	10.0	mA	$V_{ROM} = V_{FOM} = 50$ Volts Peak
C30A, C32A C31A, C33A		—	1.0	7.0	mA	$V_{ROM} = V_{FOM} = 100$ Volts Peak
C30B, C32B C31B, C33B		—	1.0	3.5	mA	$V_{ROM} = V_{FOM} = 200$ Volts Peak
C30C, C32C C31C, C33C		—	1.0	2.3	mA	$V_{ROM} = V_{FOM} = 300$ Volts Peak
C30D, C32D C31D, C33D		—	1.0	1.7	mA	$V_{ROM} = V_{FOM} = 400$ Volts Peak
Gate Trigger Current	I_{GT}	—	4.0	25.0	mAdc	$T_J = +25°C$, $V_{FX} = 6$Vdc, $R_L = 60$ ohms
C30, C32 Series		—	8.0	40.0	mAdc	$T_J = -40°C$, $V_{FX} = 6$Vdc, $R_L = 60$ ohms
Gate Trigger Current	I_{GT}	—	3.0	9.0†	mAdc	$T_J = +25°C$, $V_{FX} = 6$Vdc, $R_L = 60$ ohms
C31, C33 Series		—	7.0	20.0	mAdc	$T_J = -40°C$, $V_{FX} = 6$Vdc, $R_L = 60$ ohms
Gate Trigger Voltage	V_{GT}	—	0.8	1.5	Vdc	$T_J = +25°C$, $V_{FX} = 6$Vdc, $R_L = 60$ ohms
		—	0.9	2.0	Vdc	$T_J = -40°C$, $V_{FX} = 6$Vdc, $R_L = 60$ ohms
		0.2	0.5	—	Vdc	$T_J = +100°C$, $V_{FXM} =$ Rated, $R_L = 1000$ ohms
Peak On-Voltage	V_{FM}	—	1.30	1.5	V	$T_J = +25°C$, $I_{FM} = 50$ A Peak, single half sine wave pulse, 2.0 millisec. wide
Holding Current	I_{HO}	—	10.0	50.0	mAdc	$T_J = +25°C$, anode supply = 24Vdc

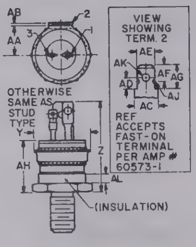
*Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for which maximum V_{ROM}(rep) ratings apply equals 18°C per watt.
†Special selections of gate current to trigger available.



PRESS-FIT



STUD


AB
2
3
1
AA
VIEW SHOWING TERM. 2
AE
AK
AF
AG
AD
AJ
AC
REF ACCEPTS FAST-ON TERMINAL PER AMP # 60573-1
OTHERWISE SAME AS STUD TYPE
Y
Z
AH
AL
(INSULATION)

ISOLATED STUD

SYM	DECIMAL (INCHES) MIN.	DECIMAL (INCHES) MAX.	METRIC (MM) MIN.	METRIC (MM) MAX.
A	.501	.505	12.73	12.83
B	.467	.475	11.86	12.07
C	.177 REF.		4.50 REF.	
D	.260	.301	6.60	7.65
E	.035	.045	.89	1.14
F	.065	.075	1.65	1.41
G		.350		8.89
H	.340	.376	8.64	9.55
J		.782		19.86
K	.083	.097	2.11	2.46
L	.130	.180	3.30	4.57
M	.085	.115	2.16	2.92

SYM	DECIMAL (INCHES) MIN.	DECIMAL (INCHES) MAX.	METRIC (MM) MIN.	METRIC (MM) MAX.
N	.016	.023	.41	.58
P	.065 REF.		1.65 REF.	
Q	.028	.035	.71	.89
R	.110	.135	2.79	3.43
S	1/4-28 UNF2A		1/4-28 UNF2A	
T	.086	.098	2.18	2.49
U		.865		21.79
V		.475		12.07
W	.552	.562	14.02	14.27
X	.432	.442	10.97	11.23
Y	.580	.610	14.73	15.49

SYM	DECIMAL (INCHES) MIN.	DECIMAL (INCHES) MAX.	METRIC (MM) MIN.	METRIC (MM) MAX.
Z		.975		24.77
AA	.290	.330	7.37	8.38
AB	.017	.024	.43	.61
AC	.235	.265	5.97	6.73
AD	.115	.121	2.29	3.07
AE	.186	.189	4.72	4.80
AF	.170 REF.		4.32 REF	
AG	.245	.255	6.22	6.48
AH		.585		14.86
AJ	.025	R-REF.	.64	R-REF.
AK	.065	.070	1.65	1.78
AL	.100	.110	2.54	2.79

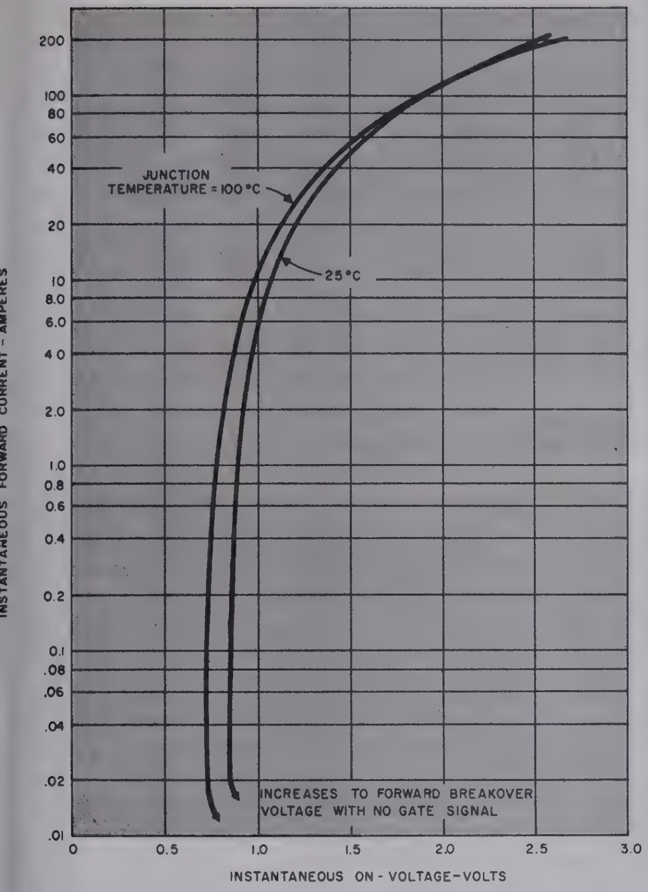
NOTES: (1)Case temperature is measured at the center of any hex flat or press-fit base.
(2)One ext. tooth lock washer and one nut (both steel, cad. plated) supplied with each stud and isolated stud unit.
(3)Insulation hardware for stud device consisting of terminal, 2 mica washers and one nlyon bushing available at extra cost upon request.

WARNING

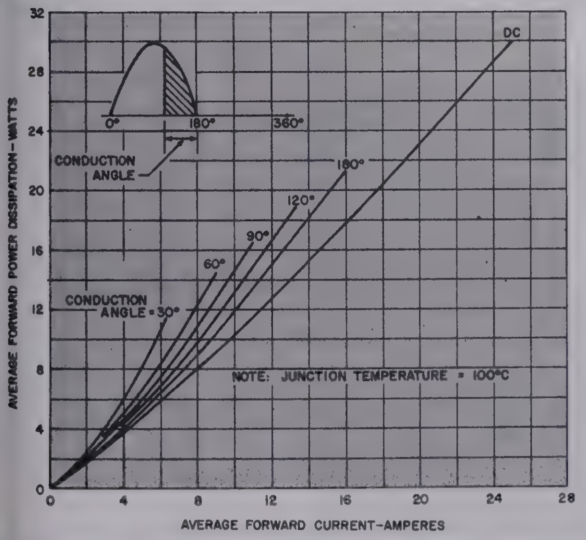
Isolated stud products described in this specification sheet should be handled with care. The ceramic portion of these thyristors contains BERYLLIUM OXIDE as a major ingredient.

Do not crush, grind, or abrade these portions of the thyristors because the dust resulting from such action may be hazardous if inhaled.

SERIES C30-33

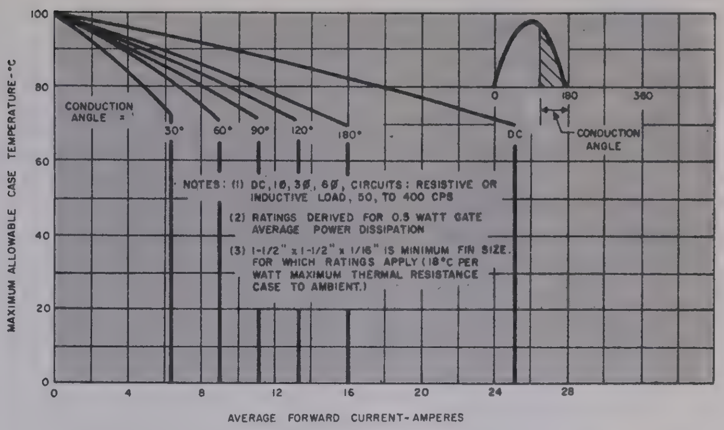


1. MAXIMUM FORWARD CHARACTERISTICS ON-STATE



NOTE: JUNCTION TEMPERATURE = 100°C

2. MAXIMUM FORWARD POWER DISSIPATION FOR HALF-WAVE RECTIFIED SINE WAVE OF CURRENT

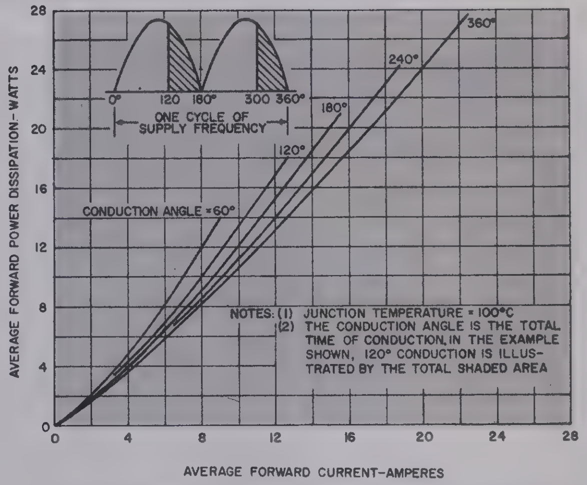


NOTES: (1) DC, 1Ø, 3Ø, 6Ø, CIRCUITS: RESISTIVE OR INDUCTIVE LOAD, 50, TO 400 CPS

(2) RATINGS DERIVED FOR 0.5 WATT GATE AVERAGE POWER DISSIPATION

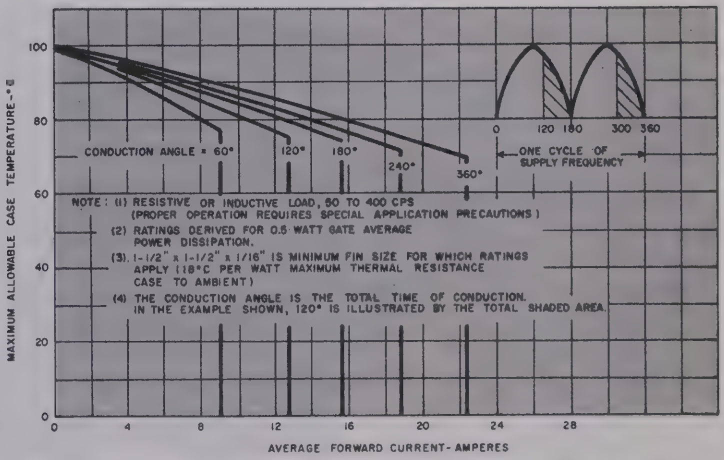
(3) 1-1/2" x 1-1/2" x 1/16" IS MINIMUM FIN SIZE. FOR WHICH RATINGS APPLY (18°C PER WATT MAXIMUM THERMAL RESISTANCE CASE TO AMBIENT.)

3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR HALF-WAVE RECTIFIED SINE WAVE OF CURRENT



NOTES: (1) JUNCTION TEMPERATURE = 100°C
(2) THE CONDUCTION ANGLE IS THE TOTAL TIME OF CONDUCTION. IN THE EXAMPLE SHOWN, 120° CONDUCTION IS ILLUSTRATED BY THE TOTAL SHADED AREA

4. MAXIMUM FORWARD POWER DISSIPATION FOR FULL-WAVE RECTIFIED SINE WAVE OF CURRENT



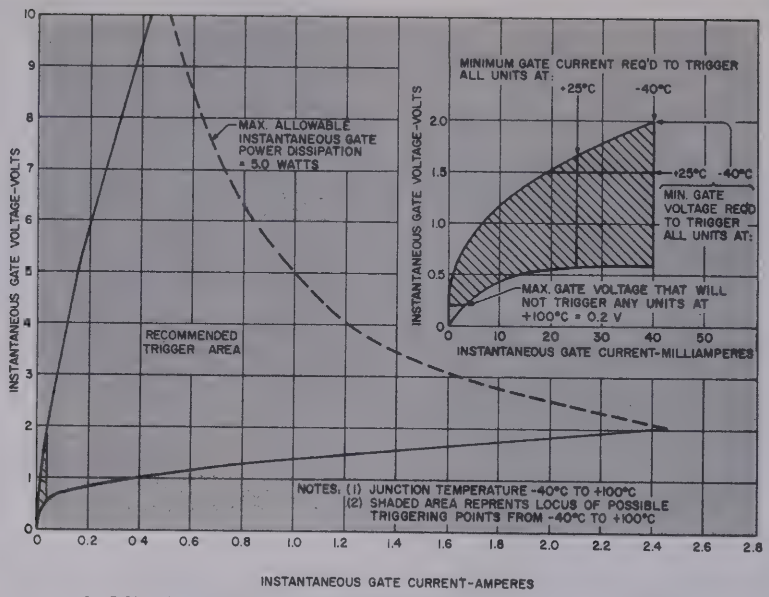
NOTE: (1) RESISTIVE OR INDUCTIVE LOAD, 50 TO 400 CPS (PROPER OPERATION REQUIRES SPECIAL APPLICATION PRECAUTIONS)

(2) RATINGS DERIVED FOR 0.5 WATT GATE AVERAGE POWER DISSIPATION.

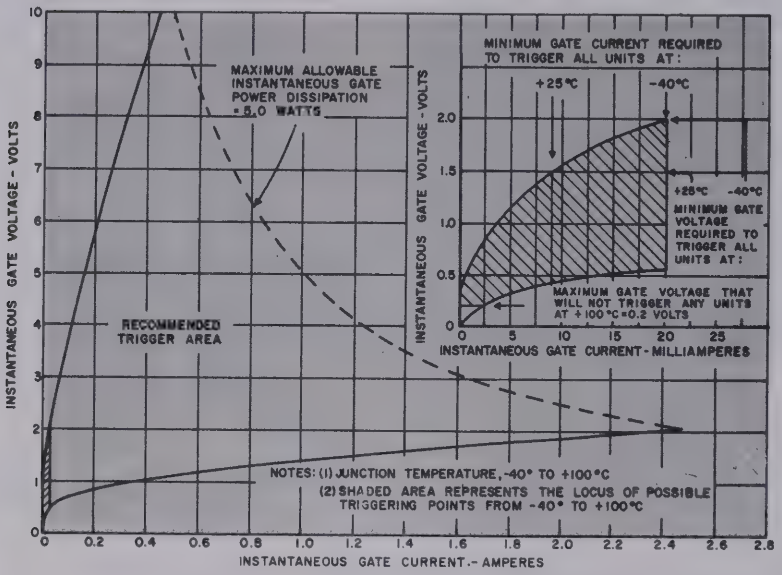
(3). 1-1/2" x 1-1/2" x 1/16" IS MINIMUM FIN SIZE FOR WHICH RATINGS APPLY (18°C PER WATT MAXIMUM THERMAL RESISTANCE CASE TO AMBIENT)

(4) THE CONDUCTION ANGLE IS THE TOTAL TIME OF CONDUCTION. IN THE EXAMPLE SHOWN, 120° IS ILLUSTRATED BY THE TOTAL SHADED AREA.

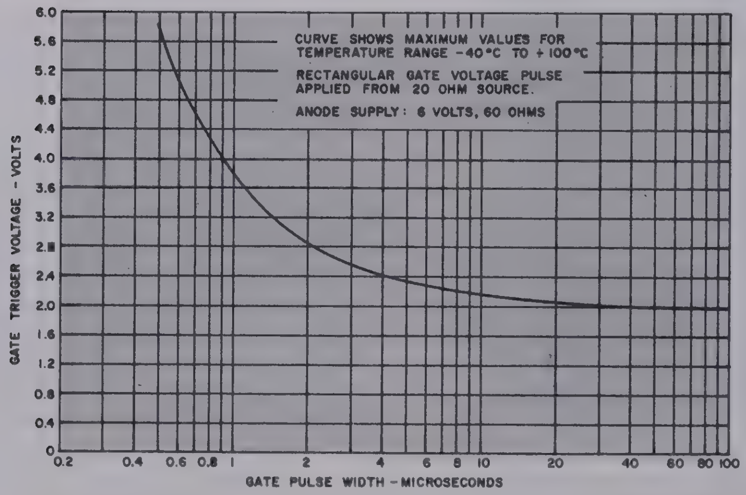
5. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR FULL-WAVE RECTIFIED SINE WAVE OF CURRENT



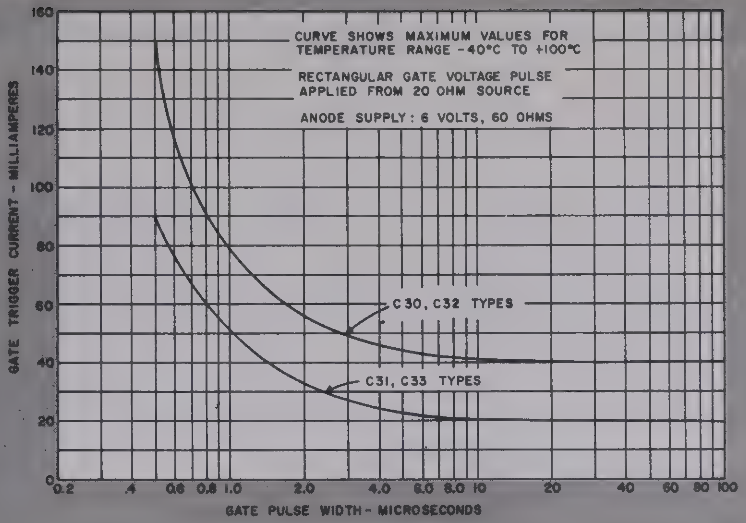
6. GATE TRIGGERING CHARACTERISTICS (C30 AND C32 TYPES)



7. GATE TRIGGERING CHARACTERISTICS (C31 AND C33 TYPES)



8. VARIATION OF GATE TRIGGER VOLTAGE WITH GATE PULSE WIDTH (ALL TYPES)

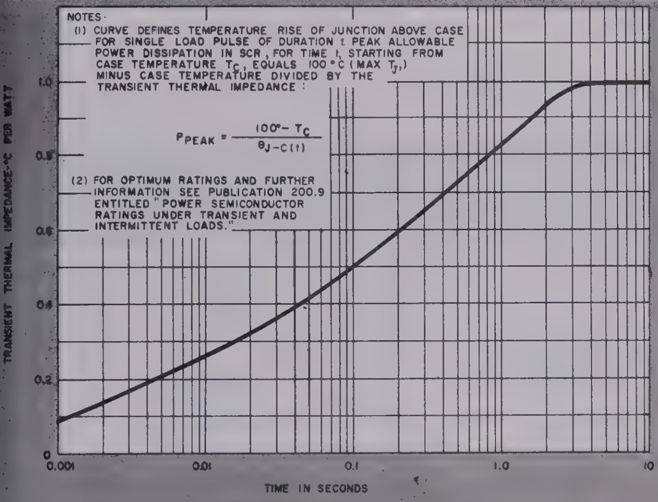


CURVE SHOWS MAXIMUM VALUES FOR TEMPERATURE RANGE -40°C TO +100°C

RECTANGULAR GATE VOLTAGE PULSE APPLIED FROM 20 OHM SOURCE

ANODE SUPPLY: 6 VOLTS, 60 OHMS

9. VARIATION OF GATE TRIGGER CURRENT WITH GATE PULSE WIDTH (ALL TYPES)



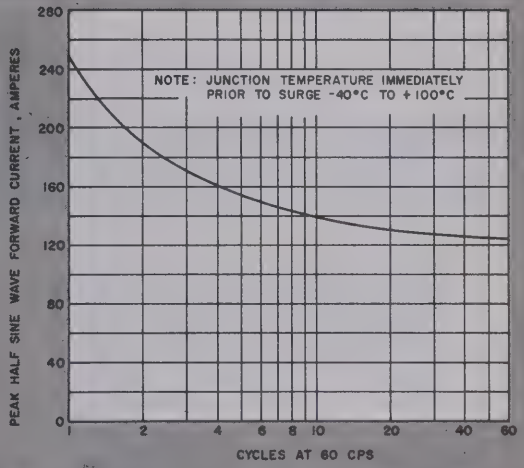
NOTES·

(1) CURVE DEFINES TEMPERATURE RISE OF JUNCTION ABOVE CASE FOR SINGLE LOAD PULSE OF DURATION t. PEAK ALLOWABLE POWER DISSIPATION IN SCR, FOR TIME t, STARTING FROM CASE TEMPERATURE T_C, EQUALS 100°C (MAX T_J,) MINUS CASE TEMPERATURE DIVIDED BY THE TRANSIENT THERMAL IMPEDANCE:

$$P_{PEAK} = \frac{100° - T_C}{\theta_{J-C(t)}}$$

(2) FOR OPTIMUM RATINGS AND FURTHER INFORMATION SEE PUBLICATION 200.9 ENTITLED "POWER SEMICONDUCTOR RATINGS UNDER TRANSIENT AND INTERMITTENT LOADS."

10. MAXIMUM TRANSIENT THERMAL IMPEDANCE, JUNCTION TO CASE



NOTE: JUNCTION TEMPERATURE IMMEDIATELY PRIOR TO SURGE -40°C TO +100°C

11. MAXIMUM ALLOWABLE PEAK SURGE FORWARD CURRENT, NON-RECURRENT (ALL TYPES)

INSTALLATION OF C32 AND C33

WHEN PRESS-FITTING THESE SCR'S INTO A HEATSINK, THE FOLLOWING SPECIFICATIONS AND RECOMMENDATIONS APPLY.

1. The heatsink materials may be copper, aluminum or steel. For maximum heat transfer and minimum corrosion problems, copper is recommended. The heatsink thickness, or amount of heatsink wall in contact with the SCR, should be ⅛ inch.

2. The hole diameter into which the SCR is pressed must be 0.4975 ± .001 inch. A slight chamfer on the hole should be used. This hole may be punched and reamed in a flat plate or extruded and sized in sheet metal.

3. The entire knurled section of the SCR should be in contact with the heatsink to insure maximum heat transfer. The SCR must not be inserted into a heatsink deeper than the knurl height.

4. The SCR insertion force must not exceed 800 pounds. If the insertion force approaches that value either the SCR is misaligned with the hole or the SCR-to-hole interference is excessive. The insertion force must be uniformly applied to the top face (terminal end) of the SCR within an annular ring which has an inside diameter not less than 0.370 inch and not larger than 0.390 inch; the outside diameter must not be less than 0.500 inch.

5. The thermal resistance between the SCR case and a copper heatsink will not exceed 0.5°C/W if the SCR is inserted in the manner described above.

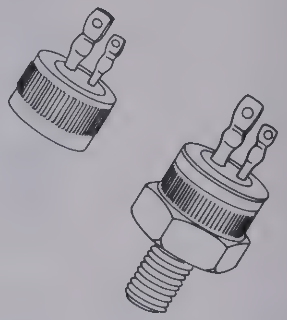
SCR

C34

The General Electric Type C34 silicon controlled rectifier is a reverse blocking triode thyristor designed primarily for high volume, inverter applications.

The C34 Series of economical inverter SCR's feature:

- Forward and reverse blocking voltages to 500 volts.
- Guaranteed maximum turn-off time of 20 μsecs.
- Characterization to 1000 Hz for both sinusoidal and rectangular anode current wave shapes.



MAXIMUM ALLOWABLE RATINGS

Types†	Repetitive Peak Off-State Voltage, V_{DRM} (1) $T_C = -40°C$ to $+100°C$	Repetitive Peak Reverse Voltage, V_{RRM} (1) (2) $T_C = -40°C$ to $+100°C$	Non-Repetitive Peak Reverse Voltage, V_{RSM} (2) (3) $T_C = -40°C$ to $+100°C$
C34F1 C34F2	50 Volts	50 Volts	75 Volts
C34A1 C34A2	100 Volts	100 Volts	150 Volts
C34B1 C34B2	200 Volts	200 Volts	300 Volts
C34C1 C34C2	300 Volts	300 Volts	400 Volts
C34D1 C34D2	400 Volts	400 Volts	500 Volts
C34E1 C34E2	500 Volts	500 Volts	600 Volts

†Isolated-case versions available.
(1) Maximum case-to-ambient thermal resistance for which maximum V_{DRM} and maximum V_{RRM} ratings apply equals 18°C per watt.
(2) Values apply for zero or negative gate voltage only.
(3) Half sine wave voltage pulse, 10 millisecond maximum duration.

Peak Positive Anode Voltage(1)	600 Volts
RMS On-State Current, $I_{T(RMS)}$	25 Amperes
Critical Rate-of-Rise of On-State Current, di/dt(2)	
Gate triggered operation: Switching from 300 volts	100 Amperes/μsec
Breakover voltage triggered operation	20 Amperes/μsec
Peak One Cycle Surge (non-rep) On-State Current, I_{TSM}	250 Amperes
I^2t (for fusing), for time = 1.0 millisecond	220 Ampere² seconds
Peak Gate Power Dissipation, P_{GM} ...... (See Chart 3)	5 Watts for 10 μsecs
Average Gate Power Dissipation, $P_{G(AV)}$	0.5 Watts
Storage Temperature, T_{STG}	−40°C to +100°C
Operating Temperature, T_J	−40°C to +100°C
Maximum Stud Torque (Type 2 only)	25 Lb-in (29 Kg-cm)

(1) This SCR may be, non-repetitively, turned-on in the forward direction by exceeding the breakover voltage (V_{DRM}) with either a rapidly or slowly rising waveform. At breakover, di/dt must be limited to 20 amps/μsec and peak current to 150 amperes.

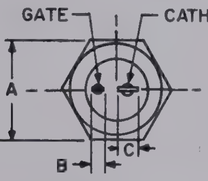
(2) di/dt rating is established in accordance with JEDEC Suggested Standard No. 7, Section 5.1.2.4. Off-state (blocking) voltage capability may be temporarily lost immediately after each current pulse for duration less than the period of applied pulse repetition rate. The pulse repetition rate for this test is 400 Hz. The duration of the JEDEC di/dt test condition is 5.0 seconds (min.). For gate trigger operation, the required gate drive is: 5 volts, 20 ohm source; 10 μsec pulse width minimum; 1.0 μsec rise time maximum; peak anode current must be limited to 150 amperes.

CHARACTERISTICS

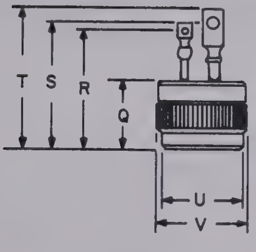
Test	Symbol	Min.	Max.	Units	Test Conditions
Peak Off-State and Reverse Current(1)	I_{DRM} & I_{RRM}			mA	$V_{DRM} = V_{RRM}$ = Rated Value
		—	1.0		$T_C = +100°C$
		—	0.5		$T_C = +25°C$
Critical Rate of Rise of Off-State Voltage. (Higher) values may cause device switching.)	dv/dt	20	—	Volts/μsec	$T_C = +100°C$, Rated V_{DRM}, Gate open circuited, Exponential waveform.
D.C. Gate Trigger Current	I_{GT}	—	25	mAdc	$T_C = +25°C$, $V_D = 6$ Vdc, $R_L = 60$ ohms
		—	40		$T_C = -40°C$, $V_D = 6$ Vdc, $R_L = 60$ ohms
D.C. Gate Trigger Voltage	V_{GT}	—	1.5	Vdc	$T_C = +25°C$, $V_D = 6$ Vdc, $R_L = 60$ ohms
		—	2.0		$T_C = -40°C$, $V_D = 6$ Vdc, $R_L = 60$ ohms
		0.2	—		$T_C = +100°C$, Rated V_{DRM}, $R_L = 1000$ ohms
Peak On-State Voltage	V_{TM}	—	1.5	Volts	$T_C = +25°C$, $I_{TM} = 50$ A peak, 1 msec wide pulse. Duty cycle $\leq 2\%$.
Holding Current	I_H		50	mAdc	$T_C = +25°C$, Anode Source Voltage = 24 Vdc, Peak initiating on-state current = 0.5 A.
Steady-State Thermal Resistance	θ_{J-C}	—	1.0	°C/watt	Junction-to-case.
Circuit Commutated Turn-Off Time	tq	—	20	μsec	$T_C = +100°C$, $I_{TM} = 35$A peak. Rectangular current pulse, 40 μsec duration. Commutation rate = −5 A/μsec. Peak reverse voltage = Rated volts max. Reverse voltage at end of turn-off time interval 12 volts min. Repetition rate = 60 pps. Rate of rise of re-applied off-stage voltage (dv/dt) = 20 V/μsec. Off-state voltage = Rated V. Gate bias during turn-off time interval = 0 volts, 100 ohms.

(1) Values apply for zero or negative gate voltage only. Maximum case-to-ambient thermal resistance for which V_{DRM} and V_{RRM} ratings apply equals 18°C per watt.

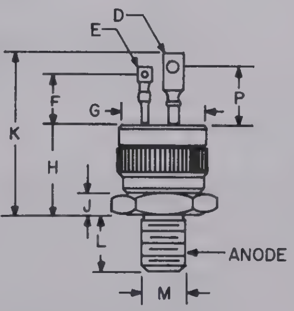
OUTLINE DRAWING



NOTE: One steel, cadmium-plated, external-toothed lock washer and one steel, cadmium-plated nut supplied with each Type 2 unit. Insulation hardware available upon request.



Type 1



Type 2

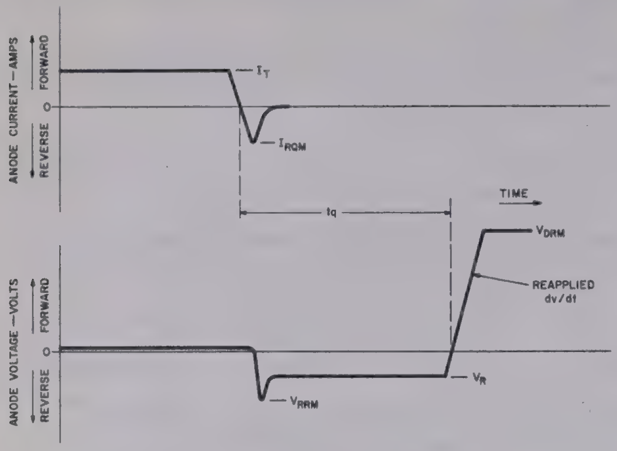
SYMBOL	DECIMAL INCHES		METRIC MM	
	Min.	Max.	Min.	Max.
A	.552	.562	14.020	14.275
B	.085	.115	2.159	2.291
C	.110	.135	2.794	3.429
D	.065	.075	1.651	1.905
E	.035	.045	.889	1.143
F	.260	.301	6.604	7.645
G	.490	.510	12.446	12.954
H	—	.475	—	12.065
J	.086	.098	2.184	2.489
K	—	.865	—	21.971
L	.432	.442	10.973	11.227
M	¼ — 28 UNF — 2A			
P	—	.350	—	8.890
Q	.340	.376	8.636	9.550
R	.600	.677	15.240	17.195
S	—	.726	—	23.216
T	—	.767	—	27.025
U	.466	.475	11.836	12.065
V	.501	.505	12.725	12.827

INSTALLATION OF PRESS-FIT DEVICES

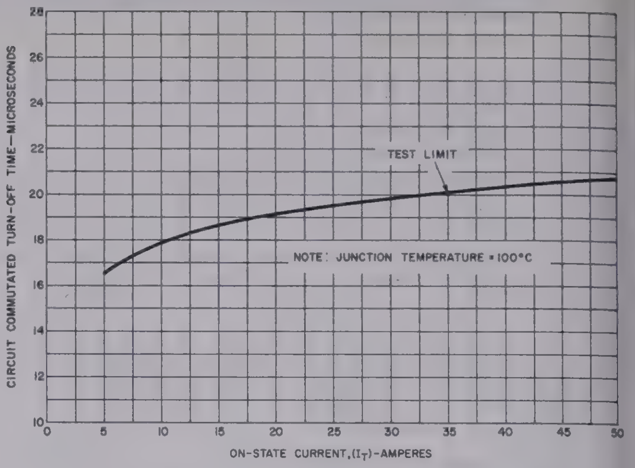
When press fitting an SCR into a heatsink, the following specifications and recommendations apply:

1. Heatsink materials may be copper, aluminum or steel. For maximum heat transfer and minimum corrosion problems, copper is recommended. The heatsink thickness, or amount of heatsink wall, in contact with the SCR should be ⅛ inch.
2. The hole diameter into which the SCR is pressed must be 0.4975 ± .001 inch. A slight chamfer on the hole should be used. This hole may be punched in a flat plate and reamed, or extruded and sized in sheet metal.
3. The entire knurled section of the SCR should be in contact with the heatsink to insure maximum heat transfer. The SCR must not be inserted into a heatsink deeper than the knurl height.
4. The SCR insertion force must not exceed 800 pounds. If the insertion force approaches this value before complete insertion, either the SCR is misaligned with the hole or the SCR-to-hole interference is excessive. The insertion force must be uniformly applied to the top face (terminal end) of the SCR within an annular ring which has an inside diameter of not less than 0.370 inch and not larger than 0.390 inch; the outside diameter of the insertion force must not be less than 0.500 inch.
5. The thermal resistance between the SCR case and a copper heatsink will not exceed 0.5°C/W, if the SCR is inserted in the manner described.

TURN-OFF TIME DATA

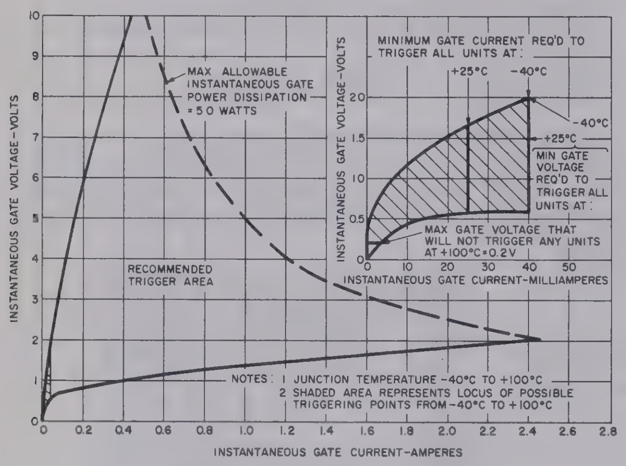

ANODE CURRENT—AMPS
FORWARD
REVERSE
0
I_T
I_{RQM}
tq
TIME
ANODE VOLTAGE —VOLTS
FORWARD
REVERSE
0
V_{DRM}
REAPPLIED dv/dt
V_R
V_{RRM}

1. Waveform Definition of Turn-Off Time with Reverse Voltage

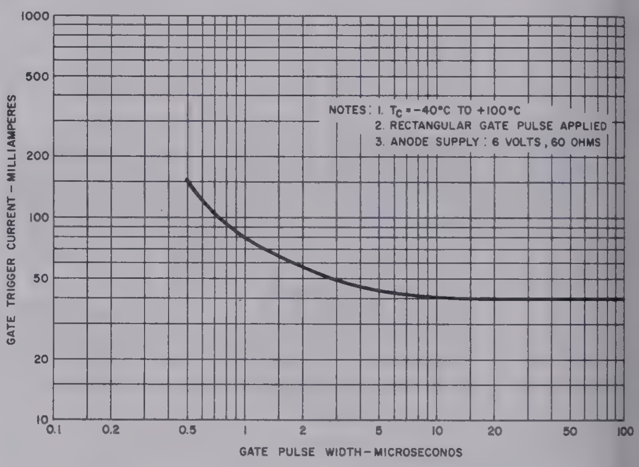


2. Variation of Maximum Circuit Commutated Turn-Off Time with On-State Current

TRIGGERING DATA

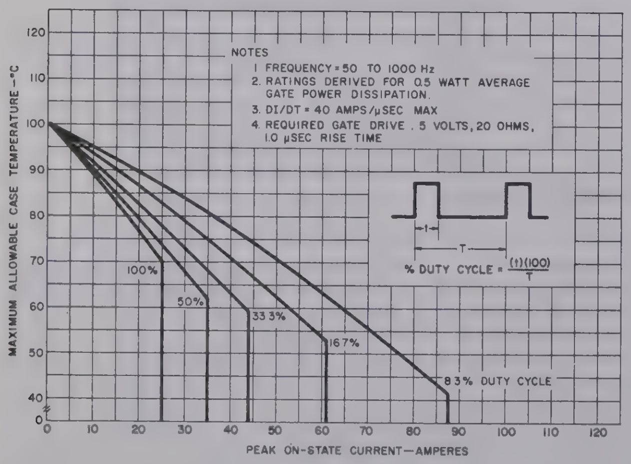


3. Gate Triggering Characteristics

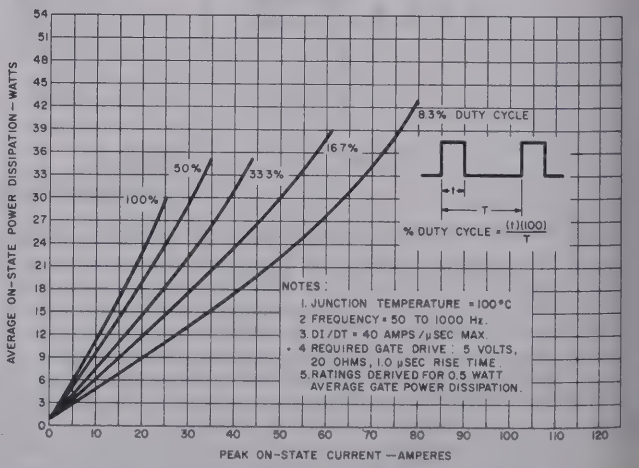


4. Variation of Maximum Gate Triggering Current with Gate Pulse Width

RECTANGULAR WAVE DATA

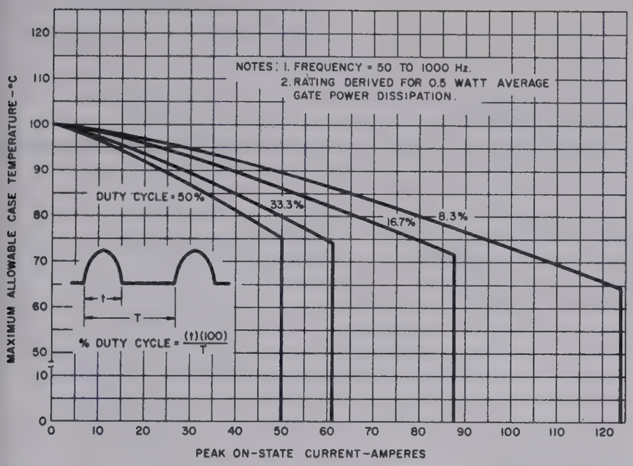


5. Maximum Allowable Case Temperature vs. On-State Current



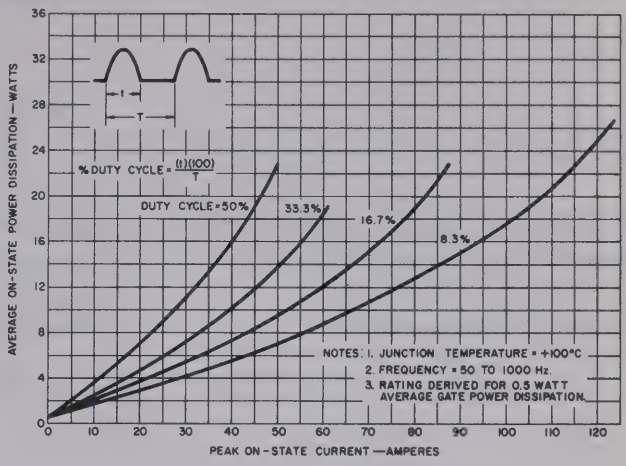
6. Maximum Allowable Power Dissipation vs. On-State Current

SINE WAVE DATA



NOTES: 1. FREQUENCY = 50 TO 1000 Hz.
2. RATING DERIVED FOR 0.5 WATT AVERAGE GATE POWER DISSIPATION.

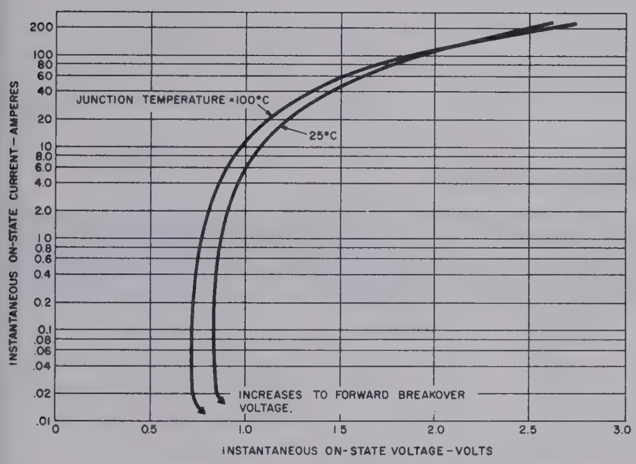
7. Maximum Allowable Case Temperature vs. On-State Current



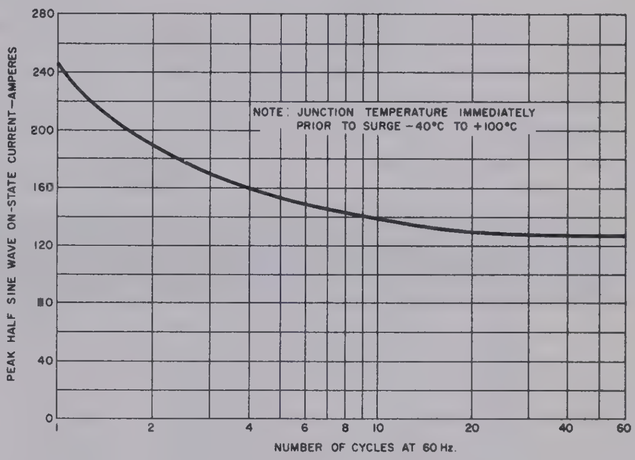
NOTES: 1. JUNCTION TEMPERATURE = +100°C
2. FREQUENCY = 50 TO 1000 Hz.
3. RATING DERIVED FOR 0.5 WATT AVERAGE GATE POWER DISSIPATION.

8. Maximum On-State Power Dissipation vs. On-State Current

LOW FREQUENCY DATA

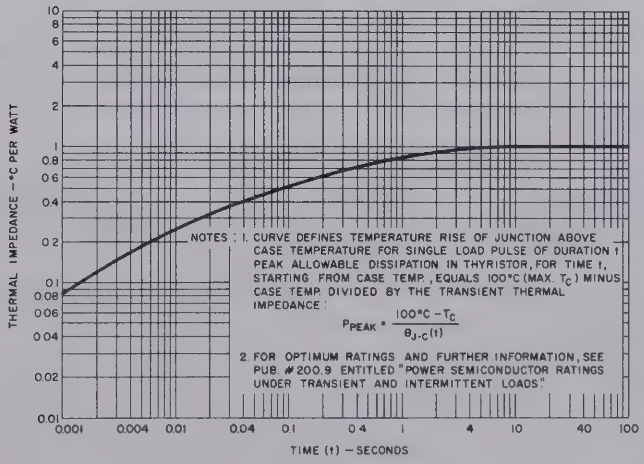


9. Maximum On-State Characteristics



NOTE: JUNCTION TEMPERATURE IMMEDIATELY PRIOR TO SURGE −40°C TO +100°C

10. Maximum Allowable Surge Current Following Rated Load Conditions



NOTES: 1. CURVE DEFINES TEMPERATURE RISE OF JUNCTION ABOVE CASE TEMPERATURE FOR SINGLE LOAD PULSE OF DURATION t PEAK ALLOWABLE DISSIPATION IN THYRISTOR, FOR TIME t, STARTING FROM CASE TEMP., EQUALS 100°C (MAX. T_C) MINUS CASE TEMP. DIVIDED BY THE TRANSIENT THERMAL IMPEDANCE:

$$P_{PEAK} = \frac{100°C - T_C}{\theta_{J-C}(t)}$$

2. FOR OPTIMUM RATINGS AND FURTHER INFORMATION, SEE PUB. #200.9 ENTITLED "POWER SEMICONDUCTOR RATINGS UNDER TRANSIENT AND INTERMITTENT LOADS."

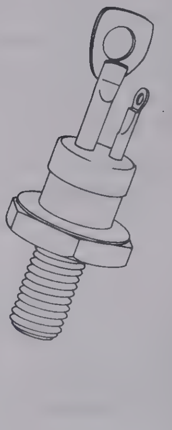
11. Maximum Transient Thermal Impedance (Junction to Case)

SCR

C35

35A RMS max. Up to 800 Volts

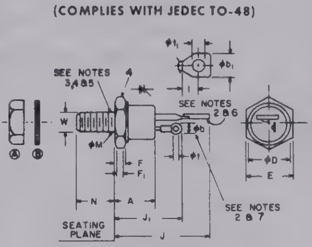
- No Peak Forward Voltage Limitation
- Broad Voltage Range-Up to 800V (400 Volt RMS Applications)
- Thermal Fatigue Free
- Standard TO-48 Outline
- Designed to Meet MIL-S-19500/108
- Backed by Years of Design and Field Experience



OUTLINE DRAWING
(COMPLIES WITH JEDEC TO-48)

NOTES.
1. Complete threads to extend to within 2½ threads of seating plane Diameter of unthreaded portion .249" (6 32MM) Maximum, .220" (5.59MM) Minimum.
2. Angular orientation of these terminals is undefined
3. ¼-28 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter .2268" (5.76MM), minimum pitch diameter .2225" (5 66MM), reference: screw thread standards for Federal Service 1957, Handbook H28, 1957, P1.
4. A chamfer (or undercut) on one or both ends of hexagonal portions is optional
5. Case is anode connection
6. Large terminal is cathode connection.
7. Small terminal is gate connection.
8. Insulating kit available upon request

A. ¼-28 steel nut, Ni. plated, 178 min thk.
B. Ext. tooth lockwasher, steel, Ni. plated, .023 min. thk.



SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	330	505	8 38	12 83	
φb	115	140	2 92	3 56	2
φb₁	210	300	5 33	7 62	2
φD		544		13 82	
E	544	562	13 82	14 27	
F	113	200	2 87	5 08	4
F₁	060		1 52		
J		1 193		30 30	
J₁		875		22 23	
I	120		3 05		
φM					1
N	422	453	10 72	11 51	
φT	060	075	1 52	1 91	
φT₁	125	165	3 18	4 19	
W					3

MAXIMUM ALLOWABLE RATINGS

TYPE†	PEAK FORWARD BLOCKING VOLTAGE V_{FOM} $T_C = -65°C$ to $+125°C$	REPETITIVE PEAK REVERSE VOLTAGE V_{ROM} (rep)* $T_C = -65°C$ to $+125°C$	NON-REPETITIVE PEAK REVERSE VOLTAGE (<5.0 MILLISEC.) V_{ROM} (non-rep)* $T_C = -65°C$ to $+125°C$
C35U	25 Volts	25 Volts	35 Volts
C35F	50 Volts	50 Volts	75 Volts
C35A	100 Volts	100 Volts	150 Volts
C35G	150 Volts	150 Volts	225 Volts
C35B	200 Volts	200 Volts	300 Volts
C35H	250 Volts	250 Volts	350 Volts
C35C	300 Volts	300 Volts	400 Volts
C35D	400 Volts	400 Volts	500 Volts
C35E	500 Volts	500 Volts	600 Volts
C35M	600 Volts	600 Volts	720 Volts
C35S	700 Volts	700 Volts	840 Volts
C35N	800 Volts	800 Volts	960 Volts

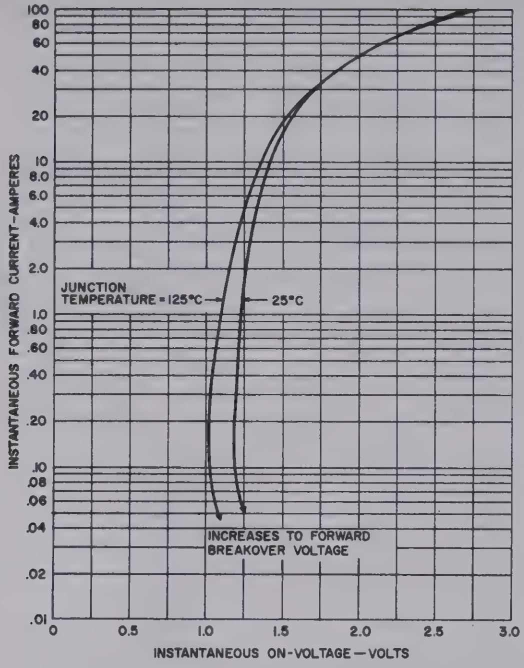
*Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for which maximum V_{FOM} and V_{ROM} ratings apply equals 11°C/watt.
†Devices are marked as indicated in this column.

RMS Forward Current, On-State	35 amperes (all conduction angles)
Average Forward Current, On-State	Depends on conduction angle (see Chart 3, 5, and 7)
Peak One-cycle Surge Forward Current, I_{FM} (surge)	225 amperes
I^2t (for fusing)	75 ampere² seconds (for times ≧1.5 milliseconds)
Peak Gate Power Dissipation, P_{GM}	5 watts
Average Gate Power Dissipation, $P_{G\ (AV)}$	0.5 watts
Peak Reverse Gate Voltage, V_{GRM}	5 volts
Storage Temperature, T_{stg}	−65°C to +150°C
Operating Temperature, T_J	−65°C to +125°C
Stud Torque	30 lb.-inch, (35 kg-cm)
Turn-On Current Limit	See Chart 11

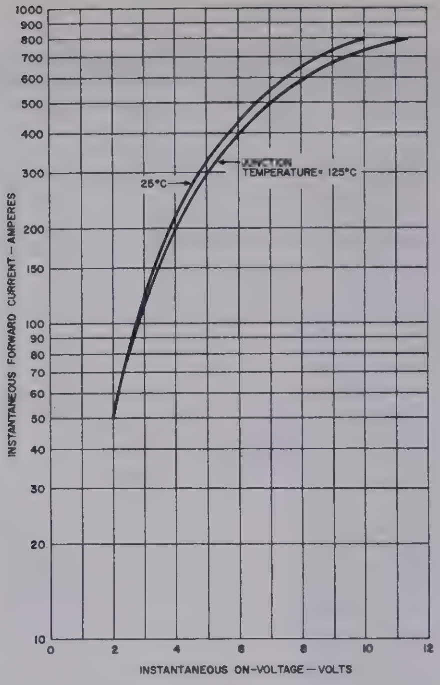
CHARACTERISTICS

TEST	SYMBOL	MIN.	MAX.	UNITS	TEST CONDITIONS
PEAK REVERSE OR FORWARD BLOCKING CURRENT†	I_{ROM} or I_{FOM}			mA	$T_C = -65$°C to $+125$°C
C35U (2N681)		—	13.0		$V_{ROM} = V_{FOM} =$ 25V Peak
C35F (2N682)		—	13.0		= 50V
C35A (2N683)		—	13.0		= 100V
C35G (2N684)		—	13.0		= 150V
C35B (2N685)		—	12.0		= 200V
C35H (2N686)		—	11.0		= 250V
C35C (2N687)		—	10.0		= 300V
C35D (2N688)		—	8.0		= 400V
C35E (2N689)		—	6.0		= 500V
C35M (2N690)		—	5.0		= 600V
C35S (2N691)		—	4.5		= 700V
C35N (2N692)		—	4.0		= 800V
FULL CYCLE AVG. REVERSE OR FORWARD BLOCKING CURRENT†	$I_{RX\ (AV)}$ or $I_{FX\ (AV)}$			mA	$T_C = +65$°C, $I_O = 16A$ 180° Conduction Angle
C35U (2N681)		—	6.5		$V_{RXM} = V_{FXM} =$ 25V Peak
C35F (2N682)		—	6.5		= 50V
C35A (2N683)		—	6.5		= 100V
C35G (2N684)		—	6.5		= 150V
C35B (2N685)		—	6.0		= 200V
C35H (2N686)		—	5.5		= 250V
C35C (2N687)		—	5.0		= 300V
C35D (2N688)		—	4.0		= 400V
C35E (2N689)		—	3.0		= 500V
C35M (2N690)		—	2.5		= 600V
C35S (2N691)		—	2.25		= 700V
C35N (2N692)		—	2.0		= 800V
GATE TRIGGER CURRENT	I_{GT}	—	40	mAdc	$T_C = +25$°C, $V_{FX} = 12$ Vdc, $R_L = 50$ ohms
		—	80	mAdc	$T_C = -65$°C, $V_{FX} = 12$ Vdc, $R_L = 50$ ohms
GATE TRIGGER VOLTAGE	V_{GT}	—	3.0	Vdc	$T_C = -65$°C to 125°C, $V_{FX} = 12$ Vdc, $R_L = 50$ ohms
		0.25	—	Vdc	$T_C = +125$°C, $V_{FXM} =$ Rated V_{FOM}, $R_L = 1000$ ohms
PEAK ON-VOLTAGE	V_{FM}	—	2.0	V	$T_C = +25$°C, $I_{FM} = 50A$ Peak, 1 millisecond wide pulse
HOLDING CURRENT	I_{HO}	—	100	mAdc	$T_C = +25$°C, Anode supply = 24 Vdc, Gate Supply = 10V, 20 ohms, 45 μsec min. pulse width. Initial forward current pulse = 0.5A, 0.1 millisecond to 10 milliseconds wide.
CRITICAL RATE OF RISE OF FORWARD BLOCKING VOLTAGE (Higher values may cause device switching)	dv/dt			V/μsec.	$T_C = +125$°C. Gate open circuited. $V_{FOM} =$ Rated.
C35U		10	—		
C35F		10	—		
C35A		20	—		
C35G		20	—		
C35B		20	—		
C35H		20	—		
C35C		25	—		
C35D		25	—		
C35E		25	—		
C35M		10	—		
C35S		10	—		
C35N		10	—		
CIRCUIT COMMUTATED TURN-OFF TIME	t_{off}	—	75	μsec.	$T_C = 125$°C, Rectangular current waveform. Rate of rise of current $<10A/\mu sec$. Rate of fall of current $\leqq 5A/\mu sec$. $I_{FM} = 10A$ (50 μsec pulse). Repetition rate = 60 Hz. $V_{RXM} \leqq$ Rated. Reverse voltage at end of turn-off time interval $V_{RX} = 15V$. $V_{FXM} =$ Rated. Rate of rise of reapplied forward voltage = 10V/μsec (C35U, C35F, C35M, C35S, C35N). Rate of rise of reapplied forward voltage = 20V/μsec (C35A, C35G, C35B, C35H, C35C, C35D, C35E). Gate bias = 0 Volts, 100 ohms (during turnoff interval).
EFFECTIVE THERMAL RESISTANCE (DC)	θ_{J-C}	—	1.7	°C/watt	

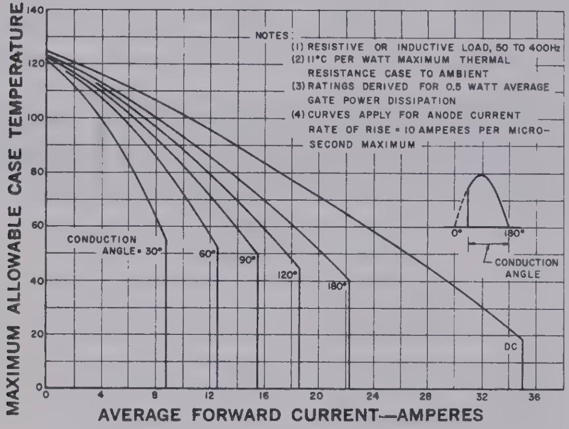
†Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for which maximum V_{FOM} and V_{ROM} ratings apply equals 11°C/watt.



1. MAXIMUM FORWARD CHARACTERISTICS—ON-STATE

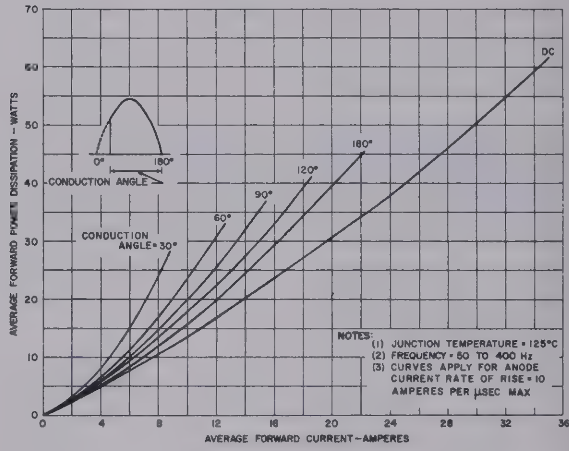


2. MAXIMUM FORWARD CHARACTERISTICS—HIGH CURRENT LEVEL—ON-STATE



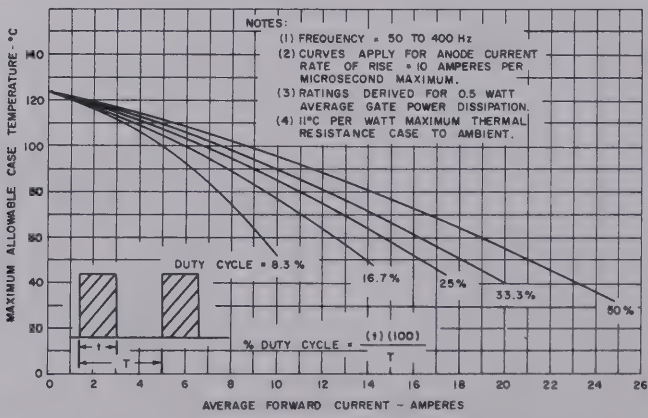
NOTES:
(1) RESISTIVE OR INDUCTIVE LOAD, 50 TO 400Hz
(2) 11°C PER WATT MAXIMUM THERMAL RESISTANCE CASE TO AMBIENT
(3) RATINGS DERIVED FOR 0.5 WATT AVERAGE GATE POWER DISSIPATION
(4) CURVES APPLY FOR ANODE CURRENT RATE OF RISE = 10 AMPERES PER MICROSECOND MAXIMUM

3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



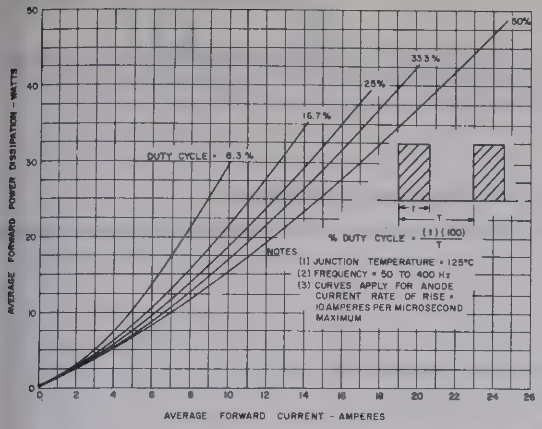
NOTES:
(1) JUNCTION TEMPERATURE = 125°C
(2) FREQUENCY = 50 TO 400 Hz
(3) CURVES APPLY FOR ANODE CURRENT RATE OF RISE = 10 AMPERES PER μSEC MAX

4. FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM

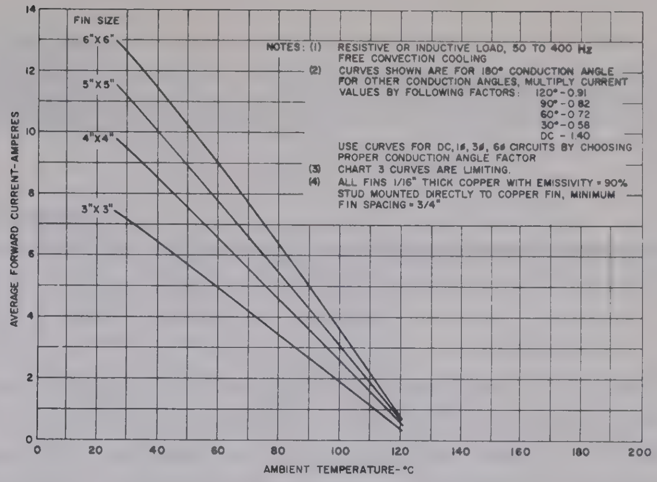


NOTES:
(1) FREQUENCY = 50 TO 400 Hz
(2) CURVES APPLY FOR ANODE CURRENT RATE OF RISE = 10 AMPERES PER MICROSECOND MAXIMUM.
(3) RATINGS DERIVED FOR 0.5 WATT AVERAGE GATE POWER DISSIPATION.
(4) 11°C PER WATT MAXIMUM THERMAL RESISTANCE CASE TO AMBIENT.

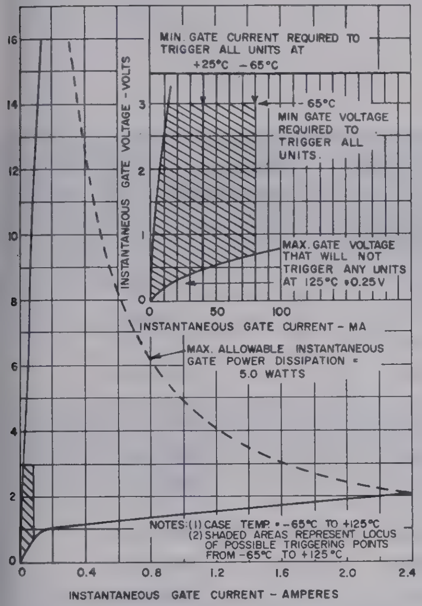
5. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



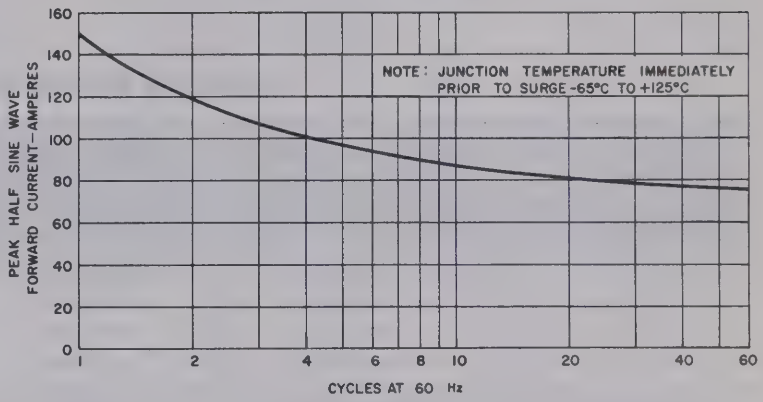
6. FORWARD POWER DISSIPATION
FOR RECTANGULAR CURRENT WAVEFORM



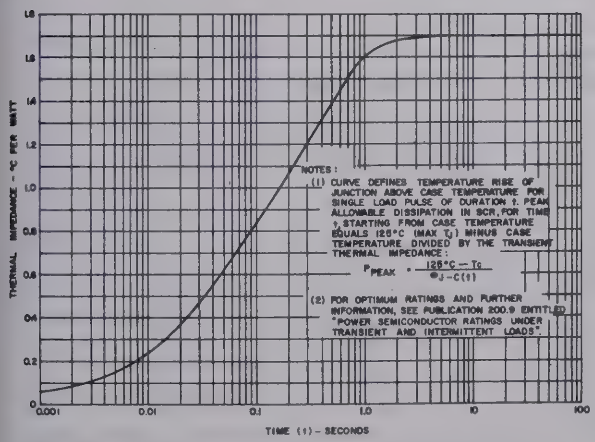
7. MAXIMUM FORWARD CURRENT VS. AMBIENT TEMPERATURE
FOR VARIOUS FIN SIZES



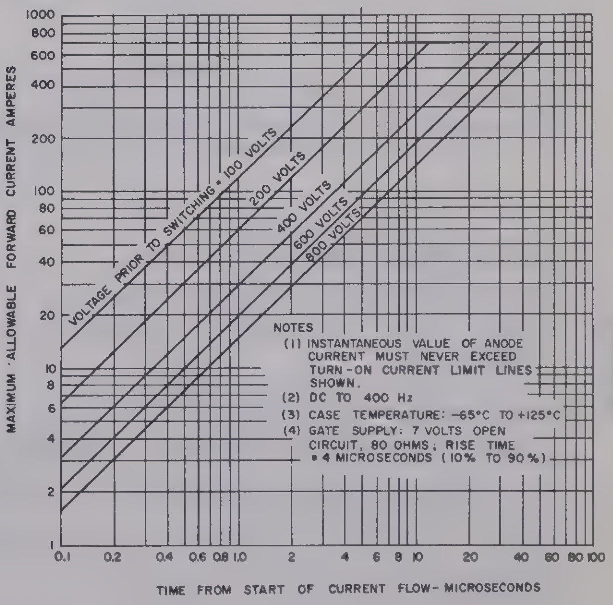
8. GATE TRIGGERING CHARACTERISTICS



9. MAXIMUM ALLOWABLE NON-RECURRENT PEAK SURGE
FORWARD CURRENT AT RATED LOAD CONDITIONS



. MAXIMUM TRANSIENT THERMAL IMPEDANCE—JUNCTION TO CASE



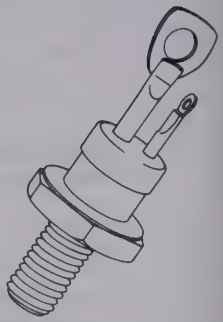
11. TURN-ON CURRENT LIMIT

SCR

800 Volts 25 A. RMS Max. 105°C Max. Case Temperature

The C37 Silicon Controlled Rectifier is a three-junction semiconductor device for use in power switching and control applications requiring a blocking voltage of 800 volts or less and average load currents up to 16 amperes. Its low cost makes it suitable for high volume consumer/industrial applications.

An ideal inexpensive trigger device for this Controlled Rectifier is a Silicon Unijunction transistor, such as type 2N2647.



MAXIMUM ALLOWABLE RATINGS

TYPE	PEAK FORWARD BLOCKING VOLTAGE, V_{FOM} $T_C = -40°C$ to $+105°C$	PEAK FORWARD VOLTAGE, PFV $T_C = -40°C$ to $+105°C$	REPETITIVE PEAK REVERSE VOLTAGE, V_{ROM} (rep)(1) $T_C = -40°C$ to $+105°C$	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{ROM} (non-rep)(1) $T_C = -40°C$ to $+105°C$
C37U	25 volts	480 volts	25 volts	40 volts
C37F	50 volts	480 volts	50 volts	75 volts
C37A	100 volts	480 volts	100 volts	150 volts
C37B	200 volts	480 volts	200 volts	300 volts
C37C	300 volts	480 volts	300 volts	400 volts
C37D	400 volts	500 volts	400 volts	500 volts
C37E	500 volts	600 volts	500 volts	600 volts
C37M	600 volts	720 volts	600 volts	720 volts
C37S	700 volts	840 volts	700 volts	840 volts
C37N	800 volts	960 volts	800 volts	960 volts

(1) Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for which maximum V_{FOM} and V_{ROM} ratings apply equals 11°C per watt.

RMS Forward Current, On-State	25 amperes
Average Forward Current, On-State	Depends on conduction angle (See Charts 3 and 5)
Peak One Cycle Surge Forward Current, I_{FM} (surge)	125 amperes
I^2t (for fusing)	40 ampere^2 seconds (for times $\geq$1.5 milliseconds)
Peak Gate Power Dissipation, P_{GM}	5.0 watts
Average Gate Power Dissipation, P_G (AV)	0.5 watts
Peak Reverse Gate Voltage, V_{GRM}	10 volts
Storage Temperature, T_{stg}	−40°C to +105°C
Operating Temperature, T_J	−40°C to +105°C
Stud Torque	30 inch-pounds (35 kg-cm)

CHARACTERISTICS

TEST	SYMBOL	MIN.	MAX.	UNITS	TEST CONDITIONS
PEAK FORWARD OR REVERSE BLOCKING CURRENT⁽¹⁾	I_{FOM} or I_{ROM}			ma	$T_C = -40°C$ to $+105°C$
C37U		—	13.0		$V_{FOM} = V_{ROM} = 25$ Volts Peak
C37F		—	13.0		$V_{FOM} = V_{ROM} = 50$ Volts Peak
C37A		—	13.0		$V_{FOM} = V_{ROM} = 100$ Volts Peak
C37B		—	12.0		$V_{FOM} = V_{ROM} = 200$ Volts Peak
C37C		—	10.0		$V_{FOM} = V_{ROM} = 300$ Volts Peak
C37D		—	8.0		$V_{FOM} = V_{ROM} = 400$ Volts Peak
C37E		—	6.0		$V_{FOM} = V_{ROM} = 500$ Volts Peak
C37M		—	5.0		$V_{FOM} = V_{ROM} = 600$ Volts Peak
C37S		—	4.5		$V_{FOM} = V_{ROM} = 700$ Volts Peak
C37N		—	4.0		$V_{FOM} = V_{ROM} = 800$ Volts Peak
FULL CYCLE AVERAGE FORWARD OR REVERSE BLOCKING CURRENT⁽¹⁾	$I_{FX(AV)}$ or $I_{RX(AV)}$			ma	$T_C = +60°C$, $I_0 = 11.0$ Amperes 180° Conduction Angle
C37U		—	6.5		$V_{FXM} = V_{RXM} = 25$ Volts Peak
C37F		—	6.5		$V_{FXM} = V_{RXM} = 50$ Volts Peak
C37A		—	6.5		$V_{FXM} = V_{RXM} = 100$ Volts Peak
C37B		—	6.0		$V_{FXM} = V_{RXM} = 200$ Volts Peak
C37C		—	5.0		$V_{FXM} = V_{RXM} = 300$ Volts Peak
C37D		—	4.0		$V_{FXM} = V_{RXM} = 400$ Volts Peak
C37E		—	3.0		$V_{FXM} = V_{RXM} = 500$ Volts Peak
C37M		—	2.5		$V_{FXM} = V_{RXM} = 600$ Volts Peak
C37S		—	2.25		$V_{FXM} = V_{RXM} = 700$ Volts Peak
C37N		—	2.0		$V_{FXM} = V_{RXM} = 800$ Volts Peak
ATE TRIGGER CURRENT	I_{GT}	—	80.0	madc	$T_C = +25°C$, $V_{FX} = 12$ Vdc, $R_L = 50$ ohms
		—	150.0	madc	$T_C = -40°C$, $V_{FX} = 12$ Vdc, $R_L = 50$ ohms
ATE TRIGGER VOLTAGE	V_{GT}	—	3.5	Vdc	$T_C = -40°C$ to $105°C$, $V_{FX} = 12$ Vdc, $R_L = 50$ ohms
		0.25	—	Vdc	$T_C = +105°C$, V_{FXM} = Rated V_{FOM}, $R_L = 1000$ ohms
PEAK ON-VOLTAGE	V_{FM}	—	2.25	Volts	$T_C = +25°C$, $I_{FM} = 30$ amperes peak, 1 millisecond wide pulse. Duty Cycle $\leqq 1\%$.

)Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for which maximum V_{FOM} and V_{ROM} ratings apply equals 11°C per watt.

IOTE:

or applications where the rate of anode current rise (di/dt) exceeds 10 amperes per microsecond, please contact your Local -E Sales Representative for component selection.

OUTLINE DRAWING

(COMPLIES WITH JEDEC TO-48)

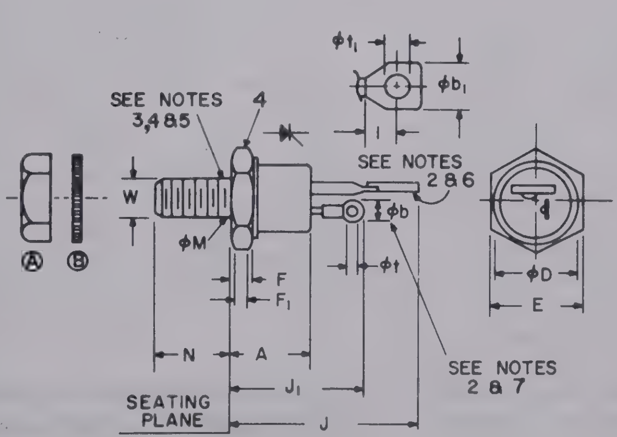
NOTES:

1. Complete threads to extend to within 2½ threads of seating plane. Diameter of unthreaded portion .249″ (6.32MM) Maximum, .220″ (5.59MM) Minimum.
2. Angular orientation of these terminals is undefined.
3. ¼-28 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter .2268″ (5.76MM), minimum pitch diameter .2225″ (5.66MM), reference: screw thread standards for Federal Service 1957, Handbook H28, 1957, P1.
4. A chamfer (or undercut) on one or both ends of hexagonal portions is optional.
5. Case is anode connection.
6. Large terminal is cathode connection.
7. Small terminal is gate connection.
8. Insulating kit available upon request.

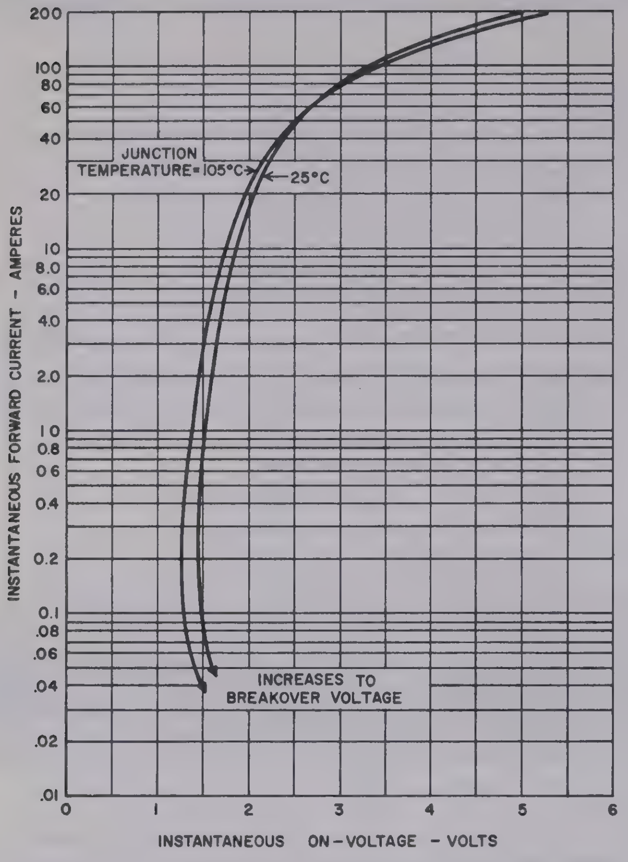
A. ¼-28 steel nut, Ni. plated, .178 min. thk.

B. Ext. tooth lockwasher, steel, Ni. plated, .023 min. thk.

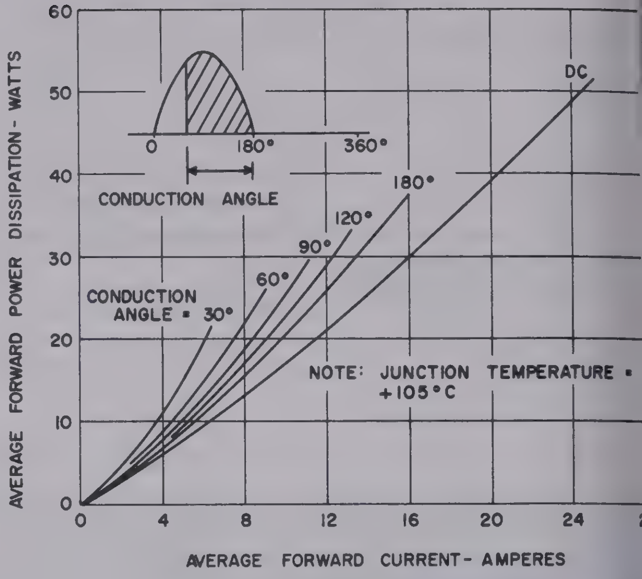
(COMPLIES WITH JEDEC TO-48)



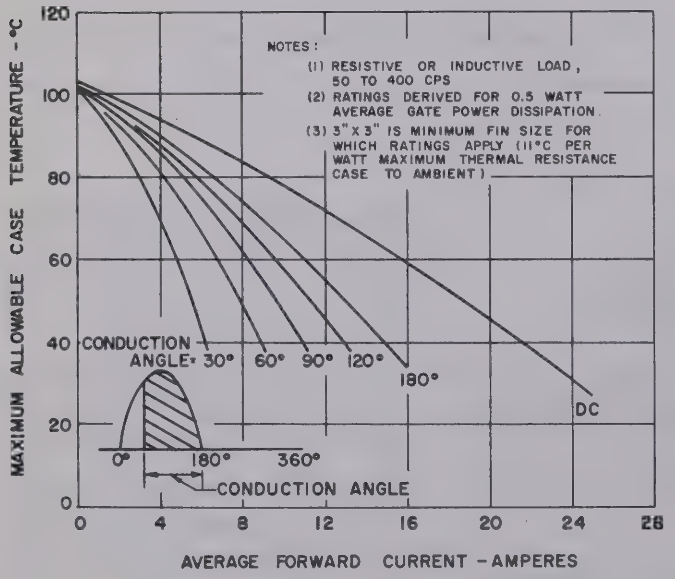
SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	330	.505	8.38	12.83	
ϕb	.115	.140	2.92	3.56	2
ϕb₁	.210	.300	5.33	7.62	2
ϕD		.544		13.82	
E	.544	.562	13.82	14.27	
F	.113	.200	2.87	5.08	4
F₁	.060		1.52		
J		1.193		30.30	
J₁		.875		22.23	
l	.120		3.05		
ϕM					1
N	.422	.453	10.72	11.51	
ϕt	.060	.075	1.52	1.91	
ϕt₁	.125	.165	3.18	4.19	
W					3



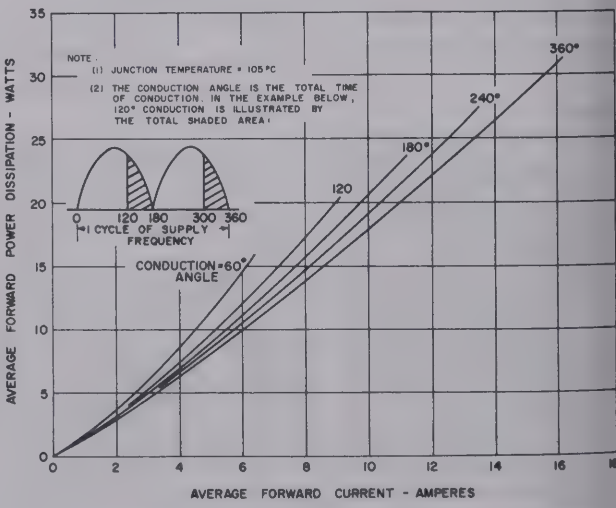
1. MAXIMUM FORWARD CHARACTERISTICS, CONDUCTING STATE



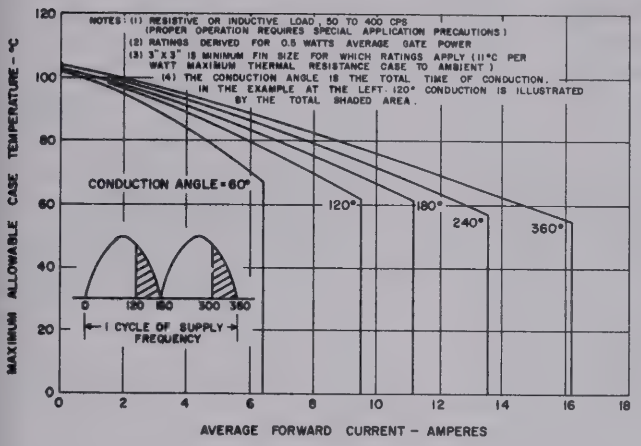
2. MAXIMUM POWER DISSIPATION FOR HALF WAVE RECTIFIED SINE WAVE OF CURRENT



3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR HALF WAVE RECTIFIED SINE WAVE OF CURRENT

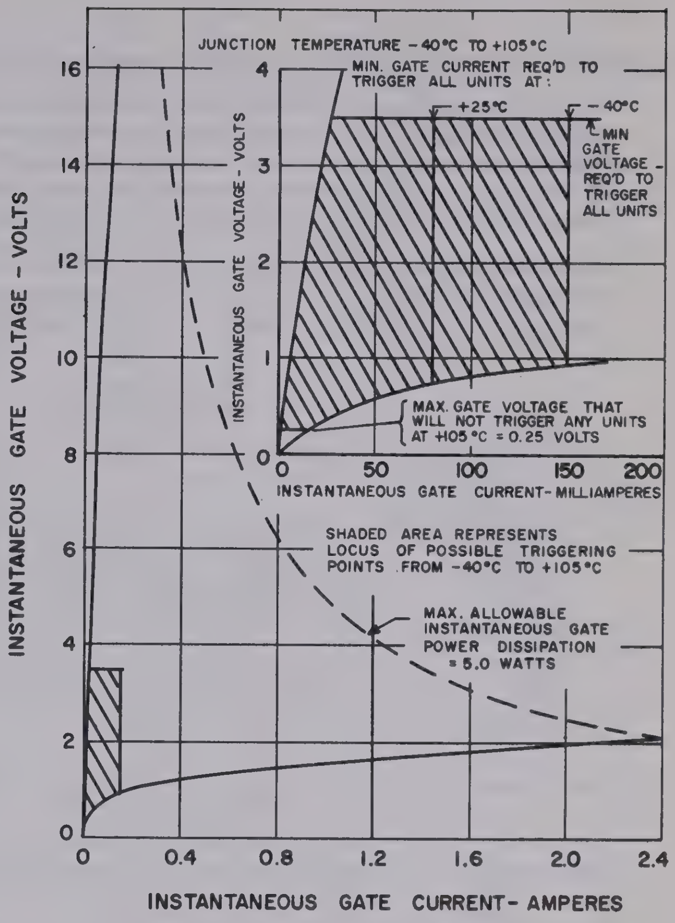


4. MAXIMUM FORWARD POWER DISSIPATION FOR FULL WAVE RECTIFIED SINE WAVE OF CURRENT

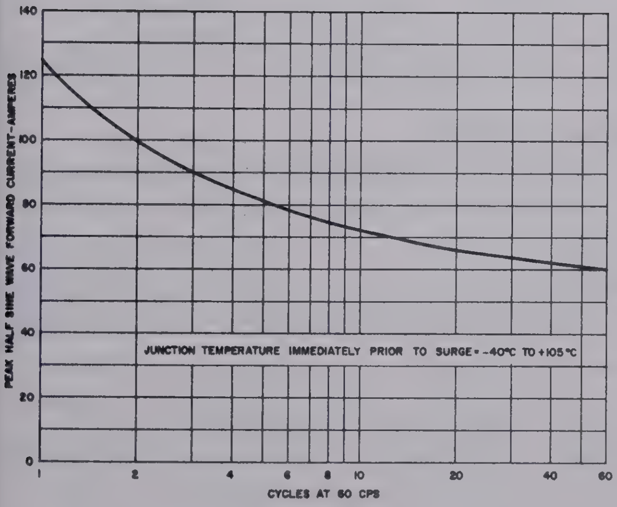


NOTES: (1) RESISTIVE OR INDUCTIVE LOAD, 50 TO 400 CPS (PROPER OPERATION REQUIRES SPECIAL APPLICATION PRECAUTIONS)
(2) RATINGS DERIVED FOR 0.5 WATTS AVERAGE GATE POWER
(3) 3" X 3" IS MINIMUM FIN SIZE FOR WHICH RATINGS APPLY (11°C PER WATT MAXIMUM THERMAL RESISTANCE CASE TO AMBIENT)
(4) THE CONDUCTION ANGLE IS THE TOTAL TIME OF CONDUCTION. IN THE EXAMPLE AT THE LEFT 120° CONDUCTION IS ILLUSTRATED BY THE TOTAL SHADED AREA.

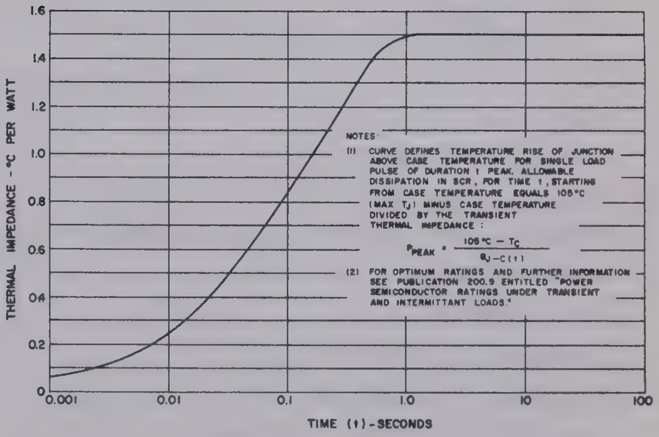
5. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR FULL WAVE RECTIFIED SINE WAVE OF CURRENT



6. GATE TRIGGER CHARACTERISTICS



MAXIMUM ALLOWABLE NON-RECURRENT PEAK SURGE FORWARD CURRENT AT RATED LOAD CONDITIONS



NOTES:
(1) CURVE DEFINES TEMPERATURE RISE OF JUNCTION ABOVE CASE TEMPERATURE FOR SINGLE LOAD PULSE OF DURATION t PEAK. ALLOWABLE DISSIPATION IN SCR, FOR TIME t, STARTING FROM CASE TEMPERATURE EQUALS 105°C (MAX T_J) MINUS CASE TEMPERATURE DIVIDED BY THE TRANSIENT THERMAL IMPEDANCE:

$$P_{PEAK} = \frac{105\,^\circ C - T_C}{\theta_{J-C}(t)}$$

(2) FOR OPTIMUM RATINGS AND FURTHER INFORMATION SEE PUBLICATION 200.9 ENTITLED "POWER SEMICONDUCTOR RATINGS UNDER TRANSIENT AND INTERMITTANT LOADS."

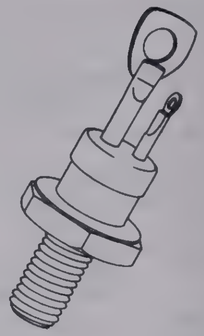
8. MAXIMUM TRANSIENT THERMAL IMPEDANCE — JUNCTION TO CASE

SCR

C38

The C38 Silicon Controlled Rectifier is a three junction semiconductor device for use in power switching and control applications requiring a blocking voltage of 500 volts or less and RMS Forward Currents up to 35 amperes. Because of its higher Junction Temperature Rating than the C35 (2N681-92) series, it will prove useful in applications calling for higher ambient temperatures or smaller heat sinks than the C35 series permits.

- No Peak Forward Voltage Limitation
- Thermal Fatigue Free
- High Junction Temperature (150°C)
- Standard TO-48 Outline
- Long Creepage Path
- Low Thermal Resistance

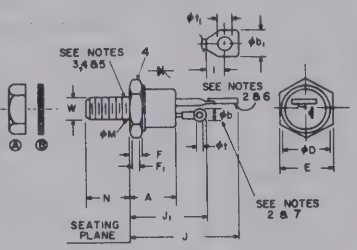


OUTLINE DRAWING
(COMPLIES WITH JEDEC TO-48)

NOTES:
1. Complete threads to extend to within 2½ threads of seating plane. Diameter of unthreaded portion .249" (6.32MM) Maximum, .220" (5.59MM) Minimum.
2. Angular orientation of these terminals is undefined.
3. ¼-28 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter .2268" (5.76MM), minimum pitch diameter .2225" (5.66MM), reference: screw thread standards for Federal Service 1957, Handbook H28, 1957, P1.
4. A chamfer (or undercut) on one or both ends of hexagonal portions is optional.
5. Case is anode connection.
6. Large terminal is cathode connection.
7. Small terminal is gate connection.
8. Insulating kit available upon request.

A. ¼-28 steel nut, Ni. plated, .178 min. thk.
B. Ext. tooth lockwasher, . steel, Ni. plated, .023 min. thk.

(COMPLIES WITH JEDEC TO-48)



SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	330	.505	8.38	12.83	
φb	.115	.140	2.92	3.56	2
φb₁	.210	.300	5.33	7 62	2
φD		544		13.82	
E	.544	.562	13.82	14 27	
F	.113	.200	2 87	5 08	4
F₁	.060		1 52		
J		1 193		30 30	
J₁		.875		22 23	
l	.120		3.05		
φM					1
N	.422	.453	10 72	11 51	
φt	060	075	1 52	1 91	
φt₁	.125	165	3 18	4 19	
W					3

Type	Minimum Forward Breakover Voltage (V_{BO})* $T_J = -65°C$ to $+150°C$	Repetitive Peak Reverse Voltage (PRV)* $T_J = -65°C$ to $+150°C$	Transient Peak Reverse Voltage (Non-recurrent <5.0 Millisec.)* $T_J = -65°C$ to $+150°C$
C38U	25 volts	25 volts	35 volts
C38F	50 volts	50 volts	75 volts
C38A	100 volts	100 volts	150 volts
C38G	150 volts	150 volts	225 volts
C38B	200 volts	200 volts	300 volts
C38H	250 volts	250 volts	350 volts
C38C	300 volts	300 volts	400 volts
C38D	400 volts	400 volts	500 volts
C38E	500 volts	500 volts	600 volts

*Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for which maximum PRV ratings apply — equals 11°C/watt.

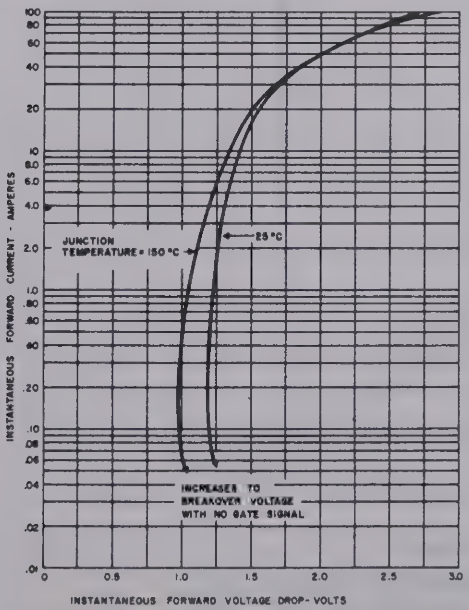
MAXIMUM ALLOWABLE RATINGS

RMS Forward Current	35 amperes (all conduction angles)
Average Forward Current (I_O)	Depends on conduction angle (see charts 3 & 5)
Peak One-cycle Non-recurrent Surge Current (i_{surge})	150 amperes
Peak Non-recurrent Surge Current during Turn-on time Interval	See Chart 10
I^2t (for fusing)	75 ampere² seconds (for times ≧ 1.5 milliseconds)
Peak Gate Power (p_G)	12 watts
Average Gate Power (P_G)	0.5 watt
Peak Gate Current (i_G)	2.0 amperes
Peak Gate Voltage (v_G) (Forward and Reverse)	10 volts
Storage Temperature	−65°C to + 150°C
Operating Temperature	−65°C to + 150°C
Stud Torque	30 inch-pounds

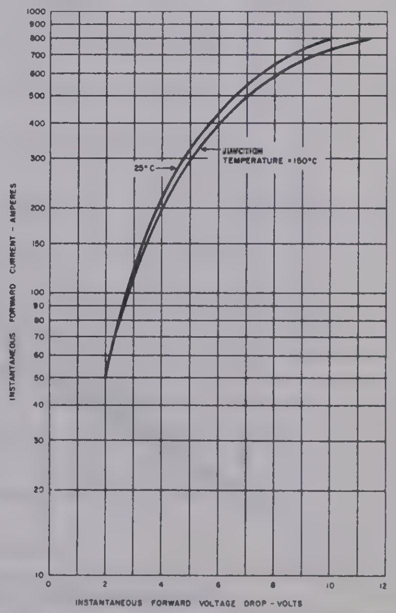
CHARACTERISTICS

Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Peak Reverse and Forward Blocking Current*	i_R and i_S					$T_J = 25°C$
C38U		——	6.0	10.0	ma	$v_{AC} = v_{CA} =$ 25v peak
C38F		——	5.5	10.0	ma	50
C38A		——	5.0	10.0	ma	100
C38G		——	4.5	10.0	ma	150
C38B		——	4.0	8.0	ma	200
C38H		——	3.0	6.0	ma	250
C38C		——	2.5	5.0	ma	300
C38D		——	2.0	4.0	ma	400
C38E		——	1.5	3.0	ma	500
Peak Reverse and Forward Blocking Current*	i_R and i_S					$T_J = 150°C$
C38U		——	9.0	13.0	ma	$v_{AC} = v_{CA} =$ 25v peak
C38F		——	8.9	13.0	ma	50
C38A		——	7.8	13.0	ma	100
C38G		——	7.7	13.0	ma	150
C38B		——	7.5	12.0	ma	200
C38H		——	7.3	11.0	ma	250
C38C		——	6.8	10.0	ma	300
C38D		——	5.3	8.0	ma	400
C38E		——	2.6	6.0	ma	500
Rate of Rise of Forward Voltage that Will Not Turn on SCR**	dv/dt	20.0	40.0	——	volts/μsec	$T_J = 150°C$. Gate open circuited. v_{AC} = Rated.
Gate Current to Fire	I_{GF}	——	15	40	mAdc	$T_J = 25°C$, $V_{AC} = 6$ Vdc, $R_L = 50$ ohms
		——	35	80	mAdc	$T_J = -65°C$, $V_{AC} = 6$ Vdc, $R_L = 50$ ohms
		——	7.5	20	mAdc	$T_J = 150°C$, $V_{AC} = 6$ Vdc, $R_L = 50$ ohms
Gate Voltage to Fire	V_{GF}	——	1.2	3.0	Vdc	$V_{AC} = 6$ Vdc, $T_J = 25°C$, $R_L = 50$ ohms
		——	2.0	3.0	Vdc	$V_{AC} = 6$ Vdc, $T_J = -65°C$, $R_L = 50$ ohms
		0.15	——	——	Vdc	v_{AC} = Rated, $T_J = 150°C$, $R_L = 1000$ ohms
Forward Voltage Drop	v_F	——	1.7	2.0	v	$i_F = 50$a peak, $T_J = 25°C$
Holding Current	I_H	——	10	80	mAdc	$T_J = 25°C$, Anode Supply = 6 Vdc
Turn-on Time	$t_d + t_r$	——	1.4	——	μsec	$T_J = 25°C$, $I_F = 5.0$ Adc, v_{AC} = Rated. Gate supply: 10 volt open circuit, 25 ohm, 0.1 μsec. max. rise time.
Turn-off Time	t_{off}	——	24	——	μsec	$T_J = 150°C$, $i_F = 10$a, $i_R = 5$a, v_{AC} (reapplied) = Rated, dv/dt = 20v/μsec Linear
Thermal Resistance	$\theta_{J\text{-}C}$	——	.75	1.5	°C/watt	Junction to case

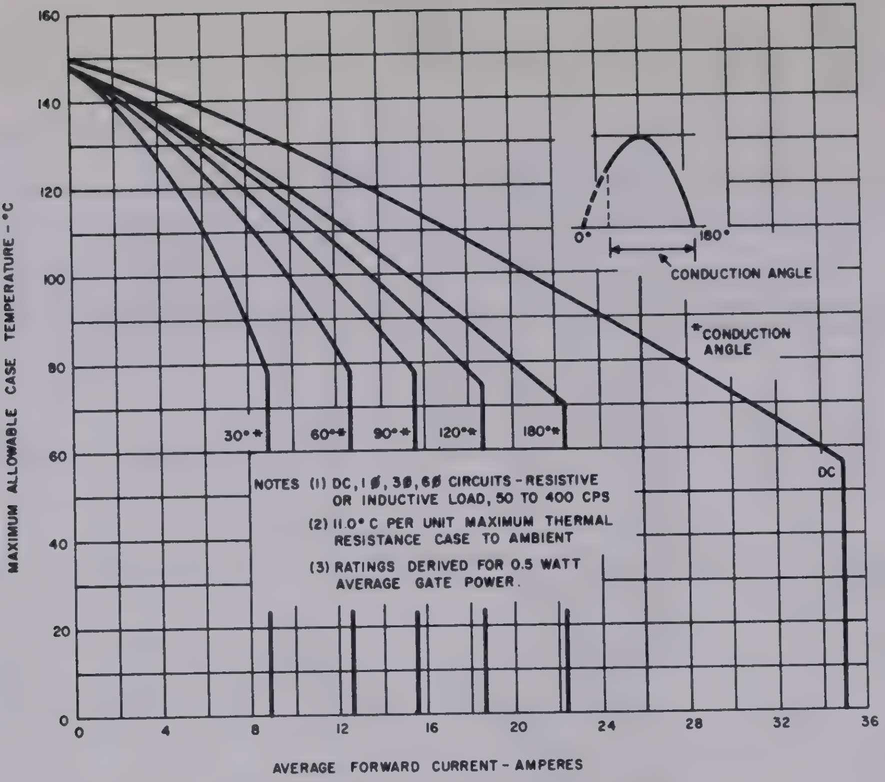
*Values apply for zero or negative gate voltage. Max. case to ambient thermal resistance for which max. PRV ratings apply = 11°C per watt.
**See Chart 8.



1. MAXIMUM FORWARD CHARACTERISTICS CONDUCTING STATE



2. MAXIMUM FORWARD CHARACTERISTICS HIGH CURRENT LEVEL—CONDUCTING STATE

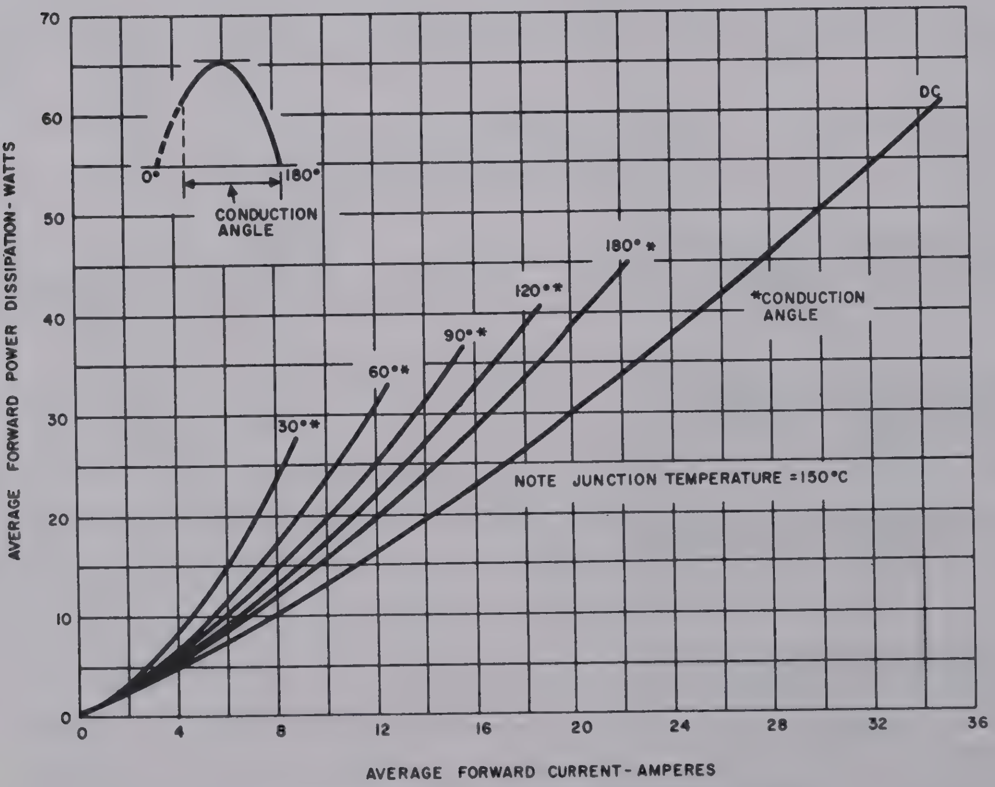


NOTES (1) DC, 1 ø, 3ø, 6ø CIRCUITS - RESISTIVE OR INDUCTIVE LOAD, 50 TO 400 CPS

(2) 11.0° C PER UNIT MAXIMUM THERMAL RESISTANCE CASE TO AMBIENT

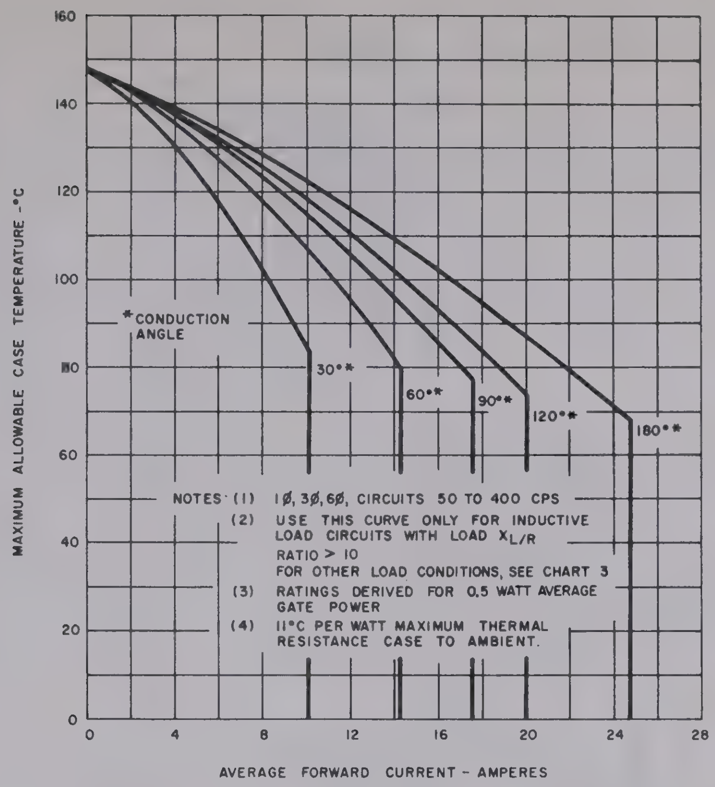
(3) RATINGS DERIVED FOR 0.5 WATT AVERAGE GATE POWER.

3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



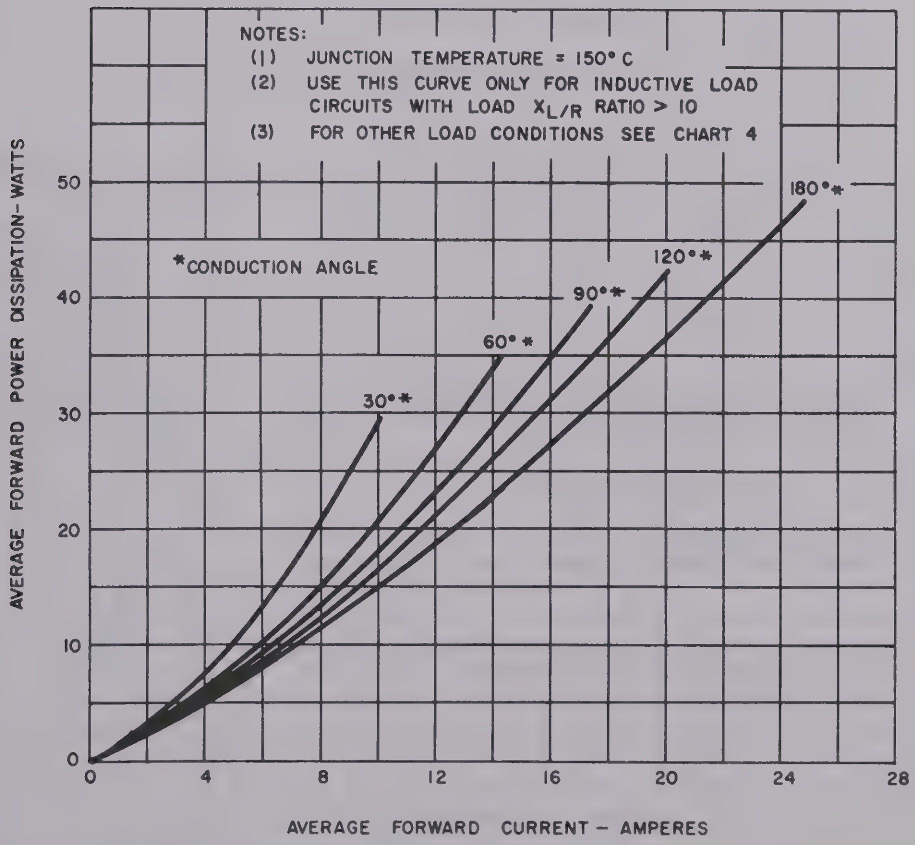
NOTE JUNCTION TEMPERATURE = 150°C

4. FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



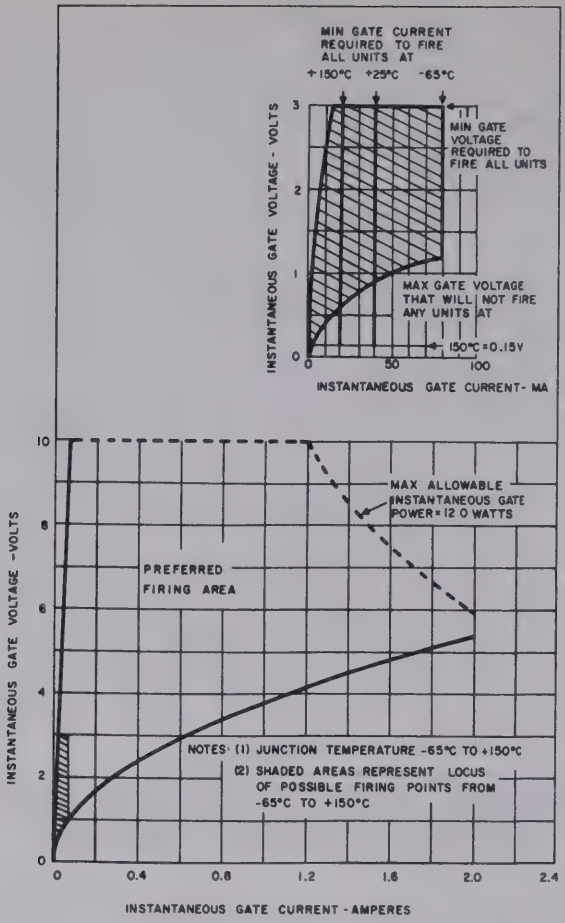
NOTES (1) 1Ø, 3Ø, 6Ø, CIRCUITS 50 TO 400 CPS
(2) USE THIS CURVE ONLY FOR INDUCTIVE LOAD CIRCUITS WITH LOAD $X_{L/R}$ RATIO > 10
FOR OTHER LOAD CONDITIONS, SEE CHART 3
(3) RATINGS DERIVED FOR 0.5 WATT AVERAGE GATE POWER
(4) 11°C PER WATT MAXIMUM THERMAL RESISTANCE CASE TO AMBIENT.

5. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



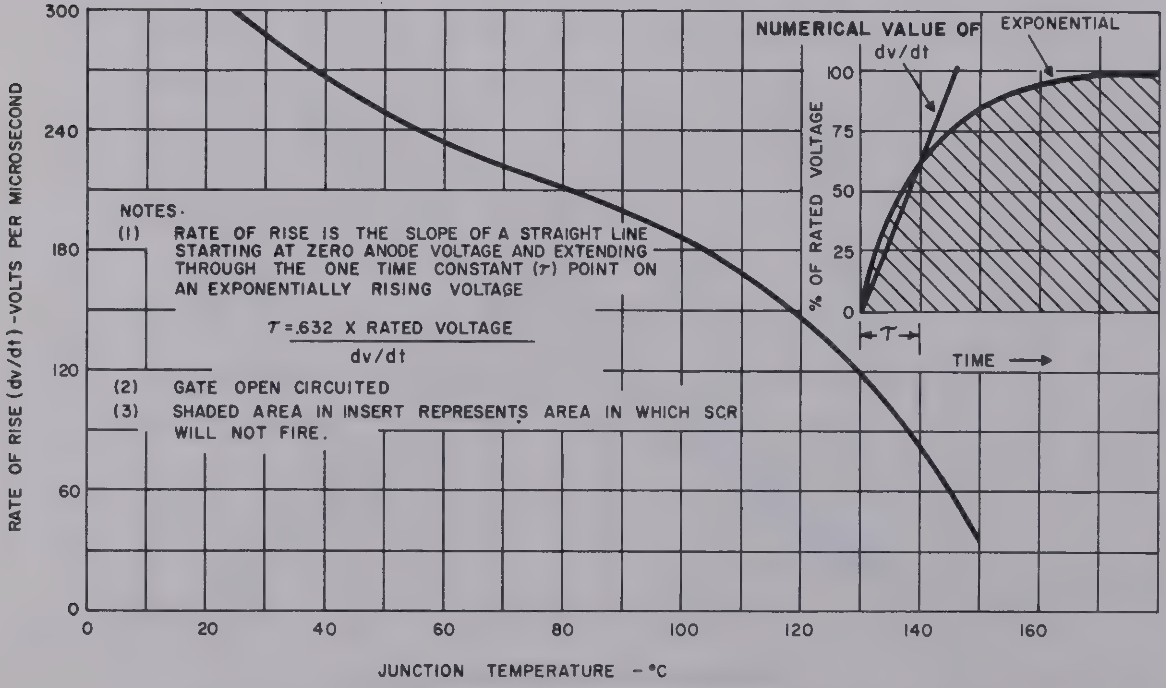
NOTES:
(1) JUNCTION TEMPERATURE = 150° C
(2) USE THIS CURVE ONLY FOR INDUCTIVE LOAD CIRCUITS WITH LOAD $X_{L/R}$ RATIO > 10
(3) FOR OTHER LOAD CONDITIONS SEE CHART 4

6. FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



NOTES: (1) JUNCTION TEMPERATURE -65°C TO +150°C
(2) SHADED AREAS REPRESENT LOCUS OF POSSIBLE FIRING POINTS FROM -65°C TO +150°C

7. FIRING CHARACTERISTICS

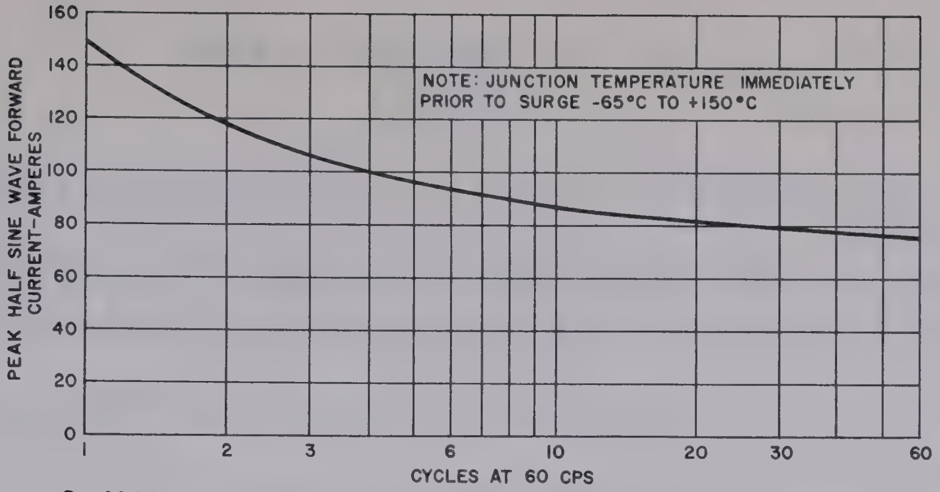


NOTES.
(1) RATE OF RISE IS THE SLOPE OF A STRAIGHT LINE STARTING AT ZERO ANODE VOLTAGE AND EXTENDING THROUGH THE ONE TIME CONSTANT (τ) POINT ON AN EXPONENTIALLY RISING VOLTAGE

$$\tau = \frac{.632 \times \text{RATED VOLTAGE}}{dv/dt}$$

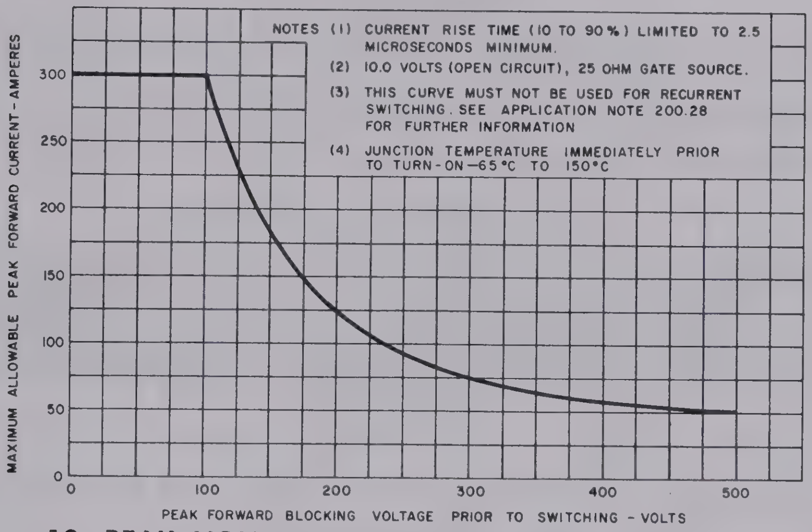
(2) GATE OPEN CIRCUITED
(3) SHADED AREA IN INSERT REPRESENTS AREA IN WHICH SCR WILL NOT FIRE.

8. TYPICAL RATE OF RISE (dv/dt) OF FORWARD VOLTAGE THAT WILL NOT TURN ON SCR



NOTE: JUNCTION TEMPERATURE IMMEDIATELY PRIOR TO SURGE -65°C TO +150°C

9. MAXIMUM ALLOWABLE NON-RECURRENT SURGE CURRENT AT RATED LOAD CONDITIONS



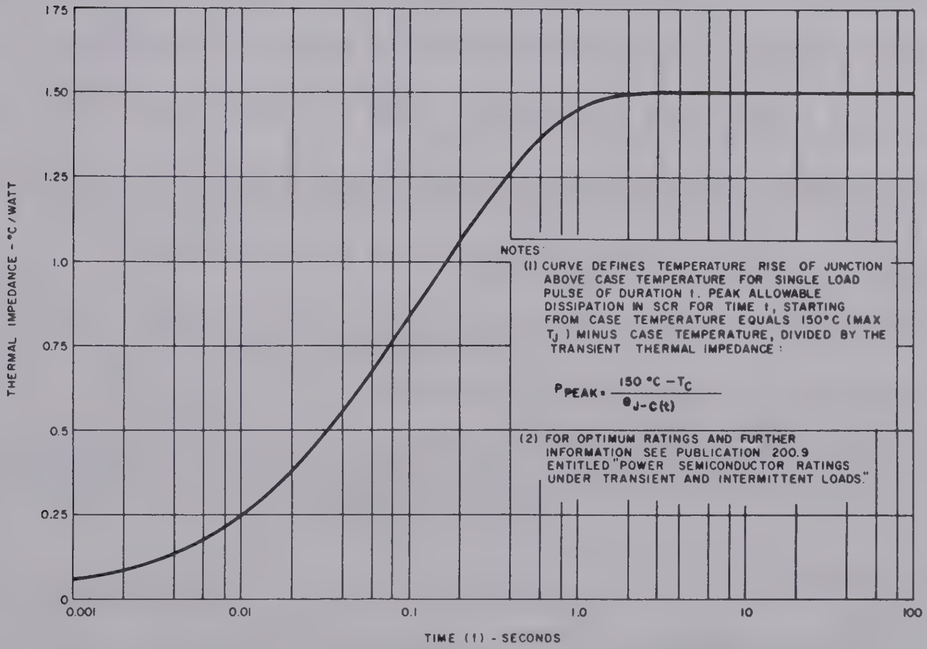
NOTES (1) CURRENT RISE TIME (10 TO 90%) LIMITED TO 2.5 MICROSECONDS MINIMUM.

(2) 10.0 VOLTS (OPEN CIRCUIT), 25 OHM GATE SOURCE.

(3) THIS CURVE MUST NOT BE USED FOR RECURRENT SWITCHING. SEE APPLICATION NOTE 200.28 FOR FURTHER INFORMATION

(4) JUNCTION TEMPERATURE IMMEDIATELY PRIOR TO TURN-ON—65°C TO 150°C

10. PEAK NON-RECURRENT SURGE CURRENT DURING TURN-ON TIME INTERVAL



NOTES:

(1) CURVE DEFINES TEMPERATURE RISE OF JUNCTION ABOVE CASE TEMPERATURE FOR SINGLE LOAD PULSE OF DURATION t. PEAK ALLOWABLE DISSIPATION IN SCR FOR TIME t, STARTING FROM CASE TEMPERATURE EQUALS 150°C (MAX T_J) MINUS CASE TEMPERATURE, DIVIDED BY THE TRANSIENT THERMAL IMPEDANCE:

$$P_{PEAK} = \frac{150\,°C - T_C}{\theta_{J-C(t)}}$$

(2) FOR OPTIMUM RATINGS AND FURTHER INFORMATION SEE PUBLICATION 200.9 ENTITLED "POWER SEMICONDUCTOR RATINGS UNDER TRANSIENT AND INTERMITTENT LOADS."

11. MAXIMUM TRANSIENT THERMAL IMPEDANCE JUNCTION TO CASE

SYMBOLS AND DEFINITION OF TERMS

RATINGS

Symbol	*Terminology and Definition*
PRV	**Peak Reverse Voltage**. Maximum instantaneous value of negative voltage which may be applied to anode with gate open.
i_{surge}	**Peak One Cycle Surge**. Maximum allowable non-recurrent peak current of a single forward cycle (8.3 milliseconds duration) in a 60 cps single phase resistive load system. The surge may be preceded and followed by maximum rated voltage, current, and junction temperature conditions, and maximum allowable gate power may be concurrently dissipated. However, limitations on anode current during switching should not be exceeded.
I^2t	**I squared t**. This is a measure of maximum forward non-recurring overcurrent capability for pulse durations of greater than 1.5 milliseconds. I is in RMS amperes, and t is pulse duration in seconds. The same conditions as listed above for i_{surge} apply.
P_G	**Gate Power Dissipation**. Power dissipation between gate and cathode.

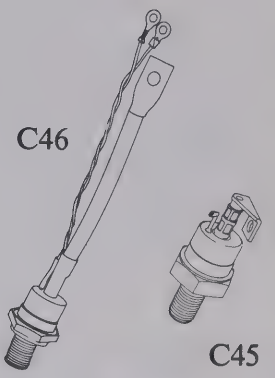
CHARACTERISTICS

Symbol	*Terminology and Definition*
V_{BO}	**Breakover Voltage**. The value of positive anode voltage at which a controlled rectifier switches into the conductive state with gate circuit open.
i_F	**Peak Forward Current**. Flow of anode current into controlled rectifier.
I_O	**Average Forward Current**. Forward current averaged over a complete cycle for a specified waveform.
I_F	**D.C. Forward Current**. Flow of anode current into controlled rectifier.
v_F	**Peak Forward Voltage Drop** between anode and cathode during conduction of current from anode to cathode with gate open.
v_{AC}	**Peak Anode to Cathode Blocking Voltage,** anode positive.
v_{CA}	**Peak Cathode to Anode Blocking Voltage,** cathode positive.
i_G	**Peak Gate Current**. Value of current flowing between gate and cathode.
v_G	**Peak Gate Voltage** Voltage between gate and cathode with anode open.
I_{GF}	**Gate Current** required to fire controlled rectifier with anode +12 volts with respect to the cathode at stated temperature conditions.
V_{GF}	**Gate Voltage** with I_{GF} flowing but prior to start of anode conduction.
I_H	**Holding Current**. Value of i_F below which controlled rectifier returns to forward blocking state. Gate open.
i_S	**Peak Forward Saturation Current**. Anode current at stated conditions of forward blocking voltage and junction temperature. Gate open.
i_R	**Peak Reverse Leakage Current**. Anode current at stated conditions of negative anode voltage and junction temperature. Gate open.
t_d	**Delay Time**. Time interval between initiation of gate current signal and reduction of forward voltage to 90% of blocking value during switching to conduction under stated conditions.
t_r	**Rise Time**. Time interval required for forward voltage to decrease from 90% to 10% of blocking value during switching to conduction under stated conditions.
t_{off}	**Turn-off Time**. Time interval required for gate to regain control of forward blocking characteristic after forward conduction under stated circuit and temperature conditions.
$\theta_{J\text{-}C}$	**Thermal Resistance in °C/watt between junction and case.**
dv/dt	**Rate of rise of anode-to-cathode voltage.** As specified for the SCR, this value will not trigger the SCR below rated voltage under stated conditions. This rate of rise is defined as the slope of a straight line starting at zero anode voltage and extending through the one time constant (τ) point on an exponentially rising voltage. $\tau = \frac{.632 \times \text{rated voltage}}{dv/dt}$
T_C	**Case Temperature.**
R_L	**Load Resistor.**
T_J	**Junction Temperature.**

SCR

C45,6

- Broad Voltage Range—Up to 800 V
- Thermal Fatigue Resistant
- Immunity to Forward Voltage Destruction(1) (On units rated above 500 volts)
- Standard TO-49 Outline
- Backed by 7 Years of Design and Field Experience



1)These devices may be turned on in the forward direction by exceeding the breakover voltage with either a rapidly, or slowly rising wave form. This has been confirmed in the laboratory by using a 3 kv. open circuit voltage, a 4-amp. short circuit, 0.1 μsec. risetime supply, and a 60 cycle half-wave sine voltage waveform.

MAXIMUM ALLOWABLE RATINGS

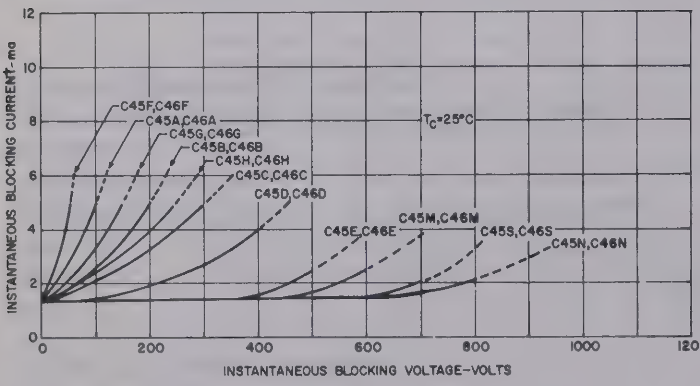
TYPE	PEAK FORWARD BLOCKING VOLTAGE, V_{FOM}*	REPETITIVE PEAK REVERSE VOLTAGE, V_{ROM} (rep)*	TRANSIENT PEAK REVERSE VOLTAGE (Non-recurrent <5 Millisec.) V_{ROM} (non-rep)	PEAK FORWARD VOLTAGE (PFV)
	T_C = −40°C to +120°C	T_C = −40°C to +120°C	T_C = −40°C to +120°C	
C45, C46U	25 Volts	25 Volts	35 Volts	500 Volts
C45, C46F	50 Volts	50 Volts	75 Volts	500 Volts
C45, C46A	100 Volts	100 Volts	150 Volts	500 Volts
C45, C46G	150 Volts	150 Volts	225 Volts	500 Volts
C45, C46B	200 Volts	200 Volts	300 Volts	500 Volts
C45, C46H	250 Volts	250 Volts	350 Volts	500 Volts
C45, C46C	300 Volts	300 Volts	400 Volts	500 Volts
C45, C46D	400 Volts	400 Volts	500 Volts	500 Volts
C45, C46E	500 Volts	500 Volts	650 Volts	No Limitation
C45, C46M	600 Volts	600 Volts	720 Volts	No Limitation
C45, C46S	700 Volts	700 Volts	840 Volts	No Limitation
C45, C46N	800 Volts	800 Volts	960 Volts	No Limitation

Ratings apply for zero or negative gate voltage. Maximum heatsink thermal resistance for which maximum PRV ratings apply equal 3.5°C/watt.

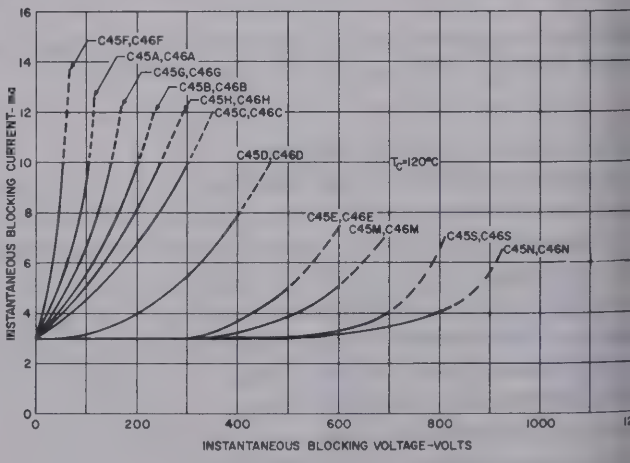
MS Forward Current, On-State	55 amperes (all conduction angles)
verage Forward Current, On-State	Depends on conduction angle (see Charts 3 and 6)
eak One-cycle Surge Forward Current, I_{FM} (surge)	700 amperes
aximum Rate of Rise of Anode Current During Turn-On Interval	(see Chart 15)
t (for fusing) T_J = −40°C to +125°C	2000 ampere^2 seconds (for times ≧ 1.0 milliseconds)
eak Gate Power Dissipation, P_{GM}	5 watts
verage Gate Power Dissipation, $P_{G(AV)}$	0.5 watts
eak Forward Gate Voltage, V_{GFM}	20 volts
eak Reverse Gate Voltage, V_{GRM}	5 volts
orage Temperature, T_{stg}	−40°C to +150°C
orage and Operating Temperature, T_J	−40°C to +125°C
ud Torque	125 Lbs.-in. (min.), 150 Lbs.-in. (max.) 150 Kg.-cm. (min.), 175 Kg.-cm. (max.)

CHARACTERISTICS

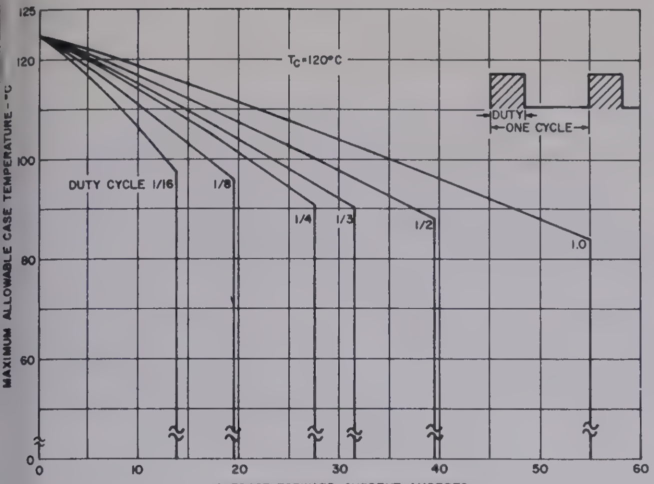
TEST	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Gate Trigger Current	I_{GT}	--------	30	75	mAdc	$T_C = +\ 25°C$, $V_{FX} = 6$ Vdc, $R_L = 12$ ohms, $t_p \geqq 20$ μsec.
		--------	50	125	mAdc	$T_C = -\ 40°C$, $V_{FX} = 6$ Vdc, $R_L = 12$ ohms, $t_p \geqq 20$ μsec.
		--------	20	40	mAdc	$T_C = +120°C$, $V_{FX} = 6$ Vdc, $R_L = 12$ ohms, $t_p \geqq 20$ μsec.
Gate Trigger Voltage	V_{GT}	--------	1.5	3.0	Vdc	$T_C = -\ 40°C$ to $+120°C$. $V_{FX} = 6$ Vdc, $R_L = 12$ ohms, $t_p \geqq 20$ μsec.
		.25	--------	--------	Vdc	$T_C = +120°C$, V_{FX} = Rated, $R_L = 1000$ ohms, $t_p \geqq 20$ μsec.
Peak On-Voltage	V_{FM}	--------	2.0	3.0	V	$T_C = +\ 25°C$, $I_{FM} = 500$A Peak, Duty cycle $\leqq$ .01%
Holding Current	I_{HO}	--------	18	100	mAdc	$T_C = +\ 25°C$, Anode supply = 24 Vdc, Initial forward current = 2A.
Turn-On Time (Delay Time + Rise Time)	$t_d + t_r$	--------	5	--------	μsec	$T_C = +\ 25°C$, $I_F = 50$ Adc, V_{FXM} = rated Gate supply: 10 volt open circuit, 20 ohm, 0.1 μsec. max. rise time
Circuit Commutated Turn-Off Time	t_{off}	--------	50	--------	μsec	$T_C = +120°C$, $I_{FM} = 50$A, $V_{rx} = 50$ volts min., V_{FXM} (reapplied) = Rated V_{FOM}, Rate of rise of reapplied forward blocking voltage = 20V/μsec linear. Gate bias: 0 volts, 100 ohms during turn-off interval, Duty cycle $\leqq$ .01%
Effective Thermal Resistance	θ_{J-C}	--------	.3	.4	°C/watt	
Critical Exponential Rate of Rise of Forward Blocking Voltage (Higher values may cause device switching)	dv/dt				V/μsec	V_{FOM} = Rated, $T_C = +120°C$, Gate open.
C45, C46U		--------	30	--------		
C45, C46F		--------	30	--------		
C45, C46A		--------	30	--------		
C45, C46G		--------	30	--------		
C45, C46B		--------	30	--------		
C45, C46H		--------	30	--------		
C45, C46C		--------	20	--------		
C45, C46D		--------	20	--------		
C45, C46E		--------	20	--------		
C45, C46M		--------	20	--------		
C45, C46S		--------	15	--------		
C45, C46N		--------	15	--------		



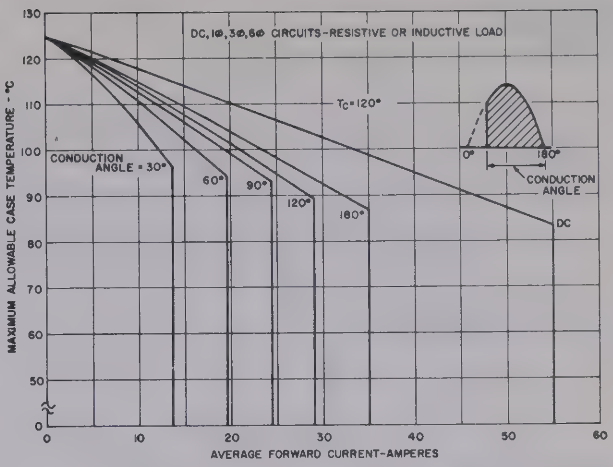
1. MAXIMUM FORWARD AND REVERSE BLOCKING CHARACTERISTICS



2. MAXIMUM FORWARD AND REVERSE BLOCKING CHARACTERISTICS

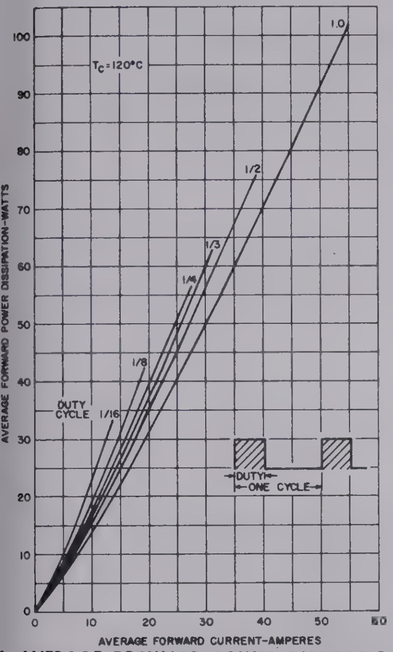


3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM

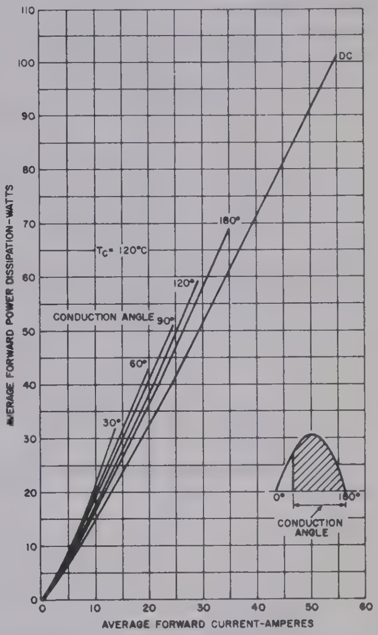


6. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM

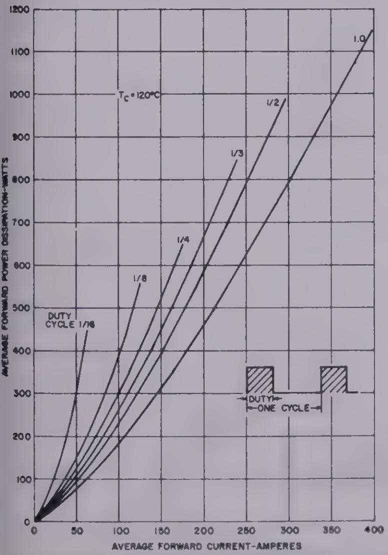
50 to 400 cps AC LINE OPERATION



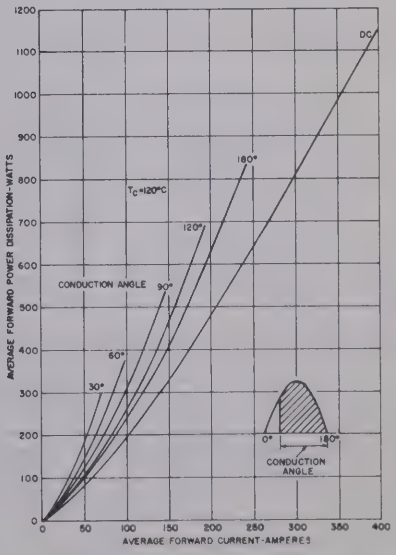
. AVERAGE FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



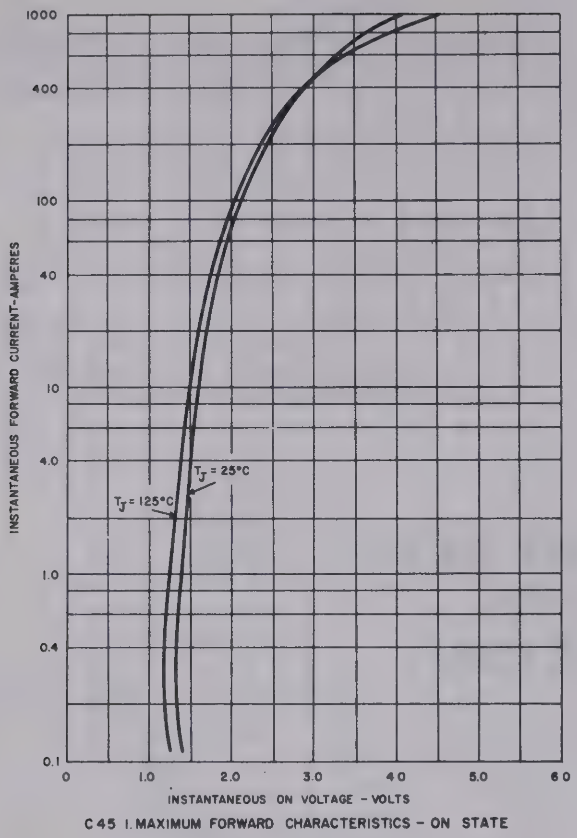
7. AVERAGE FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



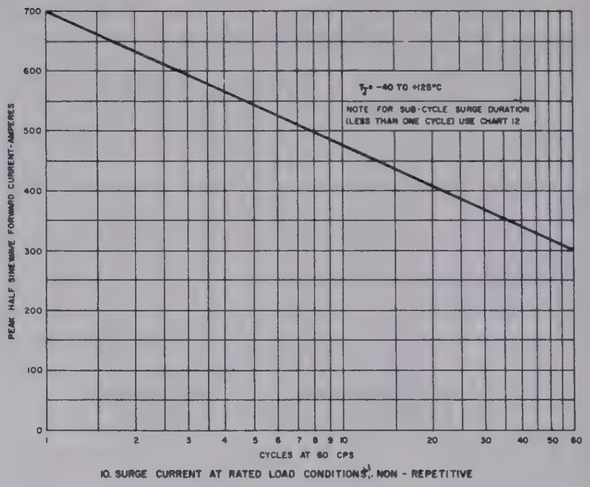
. EXTENDED FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



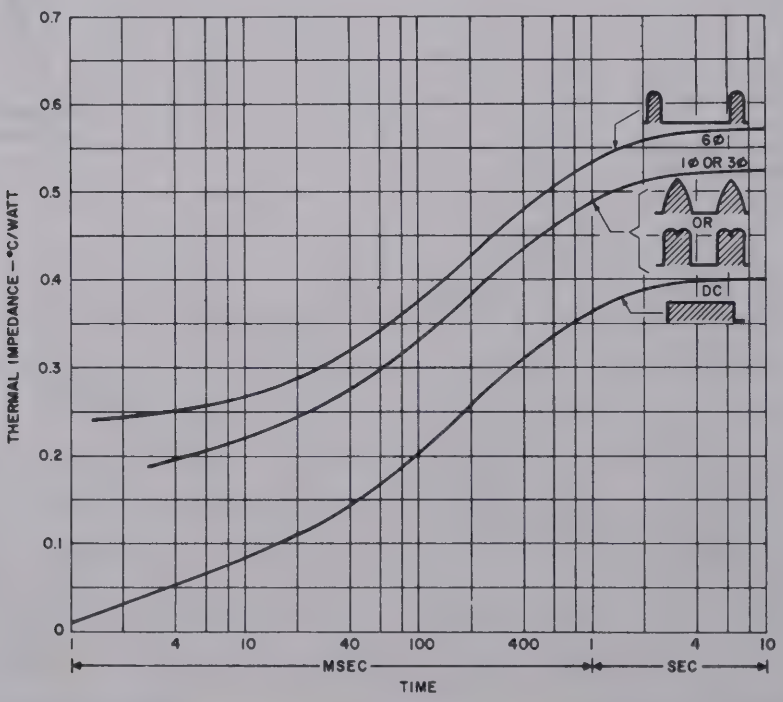
8. EXTENDED FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



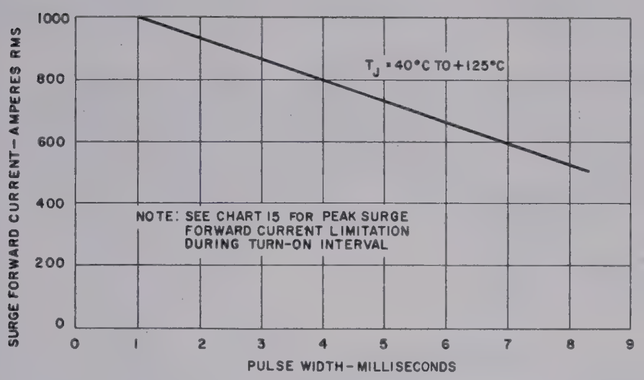
9. MAXIMUM FORWARD CHARACTERISTICS—ON-STATE



10. PEAK SURGE FORWARD CURRENT (NON-REPETITIVE)

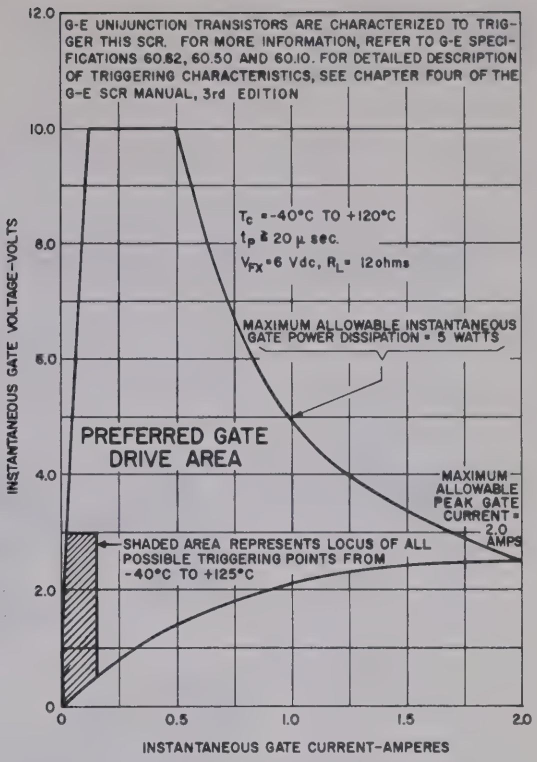


11. TRANSIENT THERMAL IMPEDANCE (JUNCTION TO CASE)



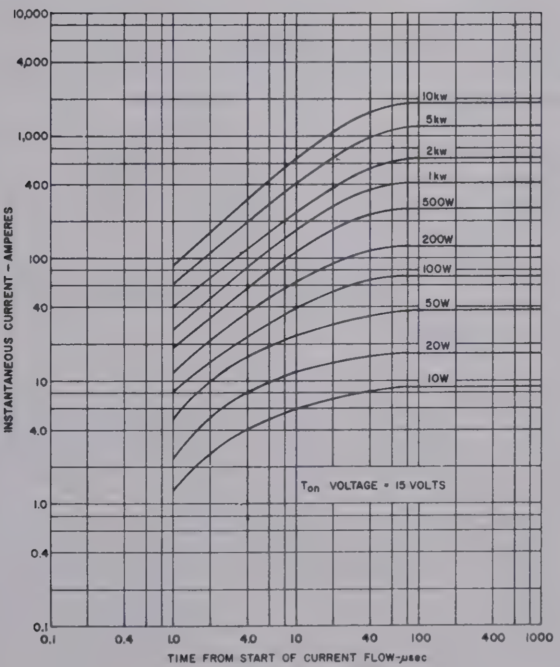
NOTE: SEE CHART 15 FOR PEAK SURGE FORWARD CURRENT LIMITATION DURING TURN-ON INTERVAL

12. SUB-CYCLE SURGE FORWARD CURRENT (NON-REPETITIVE)



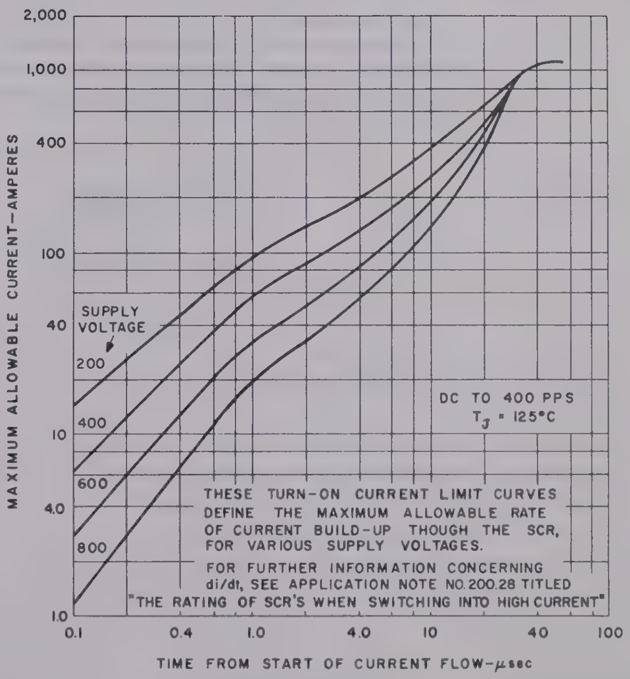
G-E UNIJUNCTION TRANSISTORS ARE CHARACTERIZED TO TRIGGER THIS SCR. FOR MORE INFORMATION, REFER TO G-E SPECIFICATIONS 60.82, 60.50 AND 60.10. FOR DETAILED DESCRIPTION OF TRIGGERING CHARACTERISTICS, SEE CHAPTER FOUR OF THE G-E SCR MANUAL, 3rd EDITION

13. GATE TRIGGERING CHARACTERISTICS



16. INSTANTANEOUS POWER DISSIPATION

14. INSTANTANEOUS POWER DISSIPATION



THESE TURN-ON CURRENT LIMIT CURVES DEFINE THE MAXIMUM ALLOWABLE RATE OF CURRENT BUILD-UP THOUGH THE SCR, FOR VARIOUS SUPPLY VOLTAGES.

FOR FURTHER INFORMATION CONCERNING di/dt, SEE APPLICATION NOTE NO. 200.28 TITLED "THE RATING OF SCR'S WHEN SWITCHING INTO HIGH CURRENT"

15. CURRENT LIMIT FOR STEEP WAVEFORM OPERATION

OUTLINE DRAWINGS

C46 OUTLINE (Conforms to JEDEC TO-94 Outline)

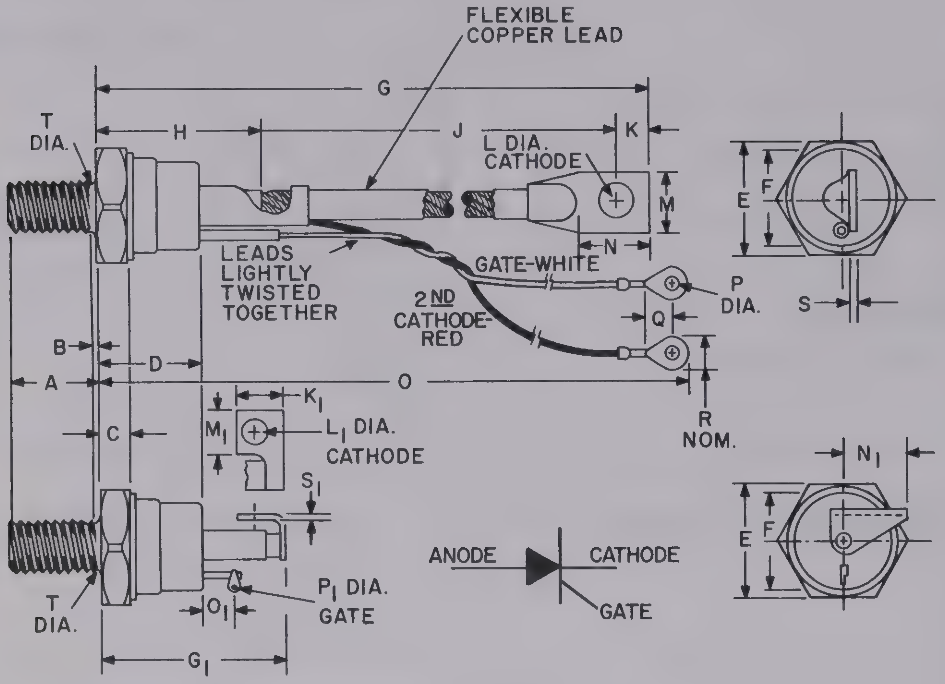

FLEXIBLE COPPER LEAD
G
T DIA.
H
J
K
L DIA. CATHODE
M
E
F
N
LEADS LIGHTLY TWISTED TOGETHER
GATE-WHITE
P DIA.
S
2ND CATHODE-RED
Q
B
D
A
O
R NOM.
C
K1
M1
L1 DIA. CATHODE
S1
N1
ANODE
CATHODE
GATE
T DIA.
O1
P1 DIA. GATE
G1

TABLE OF DIMENSIONS

Conversion Table

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.797	.827	20.243	21.005
B	–	.080	–	2.032
C	.278	.350	7.060	8.890
D	.874	1.030	22.099	26.162
E	1.049	1.062	26.644	26.975
F	.840	.910	21.335	23.115
G	6.204	6.512	157.619	165.443
G_1	–	1.750	–	44.450
H	1.484	1.640	37.653	41.656
J	4.437	5.623	112.698	142.824
K	.275	.325	6.985	8.255
K_1	.445	.485	11.302	12.319
L	.251	.281	6.375	7.137
L_1	.198	.212	5.029	5.385
M	.500	.600	12.700	15.240
M_1	.385	.415	9.778	10.541
N	.632	.725	16.052	18.390
N_1	.590	.640	14.985	16.256
O	7.000	7.342	177.799	186.487
O_1	.312 Ref.		7.925 Ref.	
P	.140	.150	3.555	3.811
P_1	.060	.075	1.524	1.905
Q	.250 Nom.		6.350 Nom.	
R	.290 Nom.		7.366 Nom.	
S	.065	.095	1.651	2.413
S_1	.058	.070	1.473	1.778
T	.463	.498	11.760	12.649

C45 OUTLINE

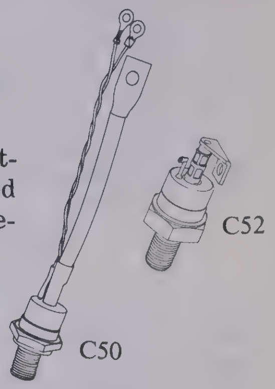
NOTES

1. Complete stud threads (½-20 UNF 2A) to within 2½ threads of head.
2. Flexible lead covered with silicon rubber insulation (Class H), 600 volt ASTM standard wall.
3. Orientation of cathode and gate terminals not defined.
4. One, ½-20 steel, cadmium plated nut and one cadmium plated spring washer supplied with each unit.
5. Approximate weights:

Unit	With Hardware		Without Hardware	
	Ounces	Grams	Ounces	Grams
C46	4.25	120	3.50	99
C45	3.50	99	2.75	78

- Broad Voltage Range—Up to 900 V
- Thermal Fatigue Resistant
- Immunity to Forward Voltage Destruction(1)
- Standard TO-94 Outline
- Designed to Meet MIL-S-19500/204A
- Backed by 5 Years of Design and Field Experience

)These devices may be turned on in the forward direction by exceeding the breakover voltage ($V_{(BO)}$) with either a rapidly, or slowly rising wave form. This has been confirmed in the laboratory by using a 3 kV. open circuit voltage, a 4-amp. short circuit. 0.1 μsec. rise-time supply, and a 60 cycle half-wave sine voltage waveform.



MAXIMUM ALLOWABLE RATINGS

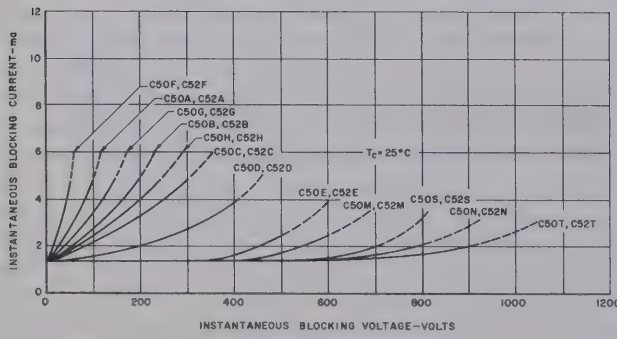
TYPE				PEAK FORWARD BLOCKING VOLTAGE, V_{DRM} (2) $T_C = -40°C$ to $+120°C$	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM} (2) $T_C = -40°C$ to $+120°C$	TRANSIENT PEAK REVERSE VOLTAGE (Non-recurrent <5 Millisec.) V_{RSM} $T_C = -40°C$ to $+120°C$
C50U	(2N1909)	C52U		25 Volts	25 Volts	35 Volts
C50F	(2N1910)	C52F	(2N1792)	50 Volts	50 Volts	75 Volts
C50A	(2N1911)	C52A	(2N1793)	100 Volts	100 Volts	150 Volts
C50G	(2N1912)	C52G	(2N1794)	150 Volts	150 Volts	225 Volts
C50B	(2N1913)	C52B	(2N1795)	200 Volts	200 Volts	300 Volts
C50H	(2N1914)	C52H	(2N1796)	250 Volts	250 Volts	350 Volts
C50C	(2N1915)	C52C	(2N1797)	300 Volts	300 Volts	400 Volts
C50D	(2N1916)	C52D	(2N1798)	400 Volts	400 Volts	500 Volts
C50E		C52E		500 Volts	500 Volts	650 Volts
C50M		C52M		600 Volts	600 Volts	720 Volts
C50S		C52S		700 Volts	700 Volts	840 Volts
C50N		C52N		800 Volts	800 Volts	960 Volts
C50T		C52T		900 Volts	900 Volts	1040 Volts

²⁾Ratings apply for zero or negative gate voltage. Maximum heatsink thermal resistance for which maximum PRV ratings apply equal 3.5°C/watt.

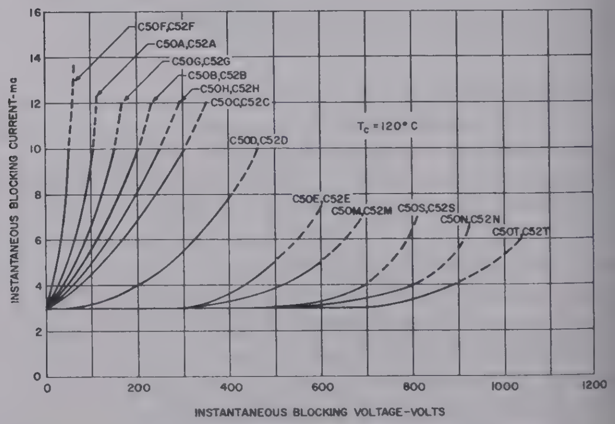
RMS Forward Current, On-State .... 110 amperes (all conduction angles)
Average Forward Current, On-State .... Depends on conduction angle (see Charts 3 and 8)
Peak One-Cycle Surge Forward Current, I_{FSM} .... 1000 amperes
Maximum Rate of Rise of Anode Current During Turn-On Interval .... see Chart 16
²t (for fusing) $T_J = -40°C$ to $-20°C$ .... 2000 ampere² seconds (for times ≧ 1.5 milliseconds)
$-20°C$ to $+125°C$ .... 4000 ampere² seconds (for times ≧ 1.5 milliseconds)
Peak Gate Power Dissipation, P_{GM} .... 5 watts
Average Gate Power Dissipation, $P_{G(AV)}$ .... 0.5 watts
Peak Forward Gate Voltage, V_{GFM} .... 10 volts
Peak Reverse Gate Voltage, V_{GRM} .... 5 volts
torage Temperature, T_{STG} .... $-40°C$ to $+150°C$
torage and Operating Temperature, T_J .... $-40°C$ to $+125°C$
tud Torque .... 125 Lbs.-in. (min.), 150 Lbs.-in. (max.)
150 Kg.-cm. (min.), 175 Kg.-cm. (max.)

CHARACTERISTICS

TEST	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Gate Trigger Current	I_{GT}	------- ------- -------	30 50 20	75 130 40	mAdc mAdc mAdc	$T_C = +25°C$, $V_D = 6$ Vdc, $R_L = 50$ ohms, $t_p \geqq 20$ μsec. $T_C = -40°C$, $V_D = 6$ Vdc, $R_L = 50$ ohms, $t_p \geqq 20$ μsec. $T_C = +120°C$, $V_D = 6$ Vdc, $R_L = 50$ ohms, $t_p \geqq 20$ μsec.
Gate Trigger Voltage	V_{GT}	------- .25	1.5 -------	3.0 -------	Vdc Vdc	$T_C = -40°C$ to $+120°C$. $V_D = 6$ Vdc, $R_L = 50$ ohms, $t_p \geqq 20$ μsec $T_C = +120°C$, $V_D =$ Rated, $R_L = 1000$ ohms, $t_p = 20$ μsec.
Peak On-Voltage	V_{TM}	-------	2.0	2.5	V	$T_C = +25°C$, $I_{TM} = 500A$ Peak, Duty cycle $\leqq .01\%$
Holding Current	I_H	-------	18	100	mAdc	$T_C = +25°C$, Anode supply = 24 Vdc, Initial forward current = 2A.
Turn-On Time (Delay Time + Rise Time)	$t_d + t_r$	-------	5	-------	μsec	$T_C = +25°C$, $I_T = 50$ Adc, $V_{DRM} =$ rated Gate supply: 10 volt open circuit, 20 ohm, 0.1 μsec. max. rise time
Circuit Commutated Turn-off Time	t_q	-------	50	-------	μsec	(1) $T_C = +120°C$, (2) $I_T = 50A$, (3) $V_R = 50$ volts min., (4) V_{DRM} (reapplied) = Rated, (5) Rate of rise of reapplied forward blocking voltage = 20V/μsec. linear. (6) Gate bias: 0 volts, 100 ohms during turn-off interval, (7) Duty cycle $\leqq .01\%$
Effective Thermal Resistance	$R_{\theta JC}$	-------	.3	.4	°C/watt	
Linear Rate of Rise of Forward Blocking Voltage (Higher values may cause device switching)	dv/dt				V/μsec	$V_{DRM} =$ Rated, $T_C = +120°C$, Gate open.
C50, C52U		-------	30	-------		
C50, C52F		-------	30	-------		
C50, C52A		-------	30	-------		
C50, C52G		-------	30	-------		
C50, C52B		-------	30	-------		
C50, C52H		-------	30	-------		
C50, C52C		-------	20	-------		
C50, C52D		-------	20	-------		
C50, C52E		-------	20	-------		
C50, C52M		-------	20	-------		
C50, C52S		-------	15	-------		
C50, C52N		-------	15	-------		
C50, C52T		-------	15	-------		



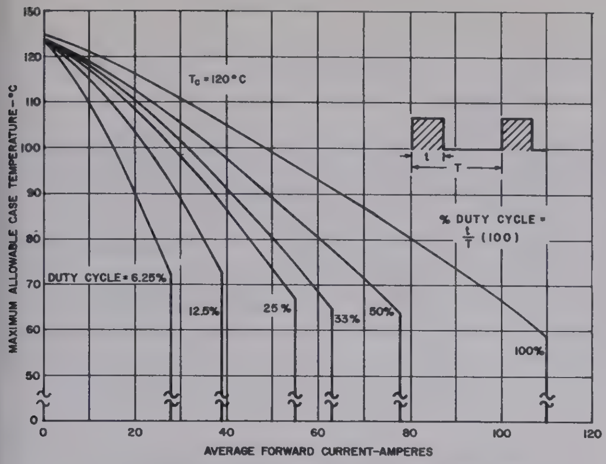
1. MAXIMUM FORWARD AND REVERSE BLOCKING CHARACTERISTICS



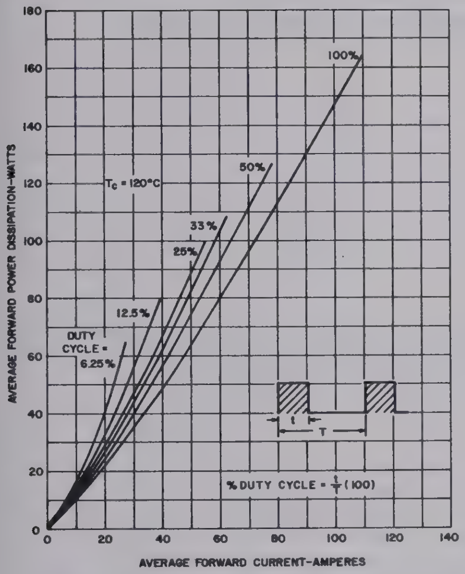
2. MAXIMUM FORWARD AND REVERSE BLOCKING CHARACTERISTICS

50 to 400 Hz AC LINE OPERATION

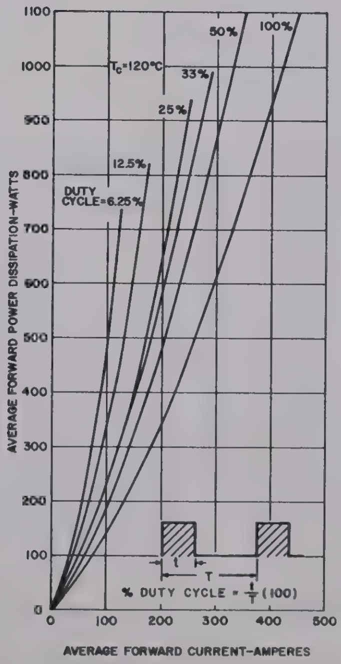
SQUARE WAVE



3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM

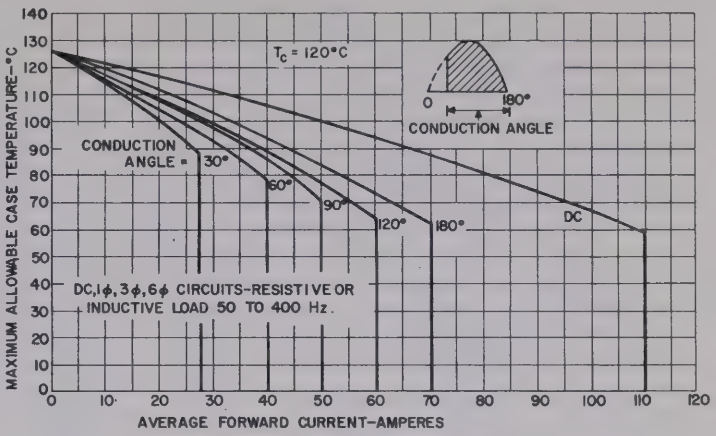


4. AVERAGE FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM

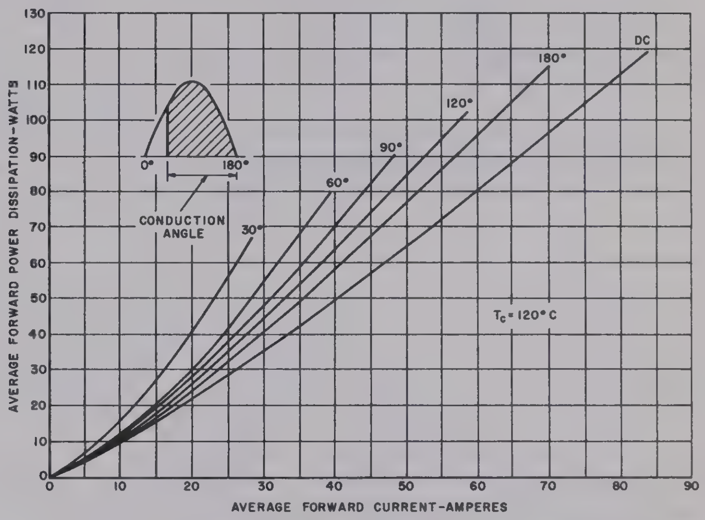


5. EXTENDED FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM

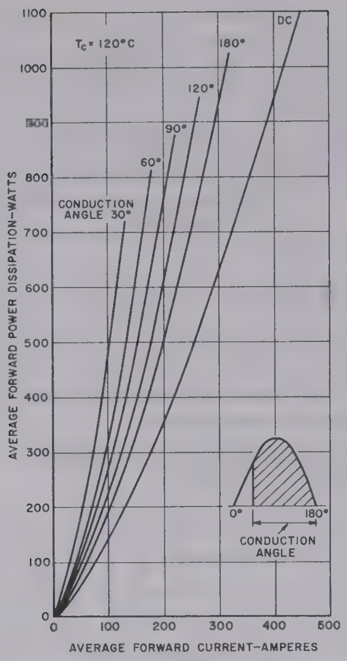
SINUSOIDAL



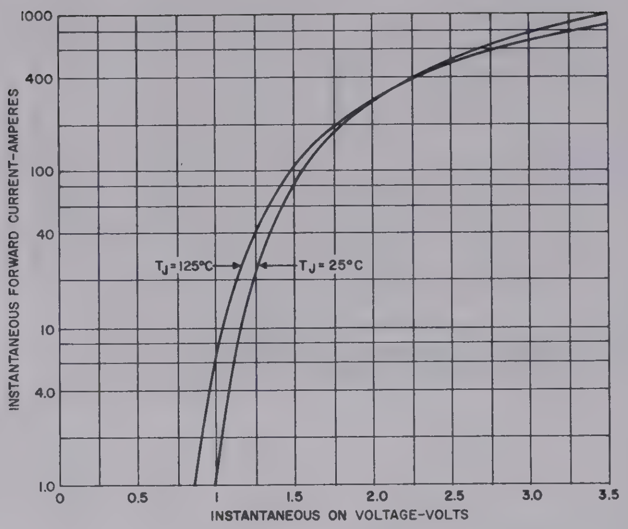
6. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



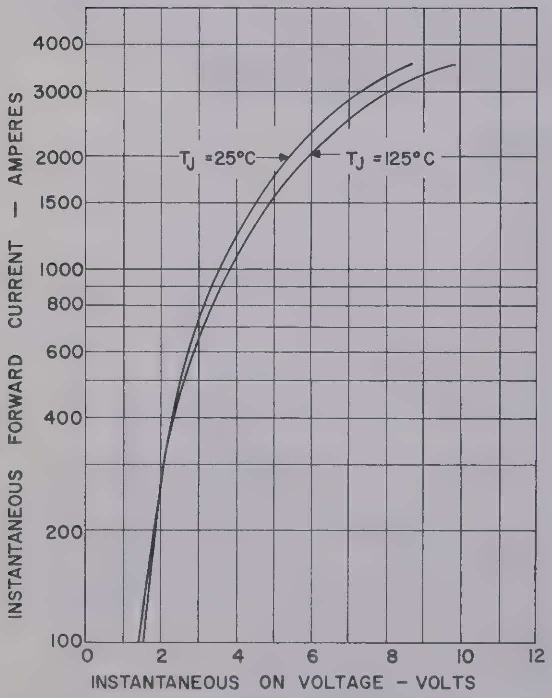
7. AVERAGE FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



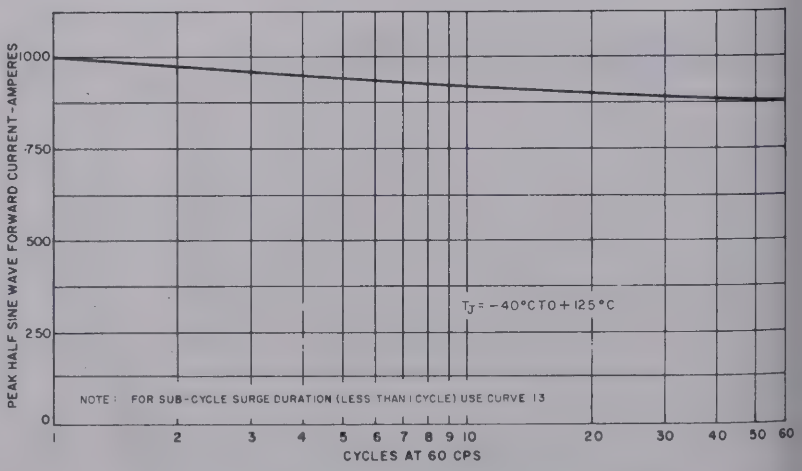
8. EXTENDED FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



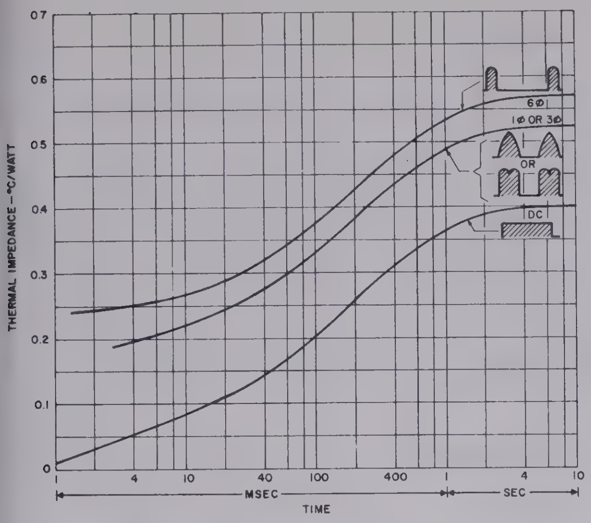
9. MAXIMUM FORWARD CHARACTERISTICS—ON-STATE



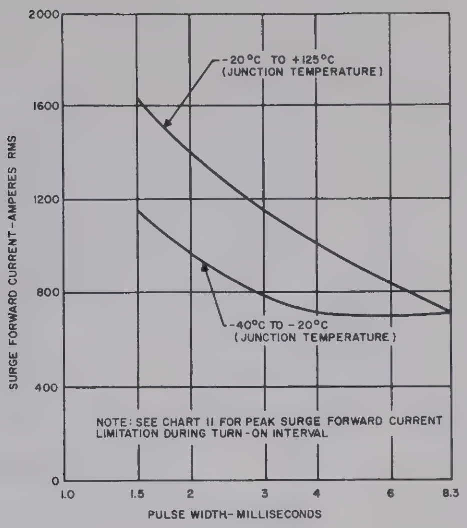
10. MAXIMUM FORWARD CHARACTERISTICS—ON-STATE (HIGH CURRENT LEVEL)



11. PEAK SURGE FORWARD CURRENT (NON-REPETITIVE)

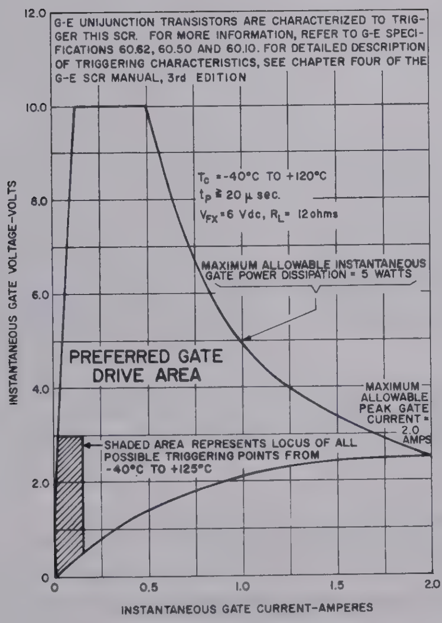


12. TRANSIENT THERMAL IMPEDANCE (JUNCTION TO CASE)



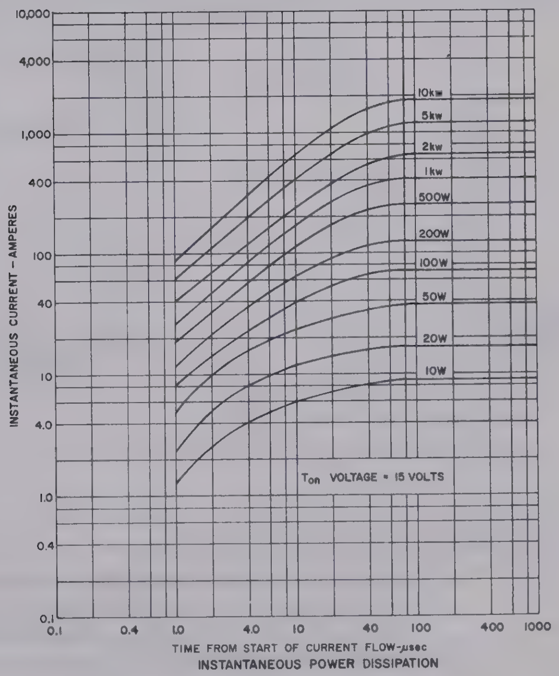
NOTE: SEE CHART 11 FOR PEAK SURGE FORWARD CURRENT LIMITATION DURING TURN-ON INTERVAL

13. SUB-CYCLE SURGE FORWARD CURRENT (NON-REPETITIVE)

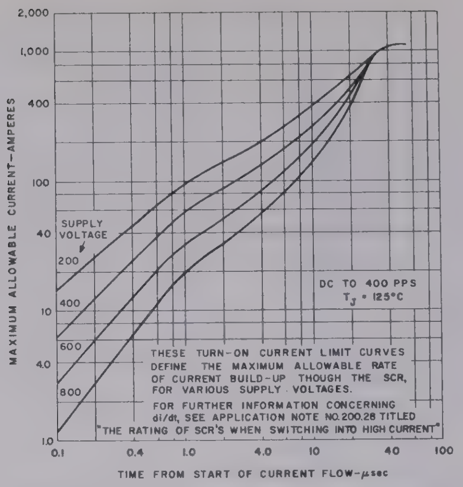


G-E UNIJUNCTION TRANSISTORS ARE CHARACTERIZED TO TRIGGER THIS SCR. FOR MORE INFORMATION, REFER TO G-E SPECIFICATIONS 60.62, 60.50 AND 60.10. FOR DETAILED DESCRIPTION OF TRIGGERING CHARACTERISTICS, SEE CHAPTER FOUR OF THE G-E SCR MANUAL, 3rd EDITION

14. GATE TRIGGERING CHARACTERISTICS



15. INSTANTANEOUS POWER DISSIPATION



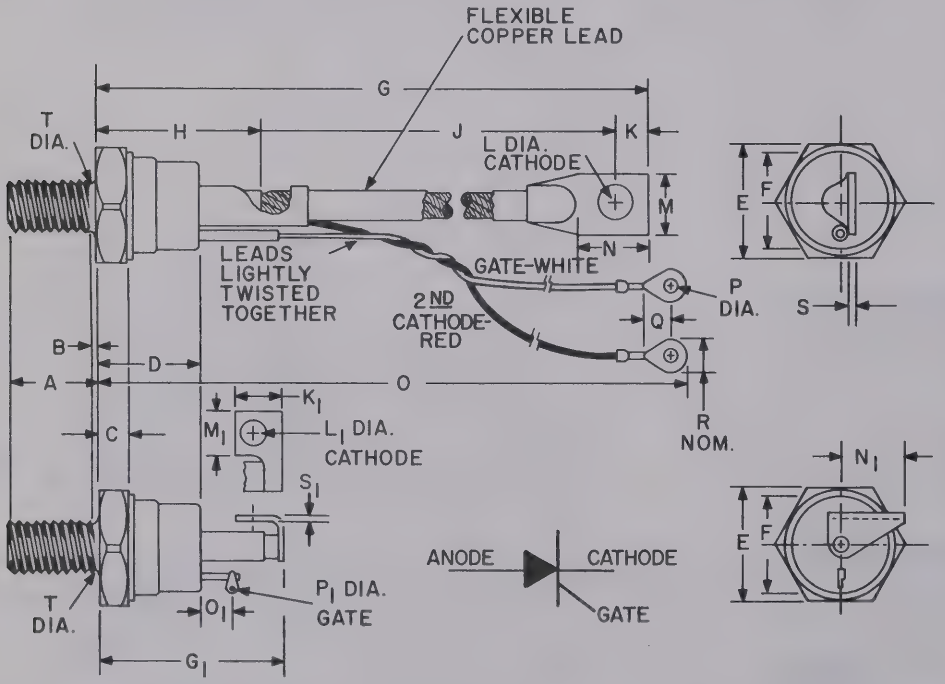
THESE TURN-ON CURRENT LIMIT CURVES DEFINE THE MAXIMUM ALLOWABLE RATE OF CURRENT BUILD-UP THOUGH THE SCR, FOR VARIOUS SUPPLY VOLTAGES.

FOR FURTHER INFORMATION CONCERNING di/dt, SEE APPLICATION NOTE NO. 200.28 TITLED "THE RATING OF SCR'S WHEN SWITCHING INTO HIGH CURRENT"

16. CURRENT LIMIT FOR STEEP WAVEFORM OPERATION

OUTLINE DRAWINGS

C50 OUTLINE (Conforms to JEDEC TO-94 Outline)


FLEXIBLE COPPER LEAD
G
T DIA.
H
J
K
L DIA. CATHODE
M
N
LEADS LIGHTLY TWISTED TOGETHER
GATE-WHITE
P DIA.
2ND CATHODE-RED
Q
B
D
A
O
R NOM.
C
M_1
K_1
L_1 DIA. CATHODE
S_1
E
F
S
N_1
ANODE
CATHODE
GATE
T DIA.
O_1
P_1 DIA. GATE
G_1

C52 OUTLINE

TABLE OF DIMENSIONS

Conversion Table

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.797	.827	20.243	21.005
B	—	.080	—	2.032
C	.278	.350	7.060	8.890
D	.874	1.030	22.099	26.162
E	1.049	1.062	26.644	26.975
F	.840	.910	21.335	23.115
G	6.204	6.512	157.619	165.443
G_1	—	1.750	—	44.450
H	1.484	1.640	37.653	41.656
J	4.437	5.623	112.698	142.824
K	.275	.325	6.985	8.255
K_1	.445	.485	11.302	12.319
L	.251	.281	6.375	7.137
L_1	.198	.212	5.029	5.385
M	.500	.600	12.700	15.240
M_1	.385	.415	9.778	10.541
N	.632	.725	16.052	18.390
N_1	.590	.640	14.985	16.256
O	7.000	7.342	177.799	186.487
O_1	.312 Ref.		7.925 Ref.	
P	.140	.150	3.555	3.811
P_1	.060	.075	1.524	1.905
Q	.250 Nom.		6.350 Nom.	
R	.290 Nom.		7.366 Nom.	
S	.065	.095	1.651	2.413
S_1	.058	.070	1.473	1.778
T	.463	.498	11.760	12.649

NOTES

1. Complete stud threads (½-20 UNF 2A) to within 2½ threads of head.
2. Flexible lead covered with silicon rubber insulation (Class H), 600 volt ASTM standard wall.
3. Orientation of cathode and gate terminals not defined.
4. One, ½-20 steel, cadmium plated nut and one cadmium plated spring washer supplied with each unit.
5. Approximate weights:

Unit	With Hardware		Without Hardware	
	Ounces	Grams	Ounces	Grams
C50	4.25	120	3.50	99
C52	3.50	99	2.75	78

SCR

The General Electric C60 (2N2023-2N2030) and C62 Series Silicon Controlled Rectifiers are designed for high-current operation at extreme temperatures. Rated as high as 110 amperes DC—with a maximum junction temperature of 150°C—they are especially suited for applications where high ambients or small heat sinks preclude the use of other controlled rectifiers at a required current level.

The C60 (2N2023-2N2030) and C62 Series have guaranteed low temperature limits of −65°C. In all other respects they are identical and offer these features:

- Hard soldered joints
- Welded seals
- Guaranteed value of di/dt
- Thermal fatigue resistant
- Silicone-rubber insulated leads
- Immunity to forward voltage destruction(1)

(1)These devices may be turned on in the forward direction by exceeding the breakover voltage ($V_{(RB)FO}$) with either a rapidly, or slowly rising wave form. This has been confirmed in the laboratory by using a 3 kv. open circuit voltage, a 4-amp. short circuit, 0.1 μsec. risetime supply, and a 60 cycle half-wave sine voltage waveform.

MAXIMUM ALLOWABLE RATINGS

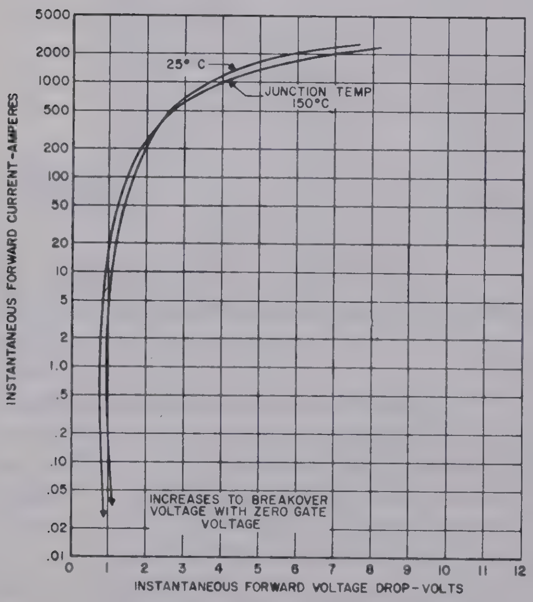
TYPE		PEAK FORWARD BLOCKING VOLTAGE, V_{FOM} (2)	REPETITIVE PEAK REVERSE VOLTAGE, V_{ROM} (rep) (2)	TRANSIENT PEAK REVERSE VOLTAGE (Non-recurrent <5 Millisec.), V_{ROM} (non-rep)
		T_C = −65°C to +145°C	T_C = −65°C to +145°C	T_C = −65°C to +145°C
C60U (2N2023)	C62U	25 Volts	25 Volts	35 Volts
C60F (2N2024)	C62F	50 Volts	50 Volts	75 Volts
C60A (2N2025)	C62A	100 Volts	100 Volts	150 Volts
C60G (2N2026)	C62G	150 Volts	150 Volts	225 Volts
C60B (2N2027)	C62B	200 Volts	200 Volts	300 Volts
C60H (2N2028)	C62H	250 Volts	250 Volts	350 Volts
C60C (2N2029)	C62C	300 Volts	300 Volts	400 Volts
C60D (2N2030)	C62D	400 Volts	400 Volts	500 Volts
C60E	C62E	500 Volts	500 Volts	650 Volts

(2)Ratings apply for zero or negative gate voltage. Maximum heatsink thermal resistance for which maximum PRV ratings apply equal 3.5°C/watt.

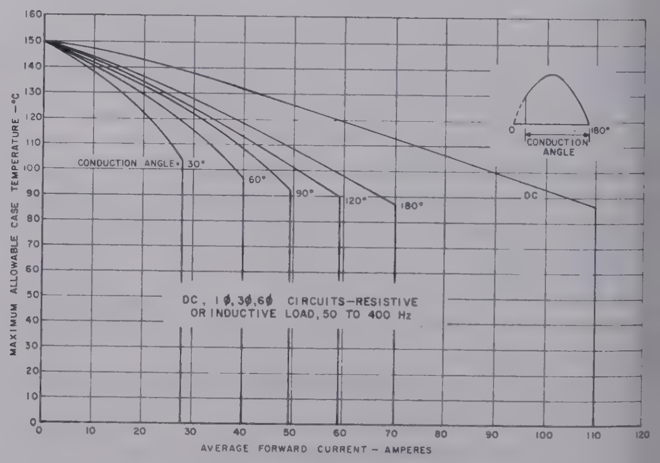
RMS Forward Current, On-State	110 amperes (all conduction angles)
Average Forward Current, On-State	Depends on conduction angle (see Charts 2 and 3)
Peak One-cycle Surge Forward Current, I_{FM} (surge)	1000 amperes (see Chart 7)
Maximum Rate of Rise of Anode Current During Turn-On Interval	(see Chart 9)
I^2t (for fusing)	Up to 4000 ampere² seconds (see Chart 8)
Peak Gate Power Dissipation, P_{GM}	5 watts
Average Gate Power Dissipation, $P_{G(AV)}$	0.5 watts
Peak Gate Current, I_{GFM}	2 amperes
Peak Forward Gate Voltage, V_{GFM}	20 volts
Peak Reverse Gate Voltage, V_{GRM}	5 volts
Storage Temperature, T_{stg}	−65°C to +150°C
Stud Torque	125 Lbs.-in. (min.), 150 Lbs.-in. (max.) 150 Kg.-cm. (min.), 175 Kg.-cm. (max.)

CHARACTERISTICS

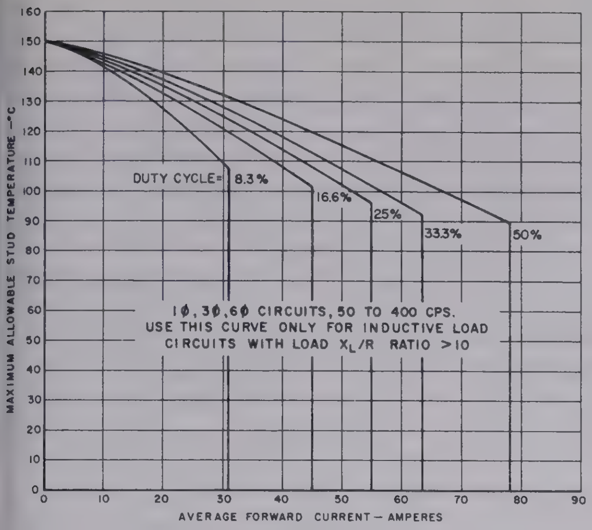
TEST	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Gate Trigger Current	I_{GT}	-------- -------- --------	30 50 15	75 125 25	mAdc	$T_C = +25°C$, $V_{FX} = 6$ Vdc, $R_L = 12$ ohms, $t_p \geqq 20$ μsec. $T_C = -65°C$, $V_{FX} = 6$ Vdc, $R_L = 12$ ohms, $t_p \geqq 20$ μsec. $T_C = +145°C$, $V_{FX} = 6$ Vdc, $R_L = 12$ ohms, $t_p \geqq 20$ μsec.
Gate Trigger Voltage	V_{GT}	-------- .25	1.5 --------	3.0 --------	Vdc	$T_C = -65°C$ to $+125°C$. $V_{FX} = 6$ Vdc, $R_L = 12$ ohms, $t_p \geqq 20$ μsec. $T_C = +145°C$, $V_{FX} =$ Rated, $R_L = 1000$ ohms, $t_p \geqq 20$ μsec.
Peak On-Voltage	V_{FM}	--------	2.0	2.5	V	$T_C = +25°C$, $I_{FM} = 1500$A Peak, Duty cycle $\leqq$ .01%
Holding Current	I_{HO}	--------	20	100	mAdc	$T_C = +25°C$, Anode supply = 24 Vdc, Initial forward curren = 2.5A
Turn-On Time (Delay Time + Rise Time)	$t_d + t_r$	--------	5	--------	μsec	$T_C = +25°C$, $I_F = 50$ Adc, $V_{FXM} =$ rated, Gate supply: 10 volt open circuit, 25 ohm, 0.1 μsec. max. rise time
Circuit Commutated Turn-Off Time	t_{off}	--------	50	--------	μsec	$T_C = +125°C$, $I_{FM} = 50$A, $i_{RM} = 5$A min., $V_{rx} = 50$ volts min., V_{FXM} (reapplied) = Rated, Rate of rise of reapplied forward blocking voltage = 20V/μsec linear. Gate bias: 0 volts, 100 ohms during turn-off interval, Duty cycle $\leqq$ .01%
Effective Thermal Resistance (DC)	θ_{J-C}	--------	.3	.4	°C/watt	
Peak Reverse and Forward Blocking Current	I_{ROM} and I_{FOM}				mA	$T_C = 145°C$
C60, C62U		--------	13	15		$V_{FOM} = V_{ROM} =$ 25 Volts peak
C60, C62F		--------	13	15		50 Volts peak
C60, C62A		--------	13	15		100 Volts peak
C60, C62G		--------	13	15		150 Volts peak
C60, C62B		--------	13	15		200 Volts peak
C60, C62H		--------	13	15		250 Volts peak
C60, C62C		--------	13	15		300 Volts peak
C60, C62D		--------	10	12		400 Volts peak
C60, C62E		--------	7	9		500 Volts peak



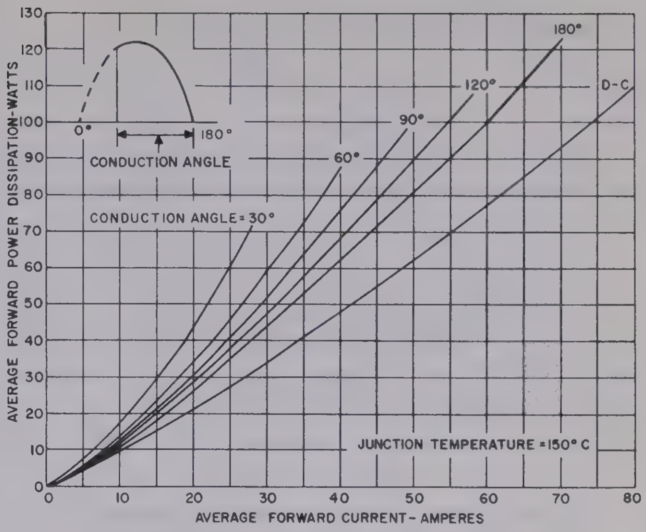
1. MAXIMUM FORWARD CHARACTERISTICS—ON-STATE



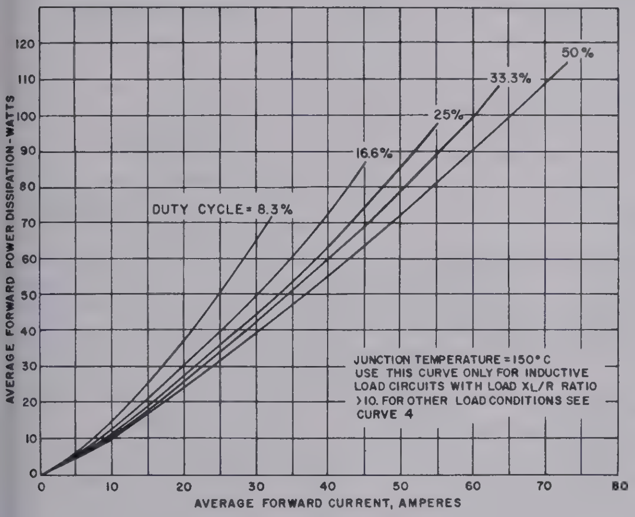
2. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



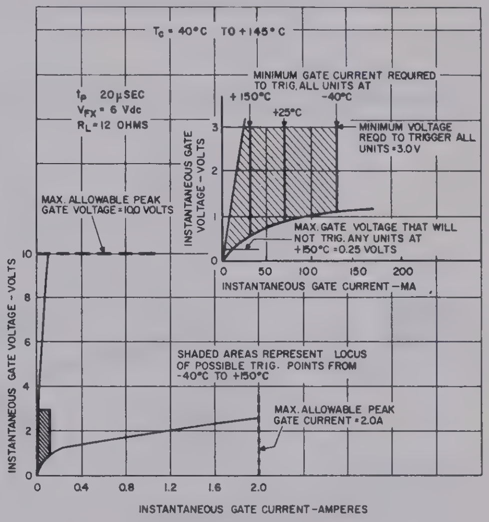
3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



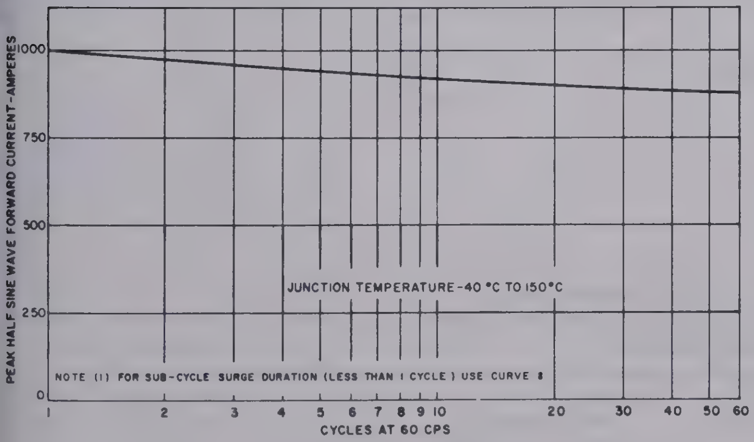
4. FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



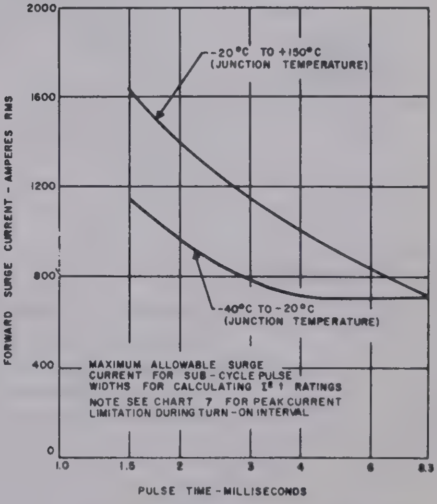
5. FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



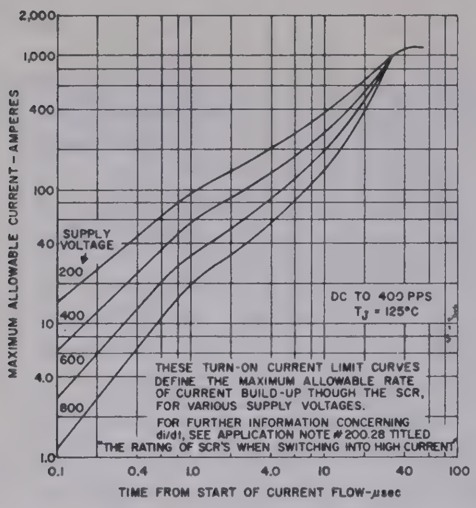
6. GATE TRIGGERING CHARACTERISTICS



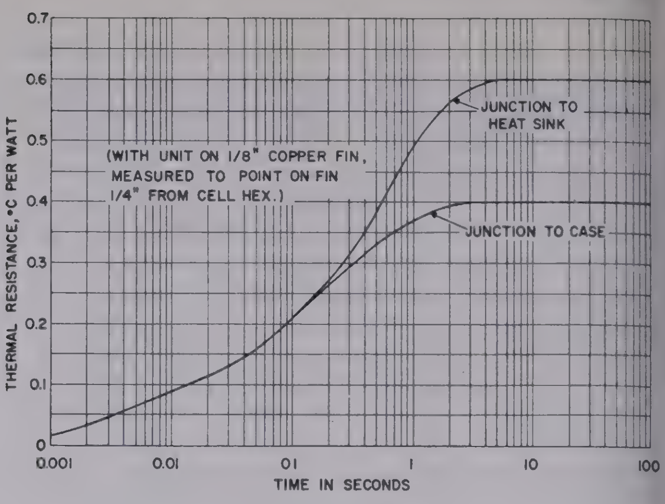
7. MAXIMUM ALLOWABLE SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS



8. SUB-CYCLE SURGE RATING FOLLOWING RATED LOAD CONDITIONS



9. CURRENT LIMIT FOR STEEP WAVEFORM OPERATION



10. TRANSIENT THERMAL IMPEDANCE (JUNCTION TO CASE)

OUTLINE DRAWINGS

C60 OUTLINE (Conforms to JEDEC TO-94 Outline)

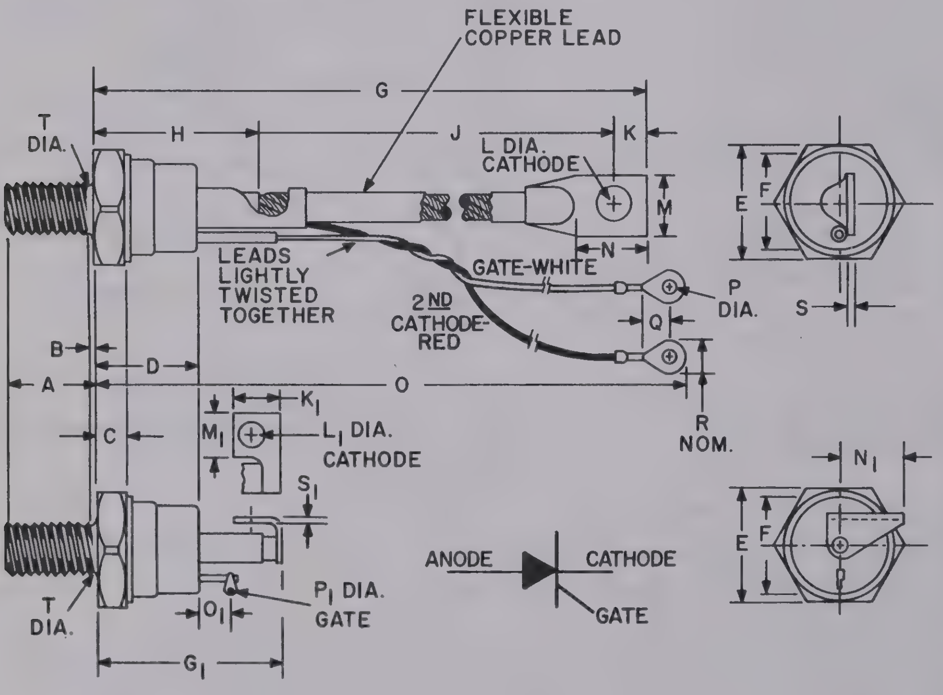

FLEXIBLE COPPER LEAD
G
T DIA.
H
J
K
L DIA. CATHODE
M
E
F
N
LEADS LIGHTLY TWISTED TOGETHER
GATE-WHITE
P DIA.
S
2ND CATHODE-RED
Q
B
D
A
O
R NOM.
C
K1
M1
L1 DIA. CATHODE
S1
N1
E
F
ANODE
CATHODE
GATE
T DIA.
O1
P1 DIA. GATE
G1

TABLE OF DIMENSIONS

Conversion Table

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.797	.827	20.243	21.005
B	—	.080	—	2.032
C	.278	.350	7.060	8.890
D	.874	1.030	22.099	26.162
E	1.049	1.062	26.644	26.975
F	.840	.910	21.335	23.115
G	6.204	6.512	157.619	165.443
G_1	—	1.750	—	44.450
H	1.484	1.640	37.653	41.656
J	4.437	5.623	112.698	142.824
K	.275	.325	6.985	8.255
K_1	.445	.485	11.302	12.319
L	.251	.281	6.375	7.137
L_1	.198	.212	5.029	5.385
M	.500	.600	12.700	15.240
M_1	.385	.415	9.778	10.541
N	.632	.725	16.052	18.390
N_1	.590	.640	14.985	16.256
O	7.000	7.342	177.799	186.487
O_1	.312 Ref.		7.925 Ref.	
P	.140	.150	3.555	3.811
P_1	.060	.075	1.524	1.905
Q	.250 Nom.		6.350 Nom.	
R	.290 Nom.		7.366 Nom.	
S	.065	.095	1.651	2.413
S_1	.058	.070	1.473	1.778
T	.463	.498	11.760	12.649

C62 OUTLINE

NOTES

1. Complete stud threads (½-20 UNF 2A) to within 2½ threads of head.
2. Flexible lead covered with silicon rubber insulation (Class H), 600 volt ASTM standard wall.
3. Orientation of cathode and gate terminals not defined.
4. One, ½-20 steel, cadmium plated nut and one cadmium plated spring washer supplied with each unit.
5. Approximate weights:

Unit	With Hardware		Without Hardware	
	Ounces	Grams	Ounces	Grams
C60	4.25	120	3.50	99
C62	3.50	99	2.75	78

SCR

C103

TYPICAL APPLICATIONS:

SENSORS —

- Temperature
- Pressure
- Dryness
- Proximity
- Voltage
- Current

AMPLIFIERS — (gate)

TIMERS

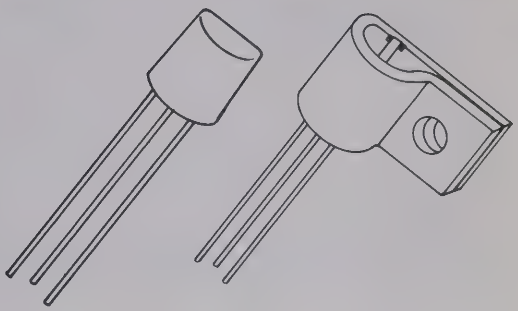
CONTROLS —

- Small motors
- Small lamps
- Remote

SWITCHING —

- Solid-state relay
- Relay driver
- Counter
- Low power inverter

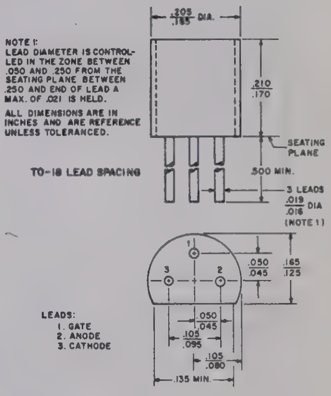
LOGIC CIRCUITS



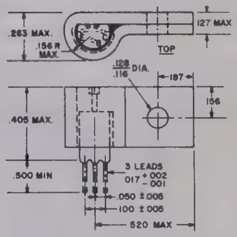
120V AC LINE OPERATION

FEATURES:

- 200 μA Gate sensitivity
- 8-amp surge
- 30-thru 200-volt selection
- Plastic TO-18 package
- Low V_F
- High dv/dt


.205 / .185 DIA.
NOTE 1:
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND .250 FROM THE SEATING PLANE BETWEEN .250 AND END OF LEAD A MAX. OF .021 IS HELD.
ALL DIMENSIONS ARE IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.
.210 / .170
SEATING PLANE
TO-18 LEAD SPACING
.500 MIN.
3 LEADS .019 / .016 DIA (NOTE 1)
1
2
3
.050 / .045
.165 / .125
LEADS:
1. GATE
2. ANODE
3. CATHODE
.050 / .045
.105 / .095
.105 / .080
.135 MIN.

Type 1


.263 MAX.
.156 R MAX.
127 MAX
TOP
.128 / .116 DIA.
187
156
.405 MAX.
.500 MIN
3 LEADS 017 + 002 − 001
.050 ± .006
100 ± 005
520 MAX

Type 2 (with P-Strap)

MAXIMUM ALLOWABLE RATINGS

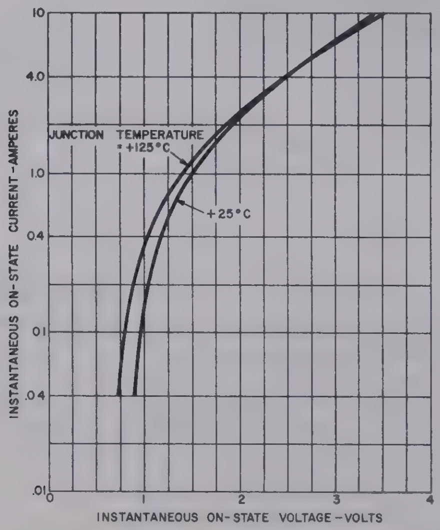
Type	Repetitive Peak Off-State Voltage, V_{DRM} (1) $T_C = -65°C$ to $+125°C$	Repetitive Peak Reverse Voltage, V_{RRM} (2) $T_C = -65°C$ to $+125°C$
C103Y	30 Volts	30 Volts
C103YY	60 Volts	60 Volts
C103A	100 Volts	100 Volts
C103B	200 Volts	200 Volts

R_{GK} = 1000 ohms maximum.
Values apply for zero or negative gate voltage only.

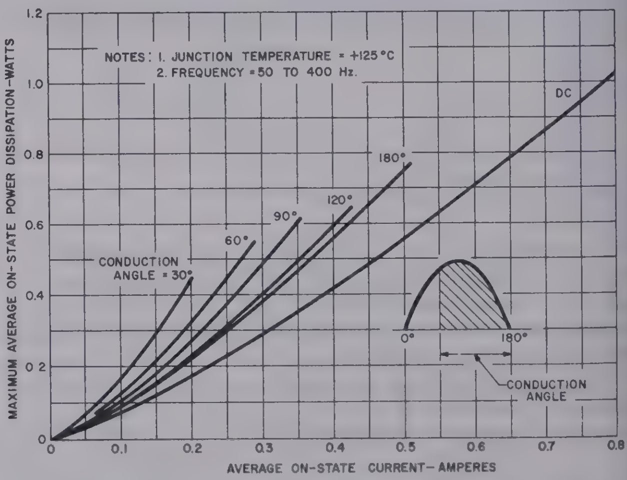
RMS On-State Current, $I_{T(RMS)}$ (all Conduction Angles)	0.8 Amperes
Peak One Cycle Surge (non-rep) On-State Current, I_{TSM}	8.0 Amperes
Peak Gate Power Dissipation, P_{GM}	1.0 Watts for 8.3 msec.
Average Gate Power Dissipation, $P_{G(AV)}$	0.01 Watts
Peak Positive Gate Current, I_{GM}	0.5 Amperes
Peak Negative Gate Voltage, V_{GM}	8 Volts
Storage Temperature, T_{STG}	−65°C to +150°C
Operating Junction Temperature, T_J	−65°C to +125°C

CHARACTERISTICS

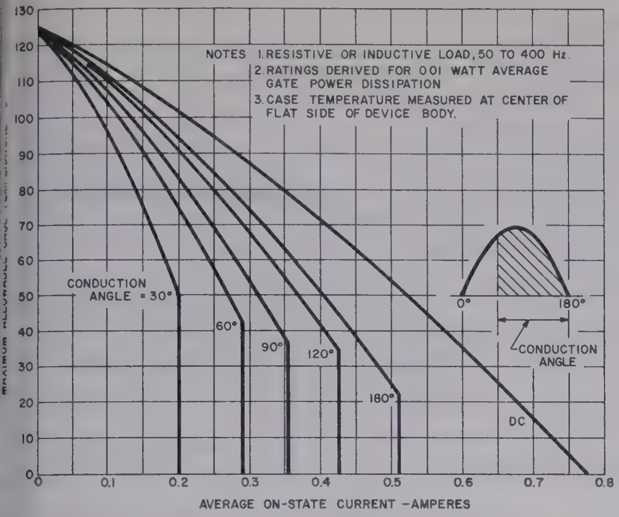
Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Peak Reverse and Off-State Current (All types)	I_{RRM} or I_{DRM}	—	—	1.0	μA	$T_C = +25°C$, $R_{GK} = 1000$ ohms $V_{RRM} = V_{DRM}$ = Rated Value.
		—	—	50		$T_C = +125°C$, $R_{GK} = 1000$ ohms $V_{RRM} = V_{DRM}$ = Rated Value.
DC Gate Trigger Current	I_{GT}	—	—	200	μAdc	$T_C = +25°C$, $V_D = 6$Vdc, $R_L = 100$ ohms.
		—	—	500		$T_C = -65°C$, $V_D = 6$Vdc, $R_L = 100$ ohms.
DC Gate Trigger Voltage	V_{GT}	—	—	0.8	Vdc	$T_C = +25°C$, $V_D = 6$Vdc, $R_L = 100$ ohms.
		—	—	1.0		$T_C = -65°C$, $V_D = 6$Vdc, $R_L = 100$ ohms.
		0.1	—	—		$T_C = +125°C$, Rated V_{DRM}, $R_L = 1000$ ohms.
Peak On-State Voltage	V_{TM}	—	—	1.5	V	$T_C = +25°C$, $I_{TM} = 1.0$A peak, 1 msec. wide pulse, Duty Cycle $\leqq 2\%$
Holding Current	I_H				mAdc	Anode source voltage = 12Vdc, $R_{GK} = 1000$ ohms.
		—	—	5.0		$T_C = +25°C$
		—	—	10.0		$T_C = -65C$
Critical Rate of Rise of Off-State Voltage	dv/dt	—	20	—	V/μsec	$T_C = +125°C$, Rated V_{DRM}, $R_{GK} = 1000$ ohms.
Circuit Commutated Turn-Off Time	t_q	—	15	—	μsec	$T_C = +125°$ C, rectangular current waveform. Rate of rise of current <10A/μsec. Rate reversal of current <5A/μsec. $I_{TM} = 1$A (50 μsec. pulse). Rep. Rate = 60 pps. V_{RRM} = Rated, $V_{RX} = 15$V Min., V_{DRM} = Rated. Rate of Rise of reapplied off-state voltage = 20V/ μsec.; Gate Bias = 0 Volts, 100 Ohms (during turn-off time interval).
Steady-State Thermal Resistance	$R_{\theta JC}$	—	—	125	°C/W	Junction-to-case (flat side of case is temp. ref. point).
	$R_{\theta JA}$	—	—	230		Junction-to-ambient (free convection).
	$R_{\theta JC}$	—	—	110		Junction to P-strap dissipator (rounded surface is temp. ref. point).
	$R_{\theta JA}$	—	—	170		Junction-to-ambient, with P-strap dissipator (free convection).



1. MAXIMUM ON-STATE CHARACTERISTICS

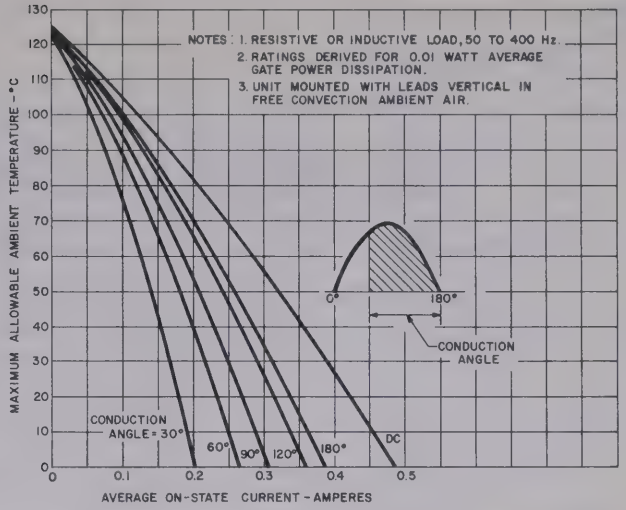


2. MAXIMUM ON-STATE POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



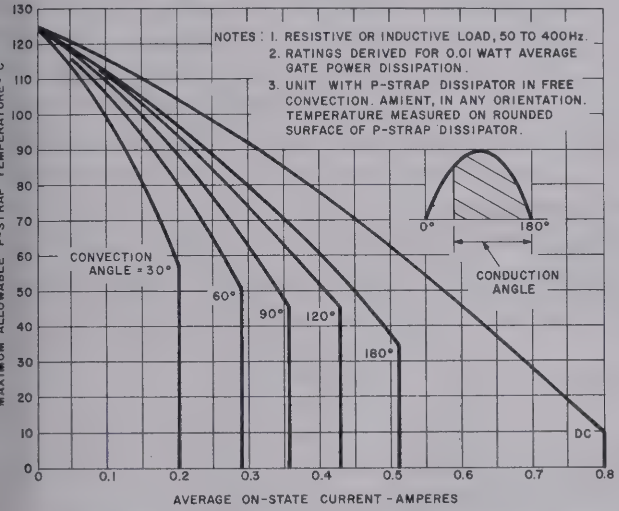
NOTES 1. RESISTIVE OR INDUCTIVE LOAD, 50 TO 400 Hz.
2. RATINGS DERIVED FOR 0.01 WATT AVERAGE GATE POWER DISSIPATION
3. CASE TEMPERATURE MEASURED AT CENTER OF FLAT SIDE OF DEVICE BODY.

3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM— WITHOUT P-STRAP DISSIPATOR



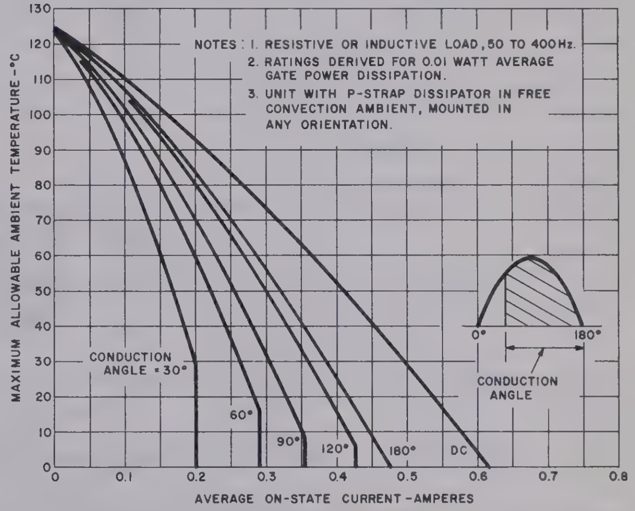
NOTES: 1. RESISTIVE OR INDUCTIVE LOAD, 50 TO 400 Hz.
2. RATINGS DERIVED FOR 0.01 WATT AVERAGE GATE POWER DISSIPATION.
3. UNIT MOUNTED WITH LEADS VERTICAL IN FREE CONVECTION AMBIENT AIR.

4. MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM— WITHOUT P-STRAP DISSIPATOR



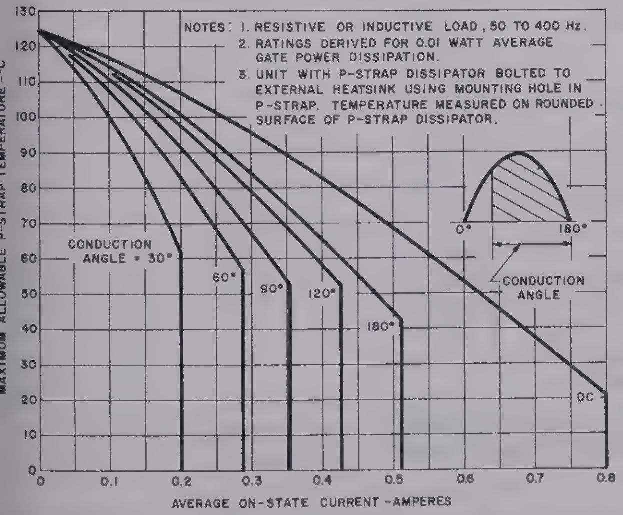
NOTES: 1. RESISTIVE OR INDUCTIVE LOAD, 50 TO 400Hz.
2. RATINGS DERIVED FOR 0.01 WATT AVERAGE GATE POWER DISSIPATION.
3. UNIT WITH P-STRAP DISSIPATOR IN FREE CONVECTION. AMIENT, IN ANY ORIENTATION. TEMPERATURE MEASURED ON ROUNDED SURFACE OF P-STRAP DISSIPATOR.

5. MAXIMUM ALLOWABLE P-STRAP TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM— NO EXTERNAL HEATSINK



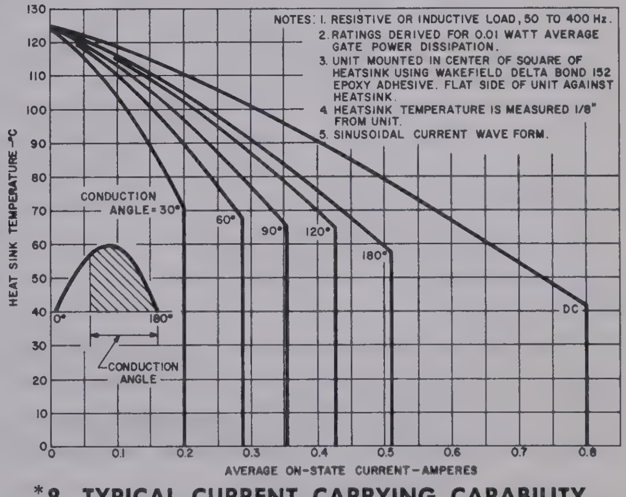
NOTES: 1. RESISTIVE OR INDUCTIVE LOAD, 50 TO 400Hz.
2. RATINGS DERIVED FOR 0.01 WATT AVERAGE GATE POWER DISSIPATION.
3. UNIT WITH P-STRAP DISSIPATOR IN FREE CONVECTION AMBIENT, MOUNTED IN ANY ORIENTATION.

6. MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM— WITH P-STRAP DISSIPATOR



NOTES: 1. RESISTIVE OR INDUCTIVE LOAD, 50 TO 400 Hz.
2. RATINGS DERIVED FOR 0.01 WATT AVERAGE GATE POWER DISSIPATION.
3. UNIT WITH P-STRAP DISSIPATOR BOLTED TO EXTERNAL HEATSINK USING MOUNTING HOLE IN P-STRAP. TEMPERATURE MEASURED ON ROUNDED SURFACE OF P-STRAP DISSIPATOR.

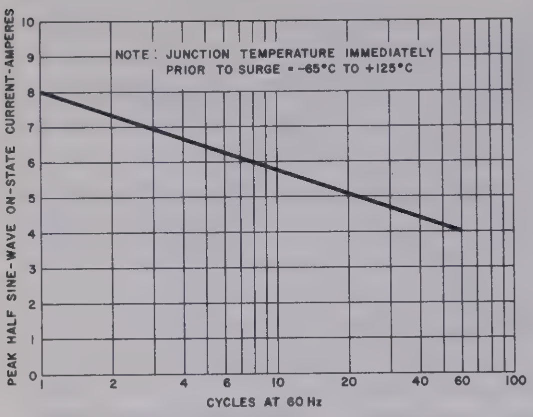
7. MAXIMUM ALLOWABLE P-STRAP TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM— MOUNTED TO EXTERNAL HEATSINK



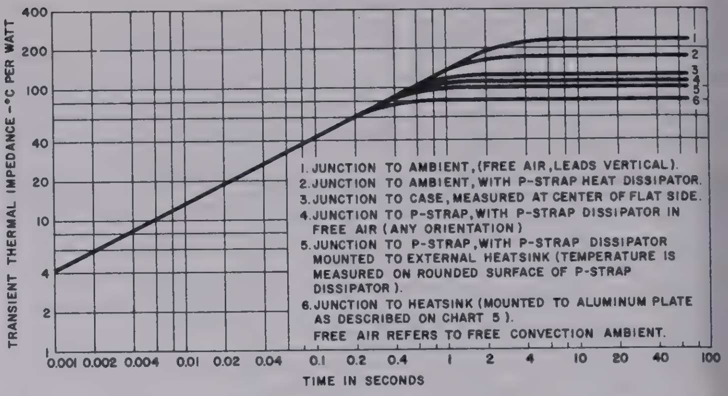
NOTES: 1. RESISTIVE OR INDUCTIVE LOAD, 50 TO 400 Hz.
2. RATINGS DERIVED FOR 0.01 WATT AVERAGE GATE POWER DISSIPATION.
3. UNIT MOUNTED IN CENTER OF SQUARE OF HEATSINK USING WAKEFIELD DELTA BOND 152 EPOXY ADHESIVE. FLAT SIDE OF UNIT AGAINST HEATSINK.
4. HEATSINK TEMPERATURE IS MEASURED 1/8" FROM UNIT.
5. SINUSOIDAL CURRENT WAVE FORM.

***8. TYPICAL CURRENT CARRYING CAPABILITY FOR DEVICE MOUNTED ON 1″ x 1″ x 1/16″ ALUMINUM HEATSINK**

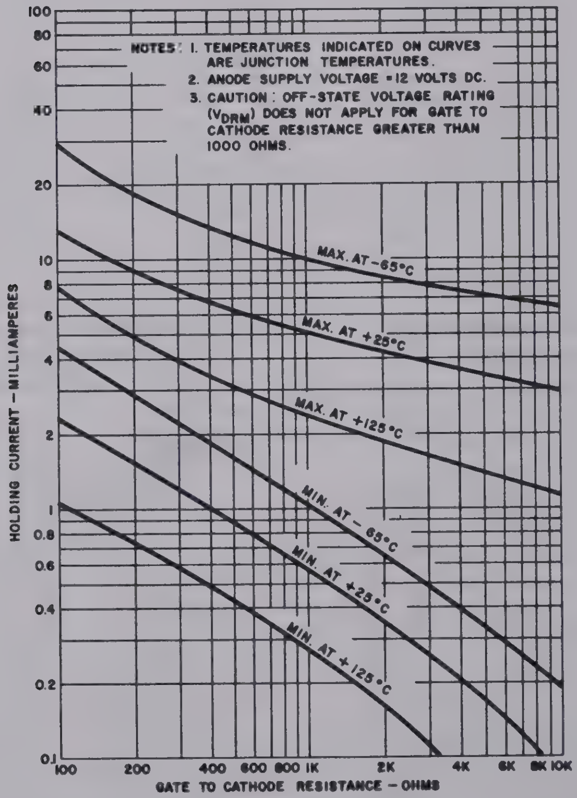
*Chart 8. For Reference only, units are not available in this configuration.



9. MAXIMUM ALLOWABLE SURGE (NON-REPETITIVE) ON-STATE CURRENT



10. MAXIMUM TRANSIENT THERMAL IMPEDANCE



11. MAXIMUM AND MINIMUM HOLDING CURRENT VARIATION WITH GATE TO CATHODE RESISTANCE

SCR

Model C106

Up to 400 Volts 4 Amperes (RMS)

PRODUCT FEATURES

he Type C106 Silicon Controlled Rectifier (SCR) as the following outstanding features:

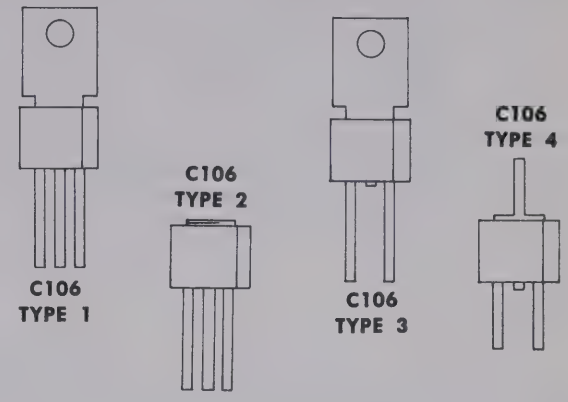
OW COST

ELIABLE Uses the proved planar passivated rocess (all junctions protected by a silicon ioxide layer)

ENSITIVE Operates directly from low signal ensors such as thermistors, photo-conductive cells, etc.

ERSATILE Designed for a variety of mount-down ethods—printed circuit, plug-in socket, screws, r point-to-point soldering

UGGED, COMPACT Uses a solid plastic encapsulant rectangular shape for high density packaging



(FULL SIZE)

YPICAL APPLICATIONS

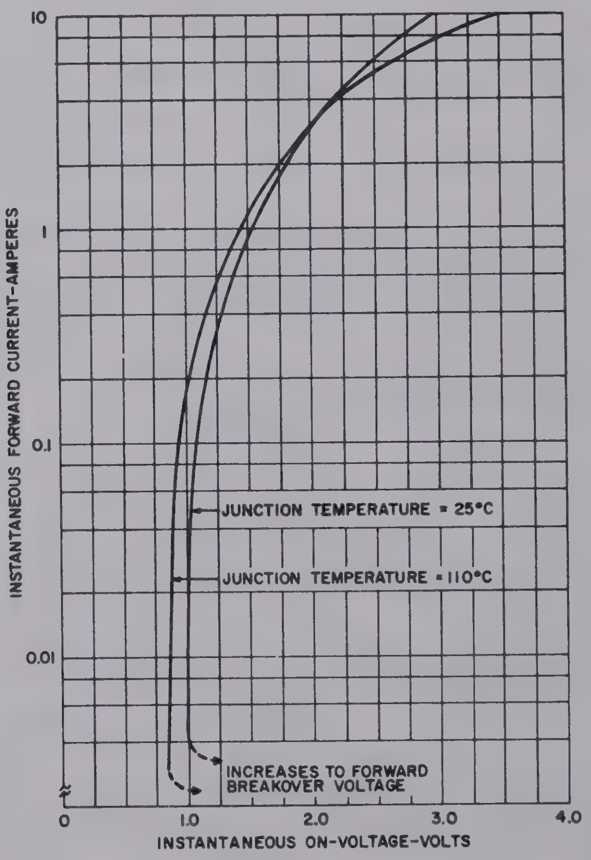
OTOR CONTROL	Electric Model Trains Sewing Machines Movie Projectors Food Mixers Electric Fans Slot Racing Cars
GHT	Flame Detectors Moving-Light Signs (Chasers) Driver for Computer Readout Lights Harbor Buoy Flashers Automotive Warning Systems Nixie & Neon Drivers
MPERATURE	Range Surface Unit (Hybrid) Chemical Processing (Photographic, etc.) Food Warmer Tray Bearing Temperature Sensor Electric Blanket Control
ESSURE	Auto Oil Pressure Gage Hot Water Boiler Safety Monitor
ME	Photo Darkroom Exposure Oven Timer Vending Machine Logic Industrial Process Control
QUID LEVEL	Basement Sump Pump Automatic Coffee Maker Automatic Shutoff for Vending Machines
REMOTE CONTROL	Armchair TV Control Master Switching Stations for Home Garage Door Openers Power Switch
DRYNESS	Clothes Dryness Sensor
PROXIMITY	Burglar Alarm Touch Switch Electric Door Openers
COUNTING	Low Speed Ring Counters Shift Registers
SWITCHING	Relay Replacement Solenoid Drivers Latching Relay Replacement Power Flip Flops Low Power Inverters Thyratron Tube Replacement
AMPLIFIERS	Gate Amplifier for Larger SCR's, Triacs —Blenders —Hand Tools
IGNITION	Small Gas Engines Gas Appliances
DETECTION	Voltage (Battery Charger) Current (Crowbar)

MAXIMUM ALLOWABLE RATINGS

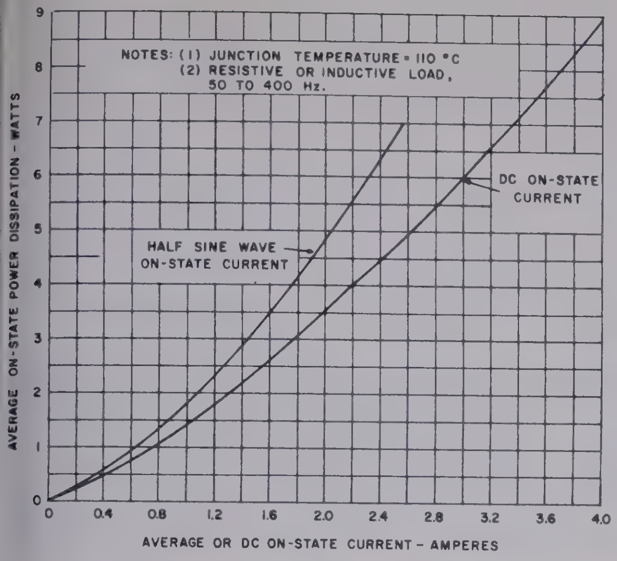
Type	Repetitive Peak Forward Blocking Voltage, V_{FXM} $R_{GK} = 1000$ Ohms $T_J = -40°C$ to $+110°C$	Working and Repetitive Peak Reverse Voltage, $V_{ROM(wkg)}$ and $V_{ROM(rep)}$ $T_J = -40°C$ to $+110°C$
C106Q1, C106Q2, C106Q3, C106Q4	15 Volts	15 Volts
C106Y1, C106Y2, C106Y3, C106Y4	30 Volts	30 Volts
C106F1, C106F2, C106F3, C106F4	50 Volts	50 Volts
C106A1, C106A2, C106A3, C106A4	100 Volts	100 Volts
C106B1, C106B2, C106B3, C106B4	200 Volts	200 Volts
C106C1, C106C2, C106C3, C106C4	300 Volts	300 Volts
C106D1, C106D2, C106D3, C106D4	400 Volts	400 Volts

RMS Forward Current, On-State	4 Amperes
Rate of Rise of Forward Current (non-repetitive), di/dt (See Chart 9)	50 Amperes/Microsecond
Peak Forward Current, On-State (repetitive)	75 Amperes*
Peak One Cycle Surge Forward Current, Non-Repetitive, I_{FM} (surge)	20 Amperes
I^2t (for fusing)	0.5 Ampere^2 seconds (for times > 1.5 Milliseconds
Peak Gate Power, P_{GM}	0.5 Watt
Average Gate Power, $P_{G(AV)}$	0.1 Watt
Peak Gate Current, I_{GFM}	0.2 Amperes
Peak Reverse Gate Voltage, V_{GRM}	6 Volts
Storage Temperature, T_{stg}	−40°C to +150°C
Operating Temperature	−40°C to +110°C

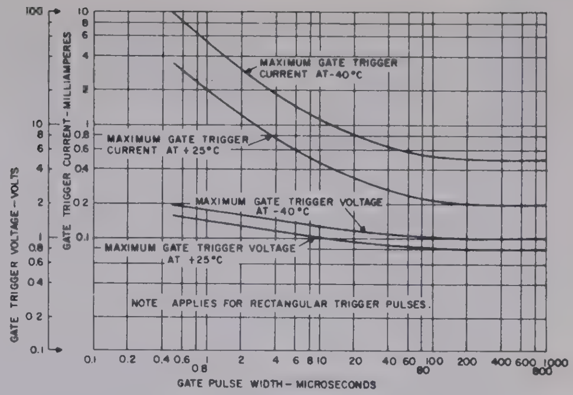
*This rating applies for operation at 60 Hz, 75°C maximum tab (or anode) lead temperature, switching from 80 volts peak, sinusoidal current pulse width 10 μsec, minimum, 15 μsec. maximum.



1. Maximum Forward Characteristics, On State



2. Maximum On-State Power Dissipation

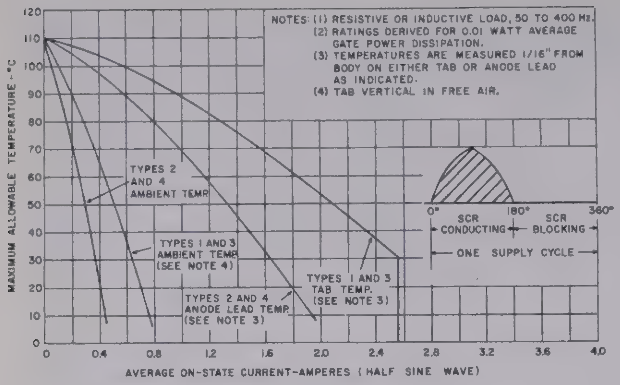


3. Maximum Gate Trigger Current and Voltage Variation with Trigger Pulse Width

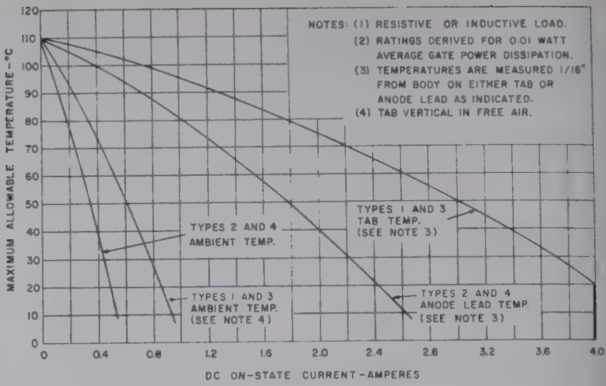
CHARACTERISTICS

Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Reverse or Forward Blocking Current (All Types)	I_{RX} or I_{FX}	—	0.1	10	μA	$V_{RX} = V_{FX}$ Rated V_{ROM} (rep) Value $T_L = 25°C$, $R_{GK} = 1000$ Ohms
		—	10	100	μA	$V_{RX} = V_{FX}$ Rated V_{ROM} (rep) Value $T_L = 110°C$, $R_{GK} = 1000$ Ohms
Gate Trigger Current	I_{GT}	—	30	200	μAdc	$T_L = 25°C$, $V_{FX} = 6$ Vdc, $R_L = 100$ Ohms $R_{GK} = 1000$ Ohms
		—	75	500	μAdc	$T_L = -40°C$, $V_{FX} = 6$ Vdc, $R_L = 100$ Ohms $R_{GK} = 1000$ Ohms
Gate Trigger Voltage	V_{GT}	0.4	0.5	0.8	Volts DC	$T_L = 25°C$, $V_{FX} = 6$ Vdc, $R_L = 100$ Ohms $R_{GK} = 1000$ Ohms
		0.5	0.7	1.0	Volts DC	$T_L = -40°C$, $V_{FX} = 6$ Vdc, $R_L = 100$ Ohms $R_{GK} = 1000$ Ohms
		0.2	—	—	Volts DC	$T_L = 110°C$, V_{FX} = Rated V_{FXM} Value $R_L = 3000$ Ohms, $R_{GK} = 1000$ Ohms
Peak On-Voltage	V_{FM}	—	1.8	2.2	Volts	$T_L = 25°C$, $I_{FM} = 4$ Amperes Peak, Single Half Sine Wave Pulse, 2 Millisec. Wide
Holding Current	I_{HX}	0.3	1.0	3.0	mAdc	$T_L = 25°C$, $V_{FX} = 12$ Vdc, $R_{GK} = 1000$ Ohms
		0.4	2.0	6.0	mAdc	$T_L = -40°C$, $V_{FX} = 12$ Vdc, $R_{GK} = 1000$ Ohms
		0.14	0.6	2.0	mAdc	$T_L = 110°C$, $V_{FX} = 12$ Vdc, $R_{GK} = 1000$ Ohms
Latching Current	I_{LX}	0.3	1.5	4.0	mAdc	$T_L = 25°C$, $V_{FX} = 12$ Vdc, $R_{GK} = 1000$ Ohms
		0.4	3.0	8.0	mAdc	$T_L = -40°C$, $V_{FX} = 12$ Vdc, $R_{GK} = 1000$ Ohms
Critical Rate of Rise of Forward Blocking Voltage	dv/dt	—	8	—	Volts/Microsecond	$T_L = 110°C$, V_{FX} = Rated V_{FXM} Value $R_{GK} = 1000$ Ohms
Turn On Time	$t_d + t_r$	—	1.2	—	Microseconds	$T_L = 25°C$, V_{FX} = Rated V_{FXM} Value $I_{FM} = 1$ Ampere, Gate Pulse = 4 Volts, 300 Ohms, 5 Microseconds Wide.
Circuit Commutated Turn-Off Time	t_{off}	—	40	100	Microseconds	$T_L = 110°C$, rectangular current waveform. Rate of rise of current <10 amps/μsec. Rate of reversal of current <5 amps/μsec. $I_{FM} = 1$ Amp (50 μsec pulse). Repetition Rate = 60 pps. V_{RXM} = Rated. $V_{RX} = 15$ Volts Minimum. V_{FXM} = Rated. Rate of Rise Reapplied Forward Blocking Voltage = 5 Volts/μsec. Gate Bias = 0 Volts, 100 Ohms (during turn-off time interval).

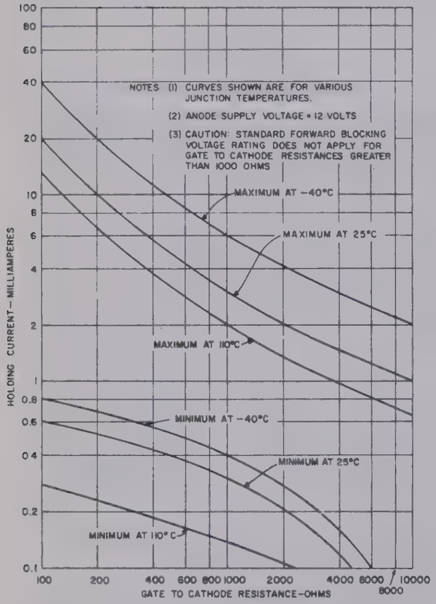
The lead temperature (T_L) is measured in the center of the tab, 1/16 inch from the body on Type 1 and Type 3 devices, and in the center of the anode lead, 1/16 inch from the body on Type 2 and Type 4 devices.



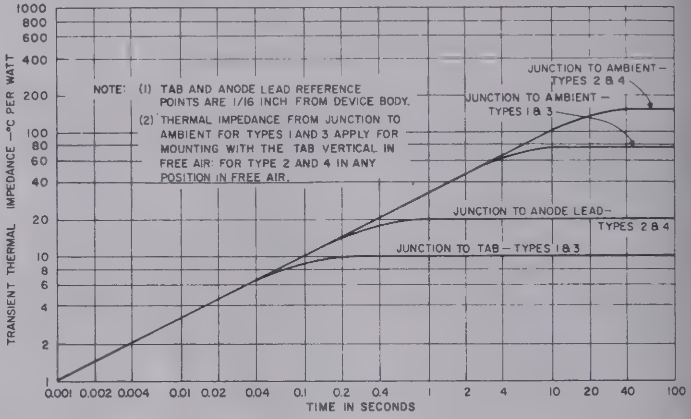
4. Maximum Allowable Temperatures for Half Sine Wave On-State Current



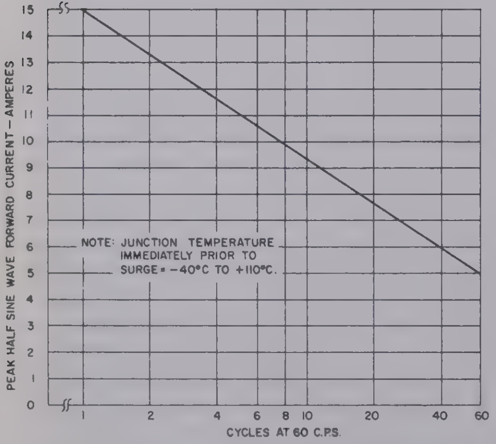
5. Maximum Allowable Temperatures for DC On-State Current



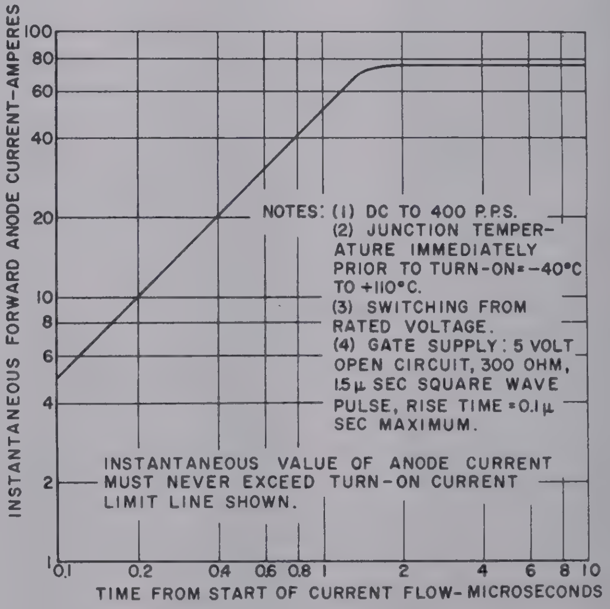
6. Maximum and Minimum Holding Current Variation with External Gate-to-Cathode Resistance



7. Maximum Transient Thermal Impedance



8. Maximum Allowable Non-Repetitive Peak Surge Forward Current



9. Turn-On Current Limit

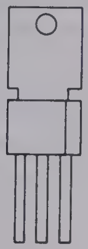
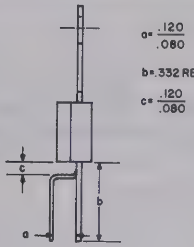
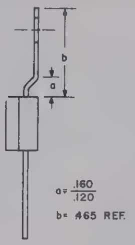
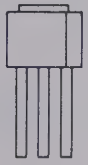
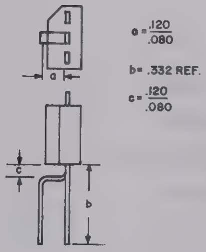
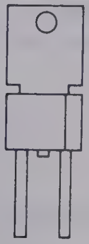
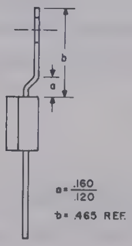
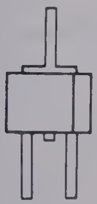
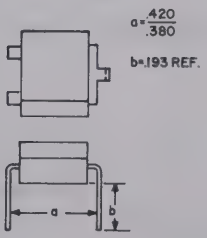
MOUNTING METHODS

The C106, because of its unique package design, is capable of being mounted in a variety of methods; depending upon the heatsink requirements and the circuit packaging methods.

The leads will bend easily, either perpendicular to the flat or to any angle, and may also be bent, if desired, immediately next to the plastic case. For sharp angle bends (90° or larger), a lead should be bent only once; since repeated bending will fatigue or break the lead. Bending in other directions may be performed as long as the lead is held firmly between the case and the bend, so that the strain on the lead is not transmitted to the plastic case.

The mounting tab may also be bent or formed into any convenient shape so long as it is held firmly between the plastic case and the area to be formed or bent. Without this precaution, bending may fracture the plastic case and permanently damage the unit.

As a service to its customers, the General Electric Company provides a lead and tab shaping capability. Any of the derived types shown in the following chart are available direct from the factory to original equipment manufacturers.

BASIC TYPES	**DERIVED TYPES** (The types shown below are derived from the basic types illustrated in the left-hand column.)		
	PRINTED CIRCUIT BOARD MOUNTING (Upright or Flat)	**RIVET OR SCREW MOUNTING TO FLAT SURFACE**	
 **C106 Type 1**	 a= .120 / .080 b=.332 REF. c= .120 / .080 c b a **C106 Type 11**	 **C106 Type 12**	
 **C106 Type 2**	 a= .120 / .080 a b= .332 REF. c= .120 / .080 c b **C106 Type 21**		
 **C106 Type 3**		 	
 **C106 Type 4**	 **C106 Type 41**		

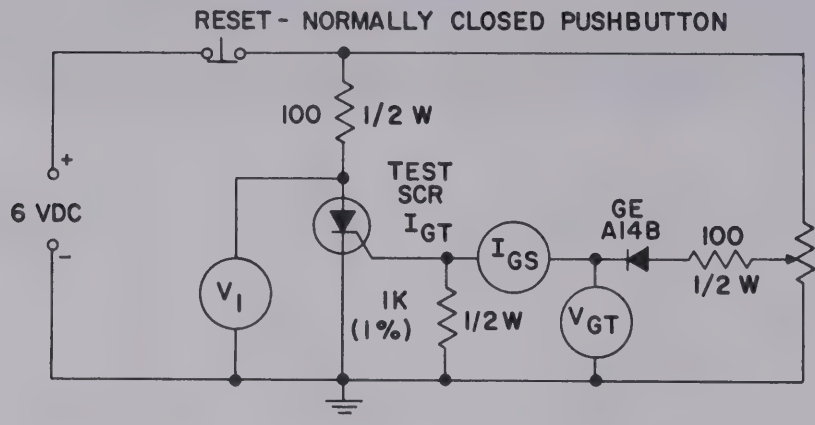
C106 CONVERSIONS

INCHES	MILLIMETERS	INCHES	MILLIMETERS
.120 .080	3.048 2.031	.332 REF.	8.433 REF.
.160 .120	4.064 3.047	.420 .380	10.668 9.651
.193 REF.	4.902 REF.	.465 REF.	11.811 REF.

In-line sockets to accommodate the 2 or 3 flat leads of the C106 are available for printed circuit board or chassis mounting. hese sockets, No. 77-115 (press-fit) or No. 77-116 (flange), may be obtained from the Connector Div., Amphenol Corp., 1830 outh 54th Ave., Chicago, Illinois 60650.

SIMPLE TEST CIRCUIT FOR THE C106 SCR*

Gate Trigger Voltage and Current Measurement


RESET - NORMALLY CLOSED PUSHBUTTON
100
1/2 W
+
6 VDC
−
TEST SCR
I_{GT}
V_1
1K (1%)
1/2 W
I_{GS}
GE A14B
100
1/2 W
R1
V_{GT}

V_1 — 0-10 volt DC meter
V_{GT} — 0-1 volt DC meter
I_{GS} — 0-1mA DC milliameter
R1 — 1K potentiometer

To measure gate trigger voltage and current, raise gate voltage (V_{GT}) until meter reading V_1 drops from 6 volts to 1 volt. Gate trigger voltage is the reading on V_{GT} *just prior* to V_1 dropping. Gate trigger current I_{GT} can be computed from the relationship:

$$I_{GT} = I_{GS} - \frac{V_{GT}}{1000} \text{ amps}$$

where I_{GS} is reading (in amps) on meter *just prior* to V_1 dropping. NOTE: I_{GT} may turn out to be a negative quantity (trigger current flows *out* from gate lead).

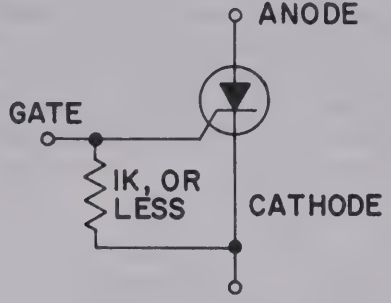
---

* *For more sophisticated equipment suitable for testing the C106 SCR see GE Application Note 200. 19 "Using Low Current SCR's".*

CIRCUIT DESIGN

1. Use of Gate Resistor

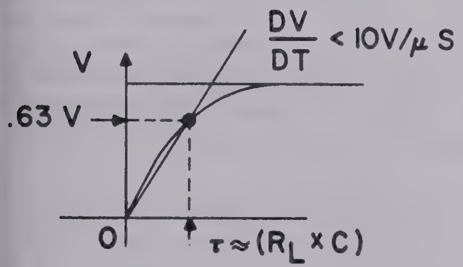
The C106 SCR is guaranteed to block rated voltage over its rated operating temperature range *only* if a resistance of not more than 1000 ohms, or equivalent, ** is connected between its gate and cathode terminals as follows:

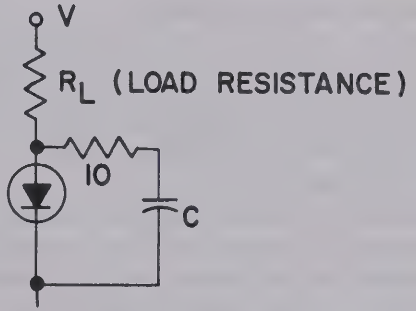

ANODE
GATE
IK, OR LESS
CATHODE

** *For alternative acceptable gate biasing methods see Application Note 200. 19 "Using Low Current SCR's".*

2. Suppression of Rate Effect

In circuits where the C106 is subjected to fast rising anode voltages, as for instance where voltage is applied suddenly with a switch, RC "slow down" filters may be required to prevent the SCR from triggering spontaneously. C should be selected in conjunction with R_L so that dv/dt is less than 10 volts per microsecond thus:

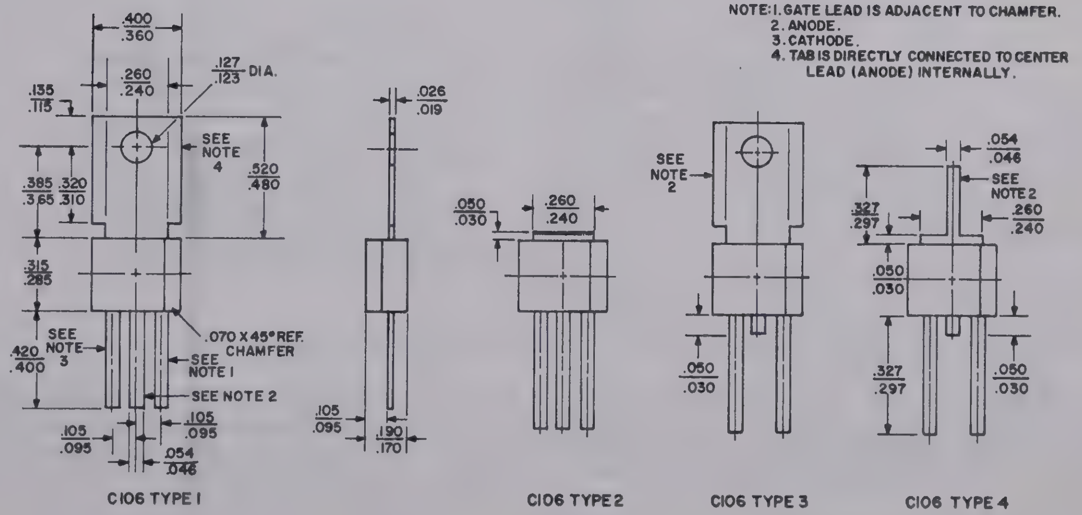



V
R_L (LOAD RESISTANCE)
10
C

The 10 ohm resistor limits turn on current through the SCR to a safe value when the SCR turns on.)

OUTLINE DRAWINGS

C106 CONVERSIONS	
INCHES	MILLIMETERS
.026 .019	.660 .483
.050 .030	1.270 .761
.054 .046	1.372 1.168
.070	1.778
.105 .095	2.667 2.412
.127 .123	3.226 3.124
.135 .115	3.429 2.920
.190 .170	4.826 4.318
.260 .240	6.604 6.095
.272 .232	6.908 5.892
.315 .285	8.001 7.239
.320 .290	8.128 7.366
.320 .310	8.128 7.874
.327 .297	8.306 7.544
.385 .365	9.779 9.271
.400 .360	10.160 9.144
.420 .400	10.668 10.160
.520 .480	13.208 12.191


.400
.360
.260
.240
.127
.123 DIA.
.135
.115
SEE NOTE 4
.520
.480
.385
.365
.320
.310
.315
.285
SEE NOTE 3
.420
.400
.070 X 45° REF. CHAMFER
SEE NOTE 1
SEE NOTE 2
.105
.095
.105
.095
.054
.046
.026
.019
.105
.095
.190
.170
.050
.030
.260
.240
SEE NOTE 2
.050
.030
.054
.046
SEE NOTE 2
.327
.297
.260
.240
.050
.030
.327
.297
.050
.030
C106 TYPE 1
C106 TYPE 2
C106 TYPE 3
C106 TYPE 4

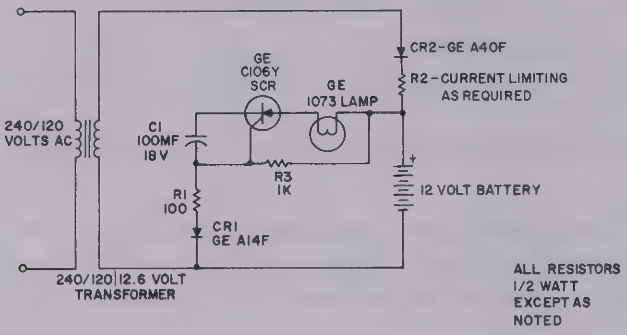
NOTE: 1. GATE LEAD IS ADJACENT TO CHAMFER.
2. ANODE.
3. CATHODE.
4. TAB IS DIRECTLY CONNECTED TO CENTER LEAD (ANODE) INTERNALLY.

REPRESENTATIVE APPLICATIONS OF THE C106 SCR

1. Emergency Light

This simple circuit provides battery operated emergency lighting instantaneously upon failure of the regular AC service. When line power is restored, the emergency light turns off and the battery recharges automatically. The circuit is ideal for use in elevator cars, corridors and similar places where loss of light due to power failure would be undesirable. Completely static in operation, the circuit requires no maintenance.

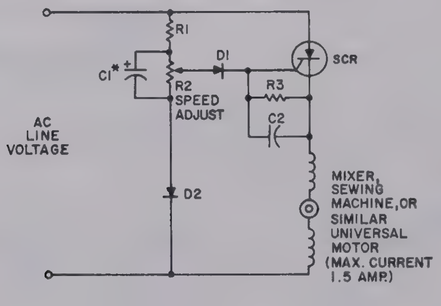
With AC power "on", capacitor C1 charges through rectifier CR1 and resistor R1 to develop a negative DC voltage at the gate of the C106Y SCR. By this means the SCR is prevented from triggering, and the emergency light stays off. At the same time, the battery is kept fully charged by rectifier CR2 and resistor R2. Should the AC power fail, C1 discharges and the SCR is triggered on by battery power through resistor R3. The SCR then energizes the emergency light. Reset is automatic when AC is restored, because the peak AC line voltage biases the SCR and turns it off.



2. Universal Motor Speed Control

This circuit can replace the carbon-pile speed controller commonly supplied with household sewing machines. It is equally effective for use with other small AC-DC motors, such as those found in food mixers and similar traffic appliances. Maximum current capability is 1.5 amps. Provision of speed-dependent feedback gives excellent torque characteristics to the motor, even at low speeds where other types of controllers are completely ineffective.

The resistor capacitor network R1-R2-C1 provides a ramp-type reference voltage superimposed on top of a DC voltage adjustable with the speed-setting potentiometer R2. This reference voltage appearing at the wiper of R2 is balanced against the residual counter emf of the motor through the SCR gate. As the motor slows down due to heavy loading, its counter emf falls, and the reference ramp triggers the SCR earlier in the AC cycle. More voltage is thereby applied to the motor causing it to pick up speed again. Performance with the C106 SCR is particularly good because the low trigger current requirements of this device allow use of a flat top reference voltage, which provides good feedback gain and close speed regulation.


R1
C1*
D1
SCR
R2 SPEED ADJUST
R3
C2
AC LINE VOLTAGE
D2
MIXER, SEWING MACHINE, OR SIMILAR UNIVERSAL MOTOR (MAX. CURRENT 1.5 AMP.)

Line Voltage	120V	240V
R1	47K	100K
R2	10K	20K
R3	1K	1K
C1	1μF, 50V	1μF, 100V
C2	0.1μF, 50V	0.1μF, 50V
D1	1N5059	1N5060
D2	1N5059	1N5060
SCR	C106B1	C106D1

Note

* *C_1 optional, contributes to performance in some circumstances.*

Neither the disclosure of any information herein nor the sale of semiconductor devices by General Electric Company conveys any license under patent claims covering combinations of semiconductor devices with other devices or elements. In the absence of an express written agreement to the contrary, General Electric Company assumes no liability for patent infringement arising out of any use of the semiconductor devices with other devices or elements by any purchaser of semiconductor devices or by others.

SCR

Model C107

Flat Pack Design

PRODUCT FEATURES

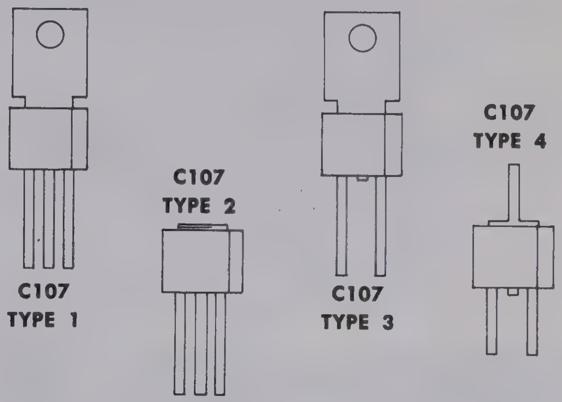
The Type C107 Silicon Controlled Rectifier (SCR) as the following outstanding features:

OW COST

ELIABLE Uses the proved planar passivated rocess (all junctions protected by a silicon ioxide layer)

ERSATILE Designed for a variety of mount-down ethods—printed circuit, plug-in socket, screws, r point-to-point soldering

UGGED, COMPACT Uses a solid plastic encapsulant n rectangular shape for high density packaging



(FULL SIZE)

TYPICAL APPLICATIONS

MOTOR CONTROL	Electric Model Trains Sewing Machines Movie Projectors Food Mixers Electric Fans Slot Racing Cars
IGHT	Flame Detectors Moving-Light Signs (Chasers) Driver for Computer Readout Lights Harbor Buoy Flashers Automotive Warning Systems Nixie & Neon Drivers
EMPERATURE	Range Surface Unit (Hybrid) Chemical Processing (Photographic, etc.) Food Warmer Tray Bearing Temperature Sensor Electric Blanket Control
RESSURE	Auto Oil Pressure Gage Hot Water Boiler Safety Monitor
IME	Photo Darkroom Exposure Oven Timer Vending Machine Logic Industrial Process Control
IQUID LEVEL	Basement Sump Pump Automatic Coffee Maker Automatic Shutoff for Vending Machines
REMOTE CONTROL	Armchair TV Control Master Switching Stations for Home Garage Door Openers Power Switch
DRYNESS	Clothes Dryness Sensor
PROXIMITY	Burglar Alarm Touch Switch Electric Door Openers
COUNTING	Low Speed Ring Counters Shift Registers
SWITCHING	Relay Replacement Solenoid Drivers Latching Relay Replacement Power Flip Flops Low Power Inverters Thyratron Tube Replacement
AMPLIFIERS	Gate Amplifier for Larger SCR's, Triacs —Blenders —Hand Tools
IGNITION	Small Gas Engines Gas Appliances
DETECTION	Voltage (Battery Charger) Current (Crowbar)

MAXIMUM ALLOWABLE RATINGS

Type	Repetitive Peak Off-State Voltage, V_{DRM} $R_{GK} = 1000$ Ohms $T_C = -40°C$ to $+110°C$	Working and Repetitive Peak Reverse Voltage, V_{RWM} and V_{RRM} $T_C = -40°C$ to $+110°C$
C107Q1, C107Q2, C107Q3, C107Q4	15 Volts	15 Volts
C107Y1, C107Y2, C107Y3, C107Y4	30 Volts	30 Volts
C107F1, C107F2, C107F3, C107F4	50 Volts	50 Volts
C107A1, C107A2, C107A3, C107A4	100 Volts	100 Volts
C107B1, C107B2, C107B3, C107B4	200 Volts	200 Volts
C107C1, C107C2, C107C3, C107C4	300 Volts	300 Volts
C107D1, C107D2, C107D3, C107D4	400 Volts	400 Volts

RMS On-State Current, $I_{T(RMS)}$	4 Amperes
Repetitive Peak On-State Current, I_{TRM}	75 Amperes †
Critical Rate-Of-Rise of On-State Current, di/dt (see Chart 8)	50 Amperes/Microsecond
Peak One Cycle Surge (non-rep) On-State Current, I_{TSM}	15 Amperes
I^2t (for fusing), for times $\geqq 1.5$ milliseconds	0.5 Ampere^2 seconds
Peak Gate Power Dissipation, P_{GM}	0.5 Watts
Average Gate Power Dissipation, $P_{G(AV)}$	0.1 Watts
Peak Positive Gate Current, I_{GM}	0.2 Amperes
Peak Negative Gate Voltage, V_{GM}	6 Volts
Storage Temperature, T_{STG}	−40°C to +150°C
Operating Temperature, T_J	−40°C to +110°C

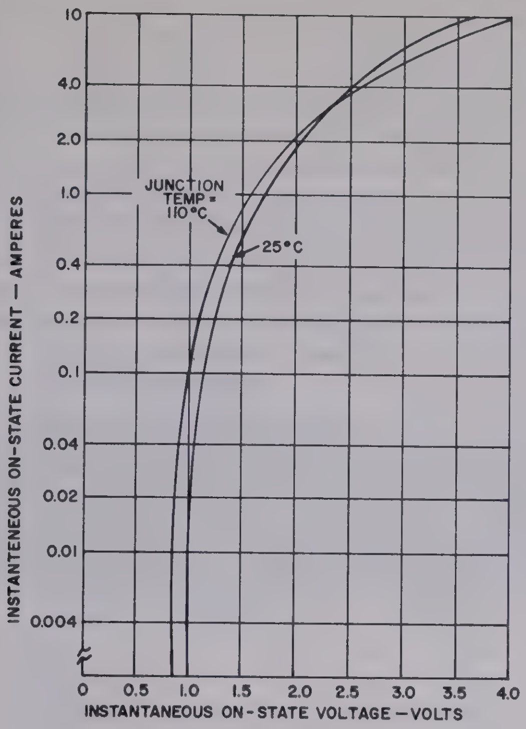
†*This rating applies for operation at 60 Hz, 75°C maximum tab (or anode lead) temperature, switching from 80 volts peak, sinusoidal current pulse, width 10 μsec. minimum, 15 μsec. maximum.*

CHARACTERISTICS

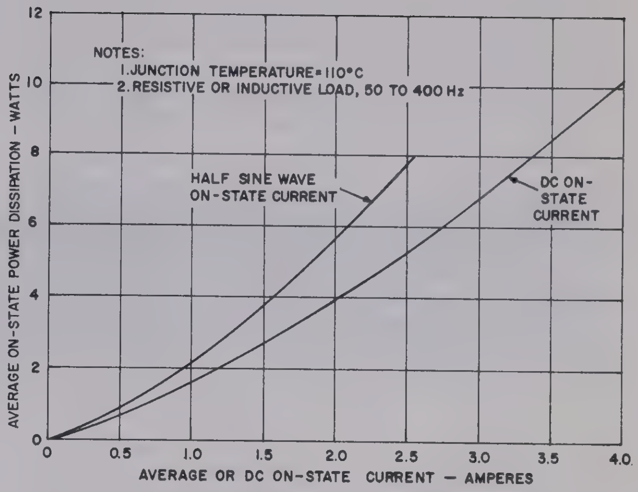
Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Peak Reverse and Off-State Current (All Types)	I_{RRM} or I_{DRM}	—	0.1	10	μA	$V_{RRM} = V_{DRM}$ = Rated Value. $T_L = 25°C$, $R_{GK} = 1000$ Ohms.
		—	10	100	μA	$V_{RRM} = V_{DRM}$ = Rated Value. $T_L = 110°C$, $R_{GK} = 1000$ Ohms.
*DC Gate Trigger Current	I_{GT}	—	—	500	μAdc	$T_L = 25°C$, $V_D = 6$ Vdc, $R_L = 100$ Ohms. $R_{GK} = 1000$ Ohms.
DC Gate Trigger Voltage	V_{GT}	0.4	0.5	0.8	Volts DC	$T_L = 25°C$, $V_D = 6$ Vdc, $R_L = 100$ Ohms. $R_{GK} = 1000$ Ohms.
		0.2	—	—	Volts DC	$T_L = 110°C$, Rated V_{DRM}. $R_L = 3000$ Ohms, $R_{GK} = 1000$ Ohms.
Peak On-State Voltage	V_{TM}	—	2.2	2.5	Volts	$T_L = 25°C$, $I_{TM} = 4$ Amperes Peak, Single Half Sine Wave Pulse, 2 Millisec. Wide.
Holding Current	I_H	0.3	1.0	3.0	mAdc	$T_L = 25°C$, Anode Supply = 12 Vdc, $R_{GK} = 1000$ Ohms.
		0.14	0.6	2.0	mAdc	$T_L = 110°C$, Anode Supply = 12 Vdc, $R_{GK} = 1000$ Ohms.
Latching Current	I_L	0.3	1.5	4.0	mAdc	$T_L = 25°C$, Anode Supply = 12 Vdc, $R_{GK} = 1000$ Ohms
Critical Rate of Rise of Off-State Voltage	dv/dt	—	8	—	Volts/Microsecond	$T_L = 110°C$, Rated V_{DRM}. $R_{GK} = 1000$ Ohms.
Turn-On Time	$t_d + t_r$	—	1.2	—	Microseconds	$T_L = 25°C$, Rated V_{DRM}. $I_{TM} = 1$ Ampere, Gate Pulse = 4 Volts, 300 Ohms, 5 Microseconds Wide.
Circuit Commutated Turn-Off Time	t_q	—	40	100	Microseconds	$T_L = 110°C$, rectangular current waveform. Rate of Rise of current <10 amps/μsec. Rate of reversal of current <5 amps/μsec. $I_{TM} = 1$ Amp (50 μsec. pulse). Repetition Rate = 60 pps. Rated V_{RRM}. $V_R = 15$ Volts Minimum. Rated V_{DRM}. Rate of Rise Reapplied Forward Blocking Voltage = 5 Volts/μsec. Gate Bias = 0 Volts, 100 Ohms (during turn-off time interval).

The lead temperature (T_L) is measured in the center of the tab, 1/16 inch from the body on Type 1 and Type 3 devices, and in the center of the anode lead, 1/16 inch from the body on Type 2 and Type 4 devices.

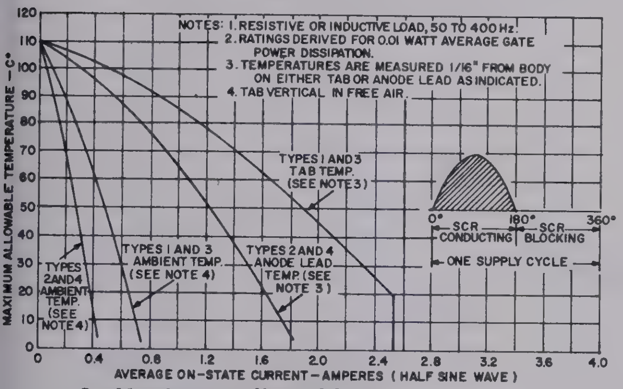
**Devices with an I_{GT} max. of 1mA and 2mA are available as C107-X1, or C107-X2 at reduced prices.*



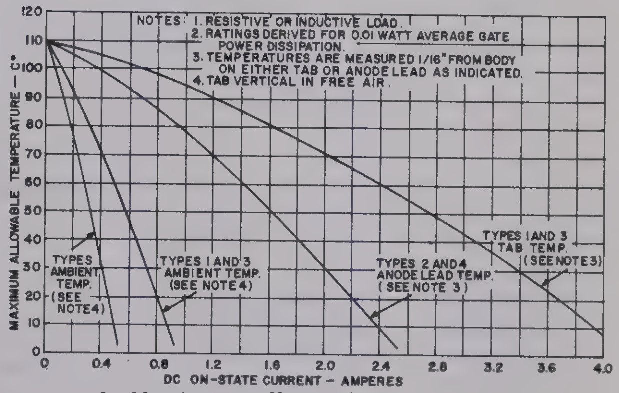
1. Maximum On-State Characteristics



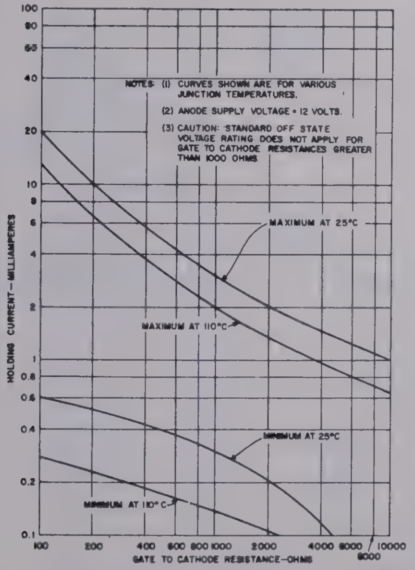
2. Maximum On-State Power Dissipation



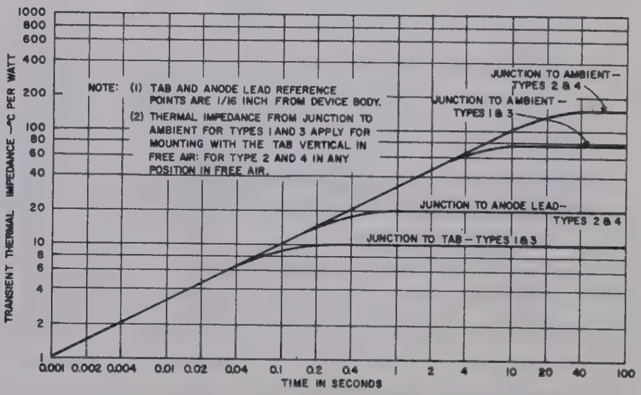
3. Maximum Allowable Temperatures for Half Sine Wave On-State Current



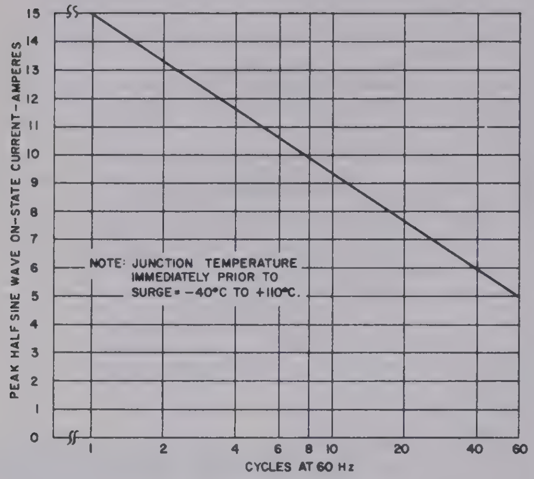
4. Maximum Allowable Temperatures for DC On-State Current



5. Maximum and Minimum Holding Current Variation with External Gate-to-Cathode Resistance

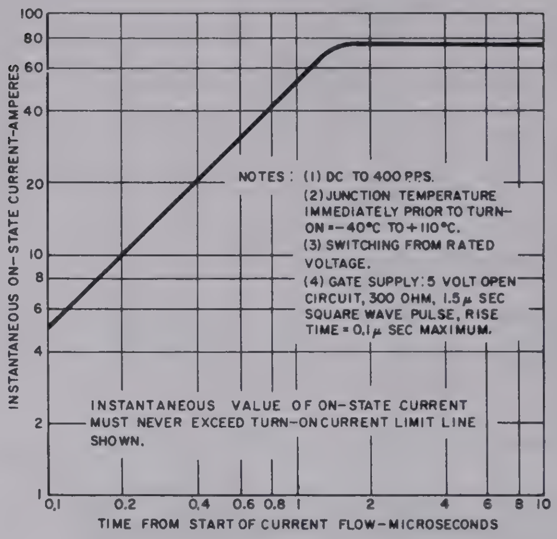


6. Maximum Transient Thermal Impedance



NOTE: JUNCTION TEMPERATURE IMMEDIATELY PRIOR TO SURGE = −40°C TO +110°C.

7. Maximum Allowable Peak Surge On-State Current (Non-repetitive)



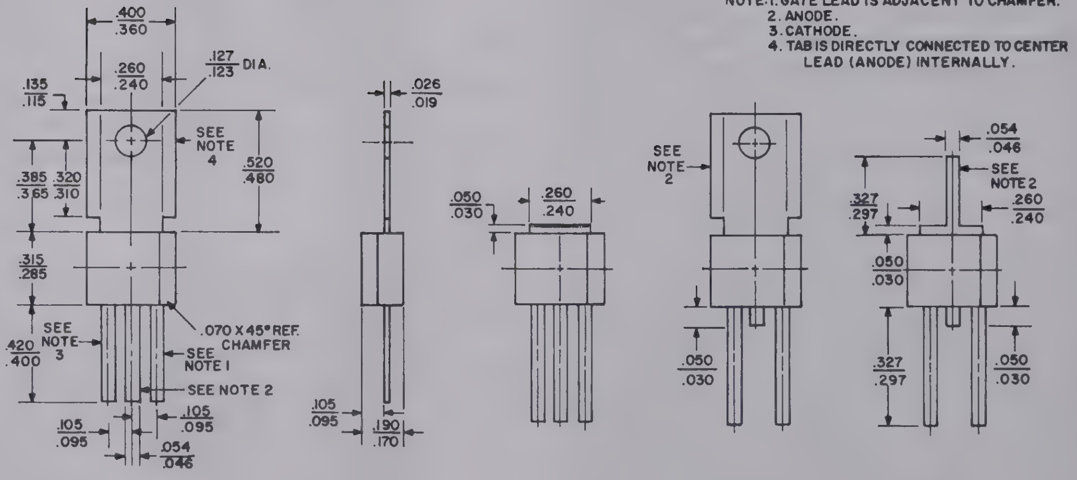
NOTES: (1) DC TO 400 P.P.S.
(2) JUNCTION TEMPERATURE IMMEDIATELY PRIOR TO TURN-ON = −40°C TO +110°C.
(3) SWITCHING FROM RATED VOLTAGE.
(4) GATE SUPPLY: 5 VOLT OPEN CIRCUIT, 300 OHM, 1.5μ SEC SQUARE WAVE PULSE, RISE TIME = 0.1μ SEC MAXIMUM.

INSTANTANEOUS VALUE OF ON-STATE CURRENT MUST NEVER EXCEED TURN-ON CURRENT LIMIT LINE SHOWN.

8. Turn-On Current Limit

OUTLINE DRAWINGS

C106 CONVERSIONS	
INCHES	MILLIMETERS
026 019	660 483
050 030	1 270 761
054 046	1 372 1 168
070	1 778
105 095	2 667 2 412
127 123	3 226 3 124
135 115	3 429 2 920
190 170	4 826 4 318
260 240	6 604 6 095
272 232	6 908 5 892
315 285	8 001 7 239
320 290	8 128 7 366
320 310	8 128 7 874
327 297	8 306 7 544
385 365	9 779 9 271
400 360	10 160 9 144
420 400	10 668 10 160
520 480	13 208 12 191


.400
.360
.260
.240
.127
.123 DIA.
.135
.115
SEE NOTE 4
.520
.480
.385
.365
.320
.310
.315
.285
.070 X 45° REF. CHAMFER
SEE NOTE 3
.420
.400
SEE NOTE 1
SEE NOTE 2
.105
.095
.105
.095
.054
.046
.026
.019
.105
.095
.190
.170
.050
.030
.260
.240
SEE NOTE 2
.050
.030
.054
.046
SEE NOTE 2
.327
.297
.260
.240
.050
.030
.327
.297
.050
.030

NOTE: 1. GATE LEAD IS ADJACENT TO CHAMFER.
2. ANODE.
3. CATHODE.
4. TAB IS DIRECTLY CONNECTED TO CENTER LEAD (ANODE) INTERNALLY.

C107 TYPE 1 C107 TYPE 2 C107 TYPE 3 C107 TYPE 4

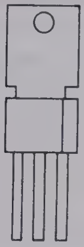
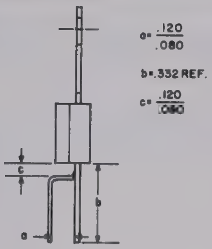
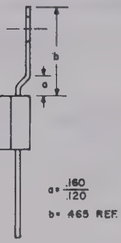
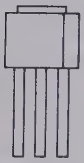
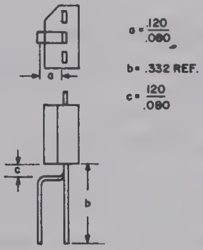
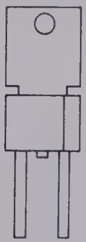
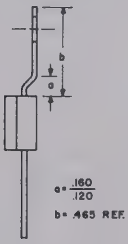
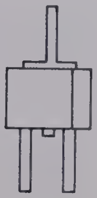
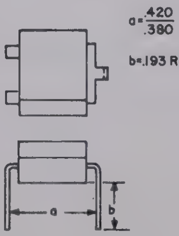
MOUNTING METHODS

The C107, because of its unique package design, is capable of being mounted in a variety of methods; depending upon the heatsink requirements and the circuit packaging methods.

The leads will bend easily, either perpendicular to the flat or to any angle, and may also be bent, if desired, immediately next to the plastic case. For sharp angle bends (90° or larger), a lead should be bent only once; since repeated bending will fatigue or break the lead. Bending in other directions may be performed as long as the lead is held firmly between the case and the bend, so that the strain on the lead is not transmitted to the plastic case.

The mounting tab may also be bent or formed into any convenient shape so long as it is held firmly between the plastic case and the area to be formed or bent. Without this precaution, bending may fracture the plastic case and permanently damage the unit.

As a service to its customers, the General Electric Company provides a lead and tab shaping capability. Any of the derived types shown in the following chart are available direct from the factory to original equipment manufacturers.

BASIC TYPES	**DERIVED TYPES** (The types shown below are derived from the basic types illustrated in the left-hand column.)		
	PRINTED CIRCUIT BOARD MOUNTING (Upright or Flat)	**RIVET OR SCREW MOUNTING TO FLAT SURFACE**	
 C107 Type 1	 C107 Type 11	 C107 Type 12	
 C107 Type 2	 C107 Type 21		
 C107 Type 3		 C107 Type 32	
 C107 Type 4	 C107 Type 41		

C107 CONVERSIONS

INCHES	MILLIMETERS	INCHES	MILLIMETERS
.120 .080	3.048 2.031	.332 REF.	8.433 REF.
.160 .120	4.064 3.047	.420 .380	10.668 9.651
.193 REF.	4.902 REF.	.465 REF.	11.811 REF.

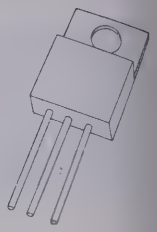
In-line sockets to accommodate the 2 or 3 flat leads of the C107 are available for printed circuit board or chassis mounting. These sockets, No. 77-115 (press-fit) or No. 77-116 (flange), may be obtained from the Connector Div., Amphenol Corp., 1830 South 54th Ave., Chicago, Illinois 60650.

SCR

C122

8A RMS Up to 500 Volts

The C122 is a molded silicon plastic SCR which incorporates General Electric's new POWER-GLAS glassivation process. This process provides for an intimate void-free bond between the silicon chip and the glass coating significantly improving performance and reliability.



JEDEC TO-220AB

FEATURES:

- Glassivated silicon chip for maximum reliability in AC or DC circuitry
- No maximum torque limit on mounting screw
- Round leads – greatly simplifies customer assembly
- Six standard lead forming configurations available from factory (including TO-66 compatibility)
- Special selections for non-standard gate requirements available upon request

TYPICAL SCR APPLICATIONS

	GENERAL FUNCTIONS				
Application	Motor Control	Temperature Control	Relay & Solenoid Driver	Power Regulator	Capacitor Discharge Circuit
Process Control Equipment	X	X	X	X	
Reproduction Equipment		X	X	X	
Blender, Mixers	X				
Hand Tools	X				
Machine Tools/Misc. Mfg.	X		X		
Sewing Machines	X				
Laundry			X		X
Farm Equipment	X		X		X
Photographic Equipment	X	X			
Clutches/Brakes			X		
Industrial Timers			X		
Vending Machines	X	X	X		
Battery Chargers				X	
Business Machines	X		X	X	
Gas & Oil Ignitors			X		X
Internal Combustion Engine Ignitions					X

MAXIMUM ALLOWABLE RATINGS

Type	Repetitive Peak Off-State Voltage, V_{DRM}(3) T_C = -40°C to +100°C	Repetitive Peak Reverse Voltage, V_{RRM}(1)(3) T_C = -40°C to +100°C	Non-Repetitive Peak Reverse Voltage, V_{RSM}(1)(2) T_C = -40°C to +100°C
C122F	50 Volts	50 Volts	75 Volts
C122B	200 Volts	200 Volts	300 Volts
C122D	400 Volts	400 Volts	500 Volts
C122E	500 Volts	500 Volts	600 Volts

Peak positive anode voltage (T_c = -40°C to +100°C)	560 Volts
RMS On-State Current, $I_{T(RMS)}$	8 Amperes (all conduction angles)
Average On-State Current, $I_{T(AV)}$	Depends on conduction angle (See Charts 3 and 4)
Critical Rate-Of-Rise of On-State Current, di/dt: (4)	
Gate triggered operation	(see Chart 10)
Switching from 200 volts	100 Amperes per microsecond
Switching from 500 volts	50 Amperes per microsecond
Peak One Cycle Surge (non-rep) On-State Current, I_{TSM} 50 Hz	82 Amperes
60 Hz	90 Amperes
I^2t (for fusing), for times at 8.3 milliseconds	see Chart 12 .34 Ampere^2 seconds
1.5 milliseconds	.27 Ampere^2 seconds
Peak Gate Power Dissipation, P_{GM}	5 Watts for 10 microseconds (see Chart 6)
Average Gate Power Dissipation, $P_{G(AV)}$	0.5 Watts
Peak Positive Gate Current I_{GM}	see Chart 6
Peak Positive Gate Voltage, V_{GM}	see Chart 6
Peak Negative Gate Voltage, V_{GM}	5 Volts
Storage Temperature, T_{stg}	-40°C to +125°C
Operating Temperature, T_J	-40°C to +100°C

NOTES:

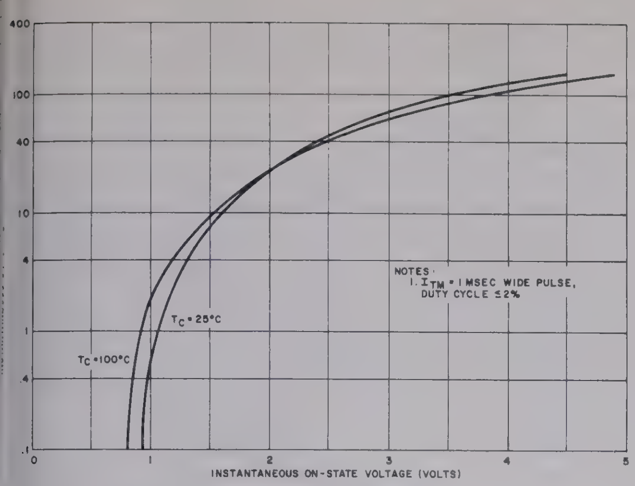
1. Values apply for zero or negative gate voltage only.
2. Half sine wave voltage pulse, 10 millisecond duration.
3. During performance of the off-state and reverse blocking tests, the thyristor should not be tested with a constant source which would permit applied voltage to exceed the device rating.
4. di/dt rating is established in accordance with JEDEC Suggested Standard No. 7, Section 5.1.2.4. Off-state (blocking) voltage capability may be temporarily lost immediately after each current pulse for duration less than the period of the applied pulse repetition rate. The pulse repetition rate for this test is 400 Hz. The duration of the JEDEC di/dt test condition is 5.0 seconds (minimum).

CHARACTERISTICS

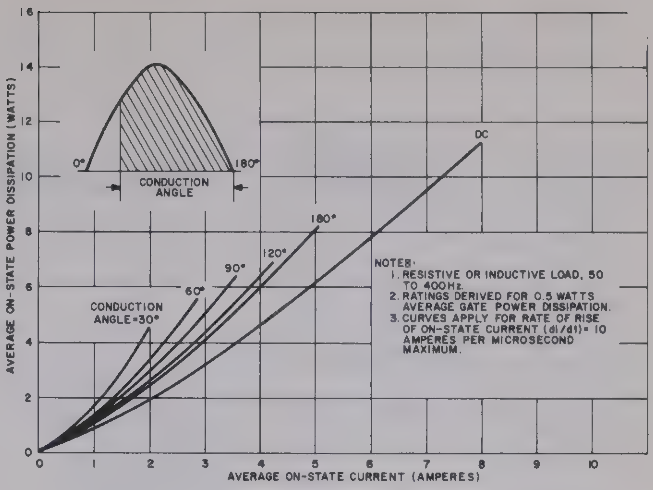
Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Peak Off-state or Reverse Current (1)	I_{DRM} or I_{RRM}				mA	$V_{DRM} = V_{RRM}$ = Max. allowable volts peak
		–	–	0.1		T_c = + 25°C
		–	–	0.5		T_c = +100°C
Peak-On-State Voltage	V_{TM}	–	–	1.83	Volts	T_c = +25°C, I_{TM} = 16A peak. 1 Millisecond wide pulse, Duty cycle $\leqq$ 2%
Critical Rate of Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt	10	50	–	Volts/μsec	T_c = +100°C, Rated V_{DRM} Gate Open Circuited, Linear Waveform
Circuit Commutated Turn-Off Time	t_q	–	50	–	μsec	T_c = +100°C, I_{TM} = 10 A peak. Rectangular current pulse, 40 μsec duration. Commutation rate = -5 A/μsec. Peak reverse voltage = Rated volts max. Reverse voltage at end of turn-off time interval 12 volts min. Repetition rate = 60 pps. Rate of rise of re-applied off-stage voltage (dv/dt) = 10 V/μsec. Off-state voltage = Rated V. Gate bias during turn-off time interval = 0 volts, 100 ohms.
D.C. Gate Trigger Current	I_{GT}	–	–	25	mAdc	T_c = +25°C V_D = 6 Vdc R_L = 91 ohms
		–	–	40		T_c = -40°C V_D = 6 Vdc R_L = 45 Ohms
D.C. Gate Trigger	V_{GT}	–	–	1.5	Vdc	T_c = +25°C V_D = 6 Vdc R_L = 91 Ohms
		–	–	2.0		T_c = -40°C V_D = 6 Vdc R_L = 45 ohms
		0.2	–	–		T_c = +100°C Rated V_{DRM} R_L = 1000 ohms
Holding Current	I_H				mAdc	Anode source voltage = 24 Vdc, Peak initiating on-state current = 0.5 A, 0.1 msec to 10 msec wide pulse. Gate trigger source = 7V, 20 ohms
		–	–	30		T_c = +25°C
		–	–	60		T_c = -40°C
Latching Current	I_L				mAdc	Main Terminal Source Voltage = 24 Vdc, Gate trigger source = 15V, 100 ohms, 50 μsec rise and fall times max.
		–	–	60		T_c = +25°C
		–	–	120		T_c = -40°C
Steady-State (2) Thermal Resistance					°C/Watt	
	$R_{\theta JC}$	–	–	1.8		Junction to Case
	$R_{\theta JA}$	–	–	75		Junction to Ambient

NOTES:

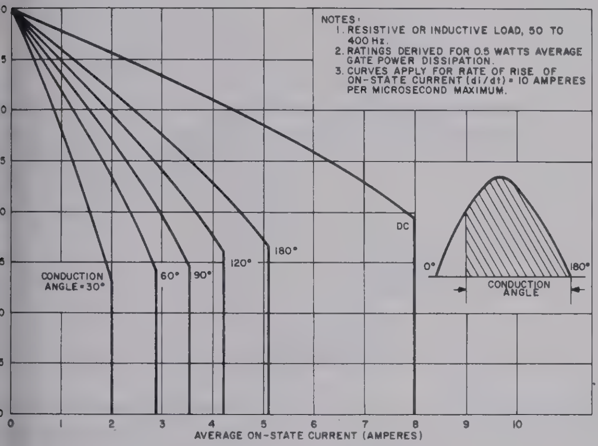
1. Values apply for zero or negative gate voltage only.
2. T_L is approximately equal to T_C, see outline drawing. The junction to ambient value is under worst case conditions, i.e., with #22 copper wire used for electrical contact to the terminals and natural convection.



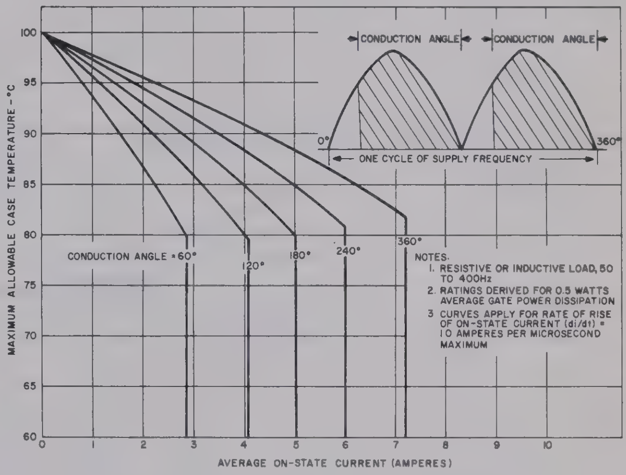
1. Max. On-State Voltage vs. On-State Current



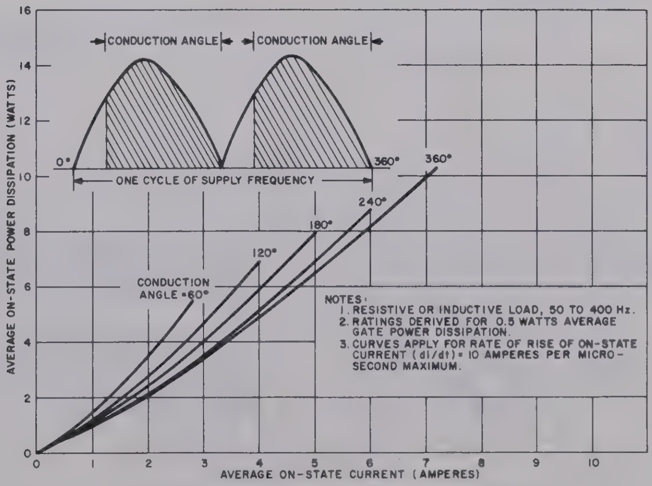
2. Max. On-State Power Dissipation for Half-Wave Rectified Sine Wave of Current



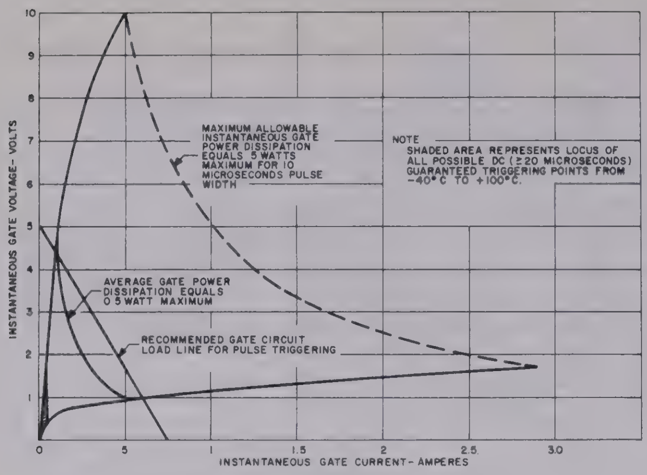
3. Max. Allowable Case Temperature For Half-Wave Rectified Sine Wave of Current



4. Max. Allowable Case Temperature For Full-Wave Rectified Sine Wave of Current

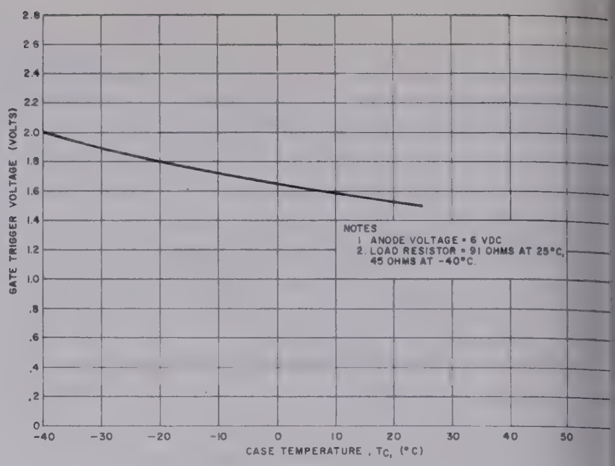


5. Max. Allowable On-State Power Dissipation for Full-Wave Sine Wave of Current



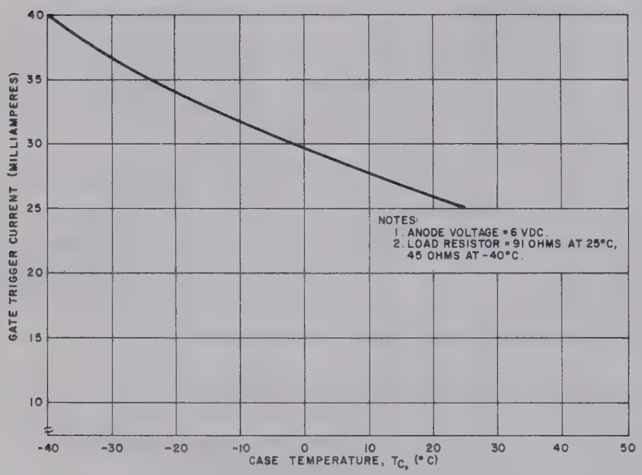
NOTE
SHADED AREA REPRESENTS LOCUS OF ALL POSSIBLE DC (≥20 MICROSECONDS) GUARANTEED TRIGGERING POINTS FROM -40°C TO +100°C.

6. Gate Trigger Characteristics



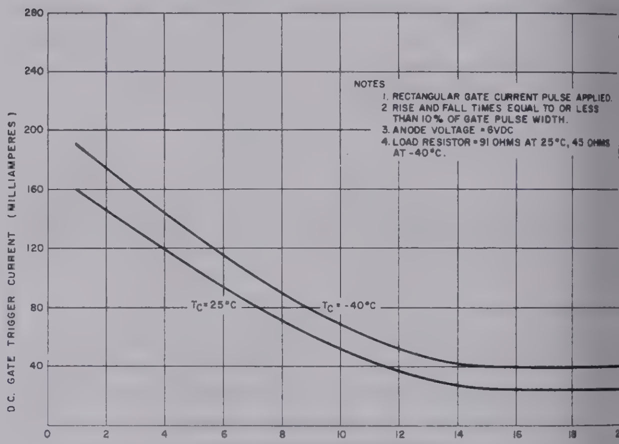
NOTES
1 ANODE VOLTAGE = 6 VDC
2. LOAD RESISTOR = 91 OHMS AT 25°C, 45 OHMS AT -40°C.

7. Max. DC Gate Voltage to Trigger vs. Case Temperature



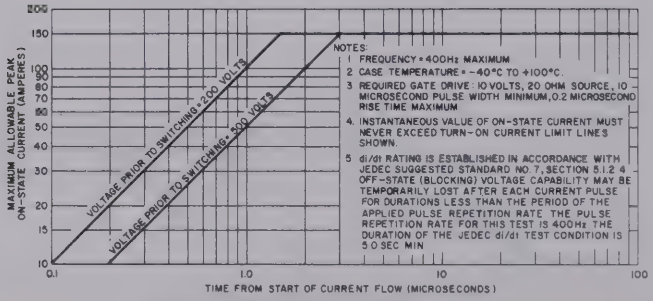
NOTES:
1. ANODE VOLTAGE = 6 VDC.
2. LOAD RESISTOR = 91 OHMS AT 25°C, 45 OHMS AT -40°C.

8. Max. DC Gate Current to Trigger vs. Case Temperature



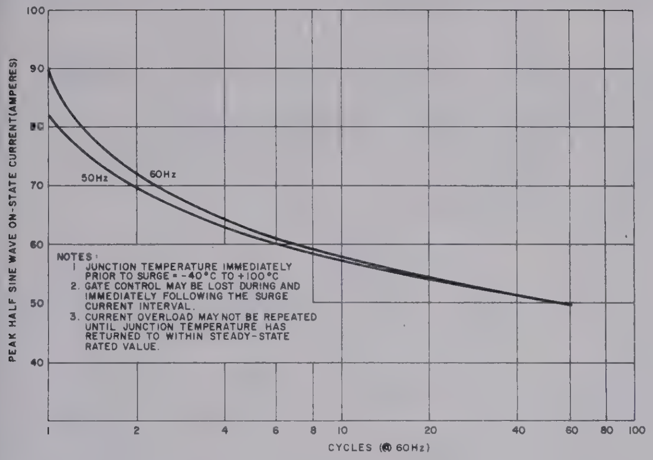
NOTES
1. RECTANGULAR GATE CURRENT PULSE APPLIED.
2 RISE AND FALL TIMES EQUAL TO OR LESS THAN 10% OF GATE PULSE WIDTH.
3. ANODE VOLTAGE = 6VDC
4. LOAD RESISTOR = 91 OHMS AT 25°C, 45 OHMS AT -40°C.

9. Max. DC Gate Current to Trigger vs. Gate Pulse Width



NOTES:
1 FREQUENCY = 400Hz MAXIMUM
2 CASE TEMPERATURE = -40°C TO +100°C.
3 REQUIRED GATE DRIVE: 10 VOLTS, 20 OHM SOURCE, 10 MICROSECOND PULSE WIDTH MINIMUM, 0.2 MICROSECOND RISE TIME MAXIMUM
4. INSTANTANEOUS VALUE OF ON-STATE CURRENT MUST NEVER EXCEED TURN-ON CURRENT LIMIT LINES SHOWN.
5 di/dt RATING IS ESTABLISHED IN ACCORDANCE WITH JEDEC SUGGESTED STANDARD NO. 7, SECTION 5.1.2 4 OFF-STATE (BLOCKING) VOLTAGE CAPABILITY MAY BE TEMPORARILY LOST AFTER EACH CURRENT PULSE FOR DURATIONS LESS THAN THE PERIOD OF THE APPLIED PULSE REPETITION RATE THE PULSE REPETITION RATE FOR THIS TEST IS 400Hz THE DURATION OF THE JEDEC di/dt TEST CONDITION IS 5 0 SEC MIN

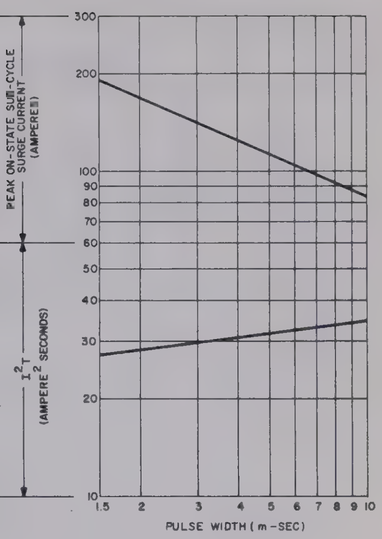
10. Turn-On Current Limit



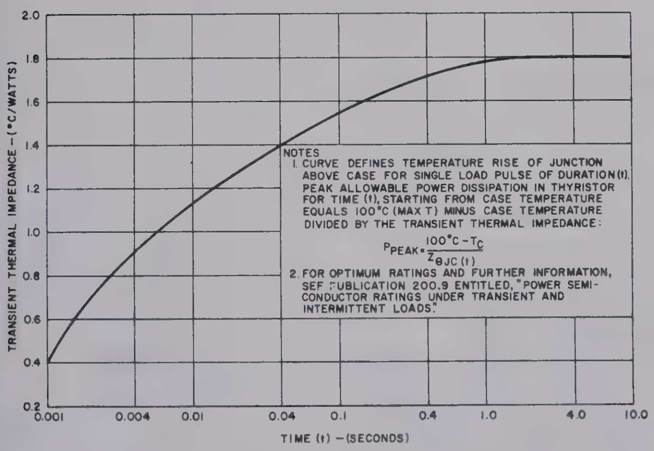
NOTES:
1 JUNCTION TEMPERATURE IMMEDIATELY PRIOR TO SURGE = -40°C TO +100°C
2. GATE CONTROL MAY BE LOST DURING AND IMMEDIATELY FOLLOWING THE SURGE CURRENT INTERVAL.
3. CURRENT OVERLOAD MAY NOT BE REPEATED UNTIL JUNCTION TEMPERATURE HAS RETURNED TO WITHIN STEADY-STATE RATED VALUE.

11. Max. Allowable Surge Current Following Rated Load Conditions

NOTES:
1. CURVES APPLY FOR HALF SINE WAVE CURRENT WAVEFORM.
2. THIS OVERLOAD MAY BE APPLIED FOLLOWING DEVICE OPERATION AT ANY VOLTAGE OR CURRENT WITHIN ITS STEADY-STATE RATING LIMITS.
3. THE OVERLOAD MAY NOT BE REPEATED UNTIL DEVICE JUNCTION TEMPERATURE HAS COOLED DOWN TO WITHIN STEADY STATE RATED VALUE.
4. NO BLOCKING VOLTAGE RATING IS IMPLIED DURING OR IMMEDIATELY FOLLOWING THE OVERLOAD CURRENT INTERVAL.
5. JUNCTION TEMPERATURE IMMEDIATELY PRIOR TO OVERLOAD = -40°C TO +100°C.



12. Sub-cycle Surge and I^2t Rating Following Rated Load Conditions

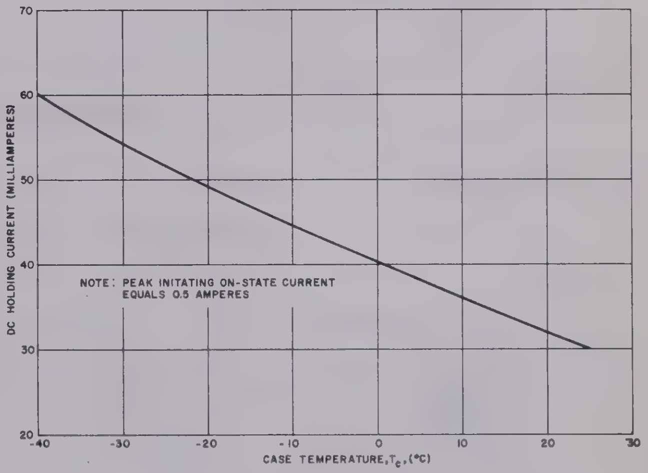


NOTES
1. CURVE DEFINES TEMPERATURE RISE OF JUNCTION ABOVE CASE FOR SINGLE LOAD PULSE OF DURATION (t). PEAK ALLOWABLE POWER DISSIPATION IN THYRISTOR FOR TIME (t), STARTING FROM CASE TEMPERATURE EQUALS 100°C (MAX T) MINUS CASE TEMPERATURE DIVIDED BY THE TRANSIENT THERMAL IMPEDANCE:

$$P_{PEAK} = \frac{100°C - T_C}{Z_{\theta JC}(t)}$$

2. FOR OPTIMUM RATINGS AND FURTHER INFORMATION, SEF PUBLICATION 200.9 ENTITLED, "POWER SEMICONDUCTOR RATINGS UNDER TRANSIENT AND INTERMITTENT LOADS."

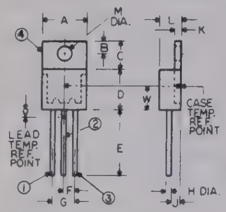
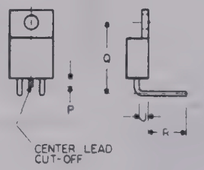
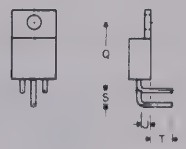
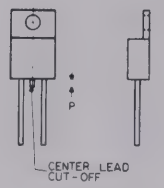
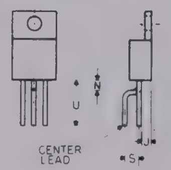
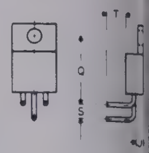
13. Max. Transient Thermal Impedance, Junction to Case



NOTE: PEAK INITATING ON-STATE CURRENT EQUALS 0.5 AMPERES

14. Max. DC Holding Current vs. Case Temperature

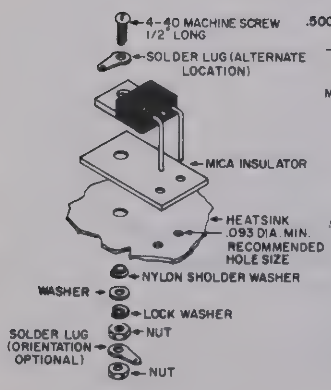
OUTLINE DRAWINGS

STANDARD TYPE	FORMED LEAD TYPES				
	TO-66 EQUIVALENT	FLAT MOUNTING CHASIS HEATSINK	CENTER LEAD CUT	UPRIGHT MOUNTING	FLAT MOUNTI RADIATOR HEATS
 A M DIA. L K ④ B C D W CASE TEMP. REF. POINT ② LEAD TEMP. REF. POINT E ① F G ③ H DIA. J 1. CATHODE 2. ANODE 3. GATE. 4. MOUNTING TAB (ELECTRICALLY COMMON TO ANODE	 Q P J R CENTER LEAD CUT-OFF		 P CENTER LEAD CUT-OFF	 N U CENTER LEAD J S	
TYPE 1	TYPE 2	TYPE 3	TYPE 4	TYPE 5	TYPE 6

SYM.	DEC. IN.		METRIC MM		SYM.	DEC. IN.		METRIC MM	
	MIN.	MAX.	MIN.	MAX.		MIN.	MAX.	MIN.	MAX.
A	.390	.420	9.906	10.668	L	.160	.190	4.064	4.826
B	.110	.120	2.794	3.048	M	.141	.145	3.581	3.683
C	.240	.260	6.096	6.604	N	.065	.095	1.651	2.413
D	.325	.355	8.255	9.017	P	.035	.065	.889	1.651
E	.500	——	12.700	——	Q	.570	.590	14.478	14.986
F	.095	.105	2.413	2.667	R	.360	——	9.144	——
G	.190	.210	4.826	5.334	S	.120	.130	3.048	3.302
H	.029	.035	.737	.889	T	.172	.202	4.369	5.131
J	.085	.115	2.159	2.921	U	.353	.433	8.966	10.998
K	.040	.060	1.016	1.524	V	——	.065	——	1.651
					W	——	.220	——	5.588

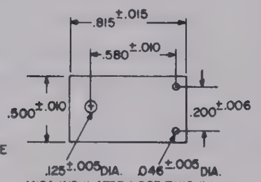
SUGGESTED MOUNTING METHODS

CHASSIS MOUNTING
TO-66

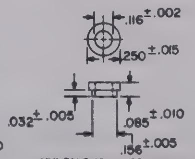

4-40 MACHINE SCREW 1/2" LONG
SOLDER LUG (ALTERNATE LOCATION)
MICA INSULATOR
HEATSINK .093 DIA. MIN. RECOMMENDED HOLE SIZE
NYLON SHOLDER WASHER
WASHER
LOCK WASHER
SOLDER LUG (ORIENTATION OPTIONAL)
NUT
NUT

TYPES 2,3

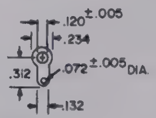
INSULATING KIT


.815 ±.015
.580 ±.010
.500 ±.010
.200 ±.006
.125 ±.005 DIA.
.046 ±.005 DIA.

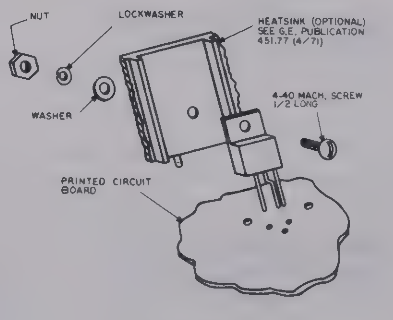
MICA INSULATOR (.003 THICK)


.116 ±.002
.250 ±.015
.032 ±.005
.085 ±.010
.156 ±.005

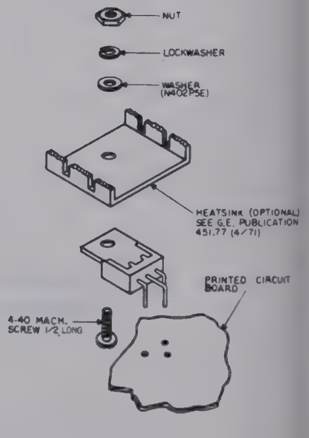
NYLON SHOULDER WASHER


.120 ±.005
.234
.312
.072 ±.005 DIA.
.132

SOLDER LUG

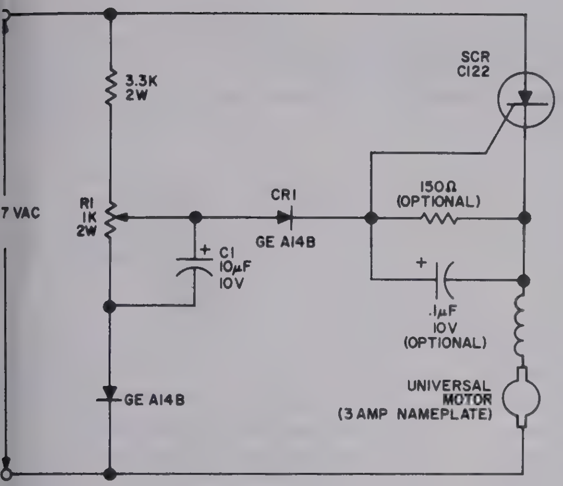

NUT
LOCKWASHER
HEATSINK (OPTIONAL) SEE G.E. PUBLICATION 451.77 (4/71)
WASHER
4-40 MACH. SCREW 1/2 LONG
PRINTED CIRCUIT BOARD

TYPES 4,5


NUT
LOCKWASHER
WASHER (N402P5E)
HEATSINK (OPTIONAL) SEE G.E. PUBLICATION 451.77 (4/71)
PRINTED CIRCUIT BOARD
4-40 MACH. SCREW 1/2 LONG

TYPE 6

TYPICAL CIRCUIT



This circuit uses the counter EMF of the motor armature due to residual field as a feedback signal of motor speed to maintain essentially constant speed characteristics with varying torque requirements. There will be some variation in the effectiveness of speed control from one motor to another depending on the magnitude of the residual field for the particular motor.

During the positive half cycle of the supply voltage, a reference voltage is established on the arm of the potentiometer R_1 which is compared with the counter EMF of the motor through the gate of the SCR. When the "pot" voltage rises above the counter EMF, current flows through CR_1 into the gate of the SCR, and thus applying the remainder of that half cycle of supply voltage to the motor. If load is applied to the motor, its speed tends to decrease, thus decreasing counter EMF in proportion to speed. The "pot" reference voltage thus causes current to flow into the SCR gate earlier in the cycle. The SCR triggers earlier in the cycle, and additional voltage is applied to the armature to compensate for the increased load and to maintain the preset speed. The particular speed at which the motor operates can be selected by R_1. Stable operation is possible over approximately a 10 to 1 speed range. Stability at very low speeds can be improved by reducing the value of C_1 at the expense of feedback gain.

OTHER APPLICATION NOTES OF INTEREST

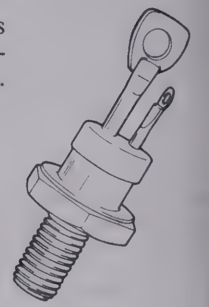
Publication Number	Application Notes
200.31	Phase Control of SCR's With Transformer and Other Inductive AC Loads
200.33	Regulated Battery Charges Using the Silicon Controlled Rectifier
200.43	Solid State Control for DC Motors Provides Variable Speed With Synchronous – Motor Performance
200.44	Speed Control for Shunt-Wound Motors
200.47	Speed Control for Universal Motors
200.48	Flashers, Ring Counters and Chasers
200.55	Thermal Mounting Considerations for Plastic Power Semiconductor Packages
201.1	A Plug-In Speed Control for Standard Portable Tools and Appliances
201.13	Universal Motor Control With Built-in Self-Timer

Silicon Controlled Rectifier

C137

35A RMS max., 500-1200 Volts, 125° C max. Junction Temperature

The C137 series of silicon controlled rectifiers are reverse blocking triode thyristor semiconductor devices for use in medium power switching and phase control (50 to 400 Hz) applications requiring blocking voltages up to 1200 volts, and overage load current (single-phase, 180° conduction angle) up to 22 amperes.



Special features of these SCR's:

- No peak forward voltage limitation
- Minimum dv/dt rating of 100 volts/μsec.
- Maximum di/dt rating of 150 amps/μsec when switching from 600 volts
- High surge current capability for overcurrent protection.

MAXIMUM ALLOWABLE RATINGS

Type	Repetitive Peak Off-State Voltage, V_{DRM}(1) (2) $T_C = -65°C$ to $+125°C$	Repetitive Peak Reverse Voltage V_{RRM}(1) (2) $T_C = -65°C$ to $+125°C$	Non-repetitive Peak Off-State and Reverse Voltage V_{DSM} and V_{RSM}(1) (3) $T_C = -65°C$ to $+125°C$
C137E	500 Volts	500 Volts	600 Volts
C137M	600 Volts	600 Volts	720 Volts
C137S	700 Volts	700 Volts	840 Volts
C137N	800 Volts	800 Volts	960 Volts
C137T	900 Volts	900 Volts	1080 Volts
C137P	1000 Volts	1000 Volts	1200 Volts
C137PB	1200 Volts	1200 Volts	1400 Volts

(1) Values apply for gate terminal open-circuited. (Negative gate bias is permissible.)

(2) Maximum case-to-ambient thermal resistance for which maximum V_{DRM} and V_{RRM} ratings apply equals 5.0°C per watt for full sine wave or full-wave rectified sinusoidal voltage waveform. (3.0°C per watt is maximum case-to-ambient thermal resistance for pure dc voltage waveform.)

(3) Half sine wave voltage pulse, 10 millisecond maximum duration.

RMS On-State Current, $I_{T(RMS)}$	35 Amperes (all conduction angles)
Average On-State Current, $I_{T(AV)}$	Depends on conduction angle (See Charts 3 and 5)
Critical Rate-of-Rise of On-State Current, di/dt: (4)	
Gate triggered operation	(See Chart 6)
Switching from 1001 volts min. to 1200 volts max.	75 Amperes per microsecond
801 volts min. to 1000 volts max.	100 Amperes per microsecond
601 volts min. to 800 volts max.	125 Amperes per microsecond
600 volts max.	150 Amperes per microsecond
Breakover voltage triggered operation	10 Amperes per microsecond
Peak One Cycle Surge (non-rep) On-State Current, I_{TSM}	360 Amperes
I^2t (for fusing), for time = 1.0 milliseconds (See Chart 9)	300 Ampere² seconds
for time = 8.3 milliseconds (See Chart 9)	540 Ampere² seconds
Peak Gate Power Dissipation, P_{GM}	60 Watts for 500 microseconds
Average Gate Power Dissipation, $P_{G(AV)}$	1.0 Watts
Peak Negative Gate Voltage, V_{GM}	10 Volts
Storage Temperature, T_{STG}	−65°C to +150°C
Operating Temperature, T_J	−65°C to +125°C
Maximum Stud Torque	30 Lb-in (35 Kg-cm)

(4) di/dt rating is established in accordance with EIA Standards Proposal No. 1101, Section 5.2.2.6. Off-state (blocking) voltage capability may be temporarily lost immediately after each current pulse for duration less than the period of the applied pulse repetition rate. The pulse repetition rate for this test is 60 Hz. The duration of the JEDEC di/dt test condition is 300 pulses minimum at 60 Hz.

CHARACTERISTICS

Test	Symbol	Min.	Max.	Units	Test Conditions
eak Off-State or Reverse urrent (1) (2)	I_{DRM} or I_{RRM}			mA	T_C = −65°C to +125°C
C137E		–	4.0		$V_{DRM} = V_{RRM}$ = 500 Volts Peak
C137M		–	3.0		600
C137S		–	2.8		700
C137N		–	2.5		800
C137T		–	2.3		900
C137P		–	2.0		1000
C137PB		–	1.7		1200
.C. Gate Trigger Current	I_{GT}	–	40	mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 12 ohms
		–	80		T_C = −65°C, V_D = 12 Vdc, R_L = 12 ohms
.C. Gate Trigger Voltage	V_{GT}	–	2.2	Vdc	T_C = +25°C, V_D = 6 Vdc, R_L = 12 ohms
		–	3.0		T_C = −65°C, V_D = 12 Vdc, R_L = 12 ohms
		0.25	–		T_C = +125°C, Rated V_{DRM}, R_L = 1000 ohms
eak On-State Voltage	V_{TM}	–	2.3	Volts	T_C = +25°C, I_{TM} = 70 A peak, 1 msec wide pulse. Duty cycle ≦ 2%.
olding Current	I_H			mAdc	Anode supply = 24 Vdc, Gate supply = 10 V, 20 ohms. Initial Forward Current Pulse = 0.5 A, 0.1 to 10.0 msec wide.
		–	100		T_C = +25°C
		–	200		T_C = −65°C
ritical Rate of Rise f Off-state Voltage. Higher values may cause evice switching.)	dv/dt	100	–	Volts/ μsec	T_C = +125°C, Rated V_{DRM}, Gate open circuited.
hermal Resistance	$R_{\theta JC}$	–	1.0	°C/watt	Junction-to-case, dc
ircuit Commutated urn-Off Time	t_q	–	–(3)	μsec	T_C = 125°C, I_{TM} = 10A Peak Rectangular Current Pulse, 50 μsec duration. DI/DT < 10 Amps per microsecond. Commutation Rate ≤ 5 A per μsec. PRV = Rated V_{RRM} Volts max. Reverse Voltage at end of Turn-Off Time interval = 15 volts. Repetition Rate = 60 PPS. Rate of Rise of Re-applied Off-State Voltage (dv/dt) = 100V/μsec. Off-State Voltage = Rated V_{DRM} Volts. Gate Bias during Turn-Off Time interval = 0 Volts, 100 ohms.

TES:

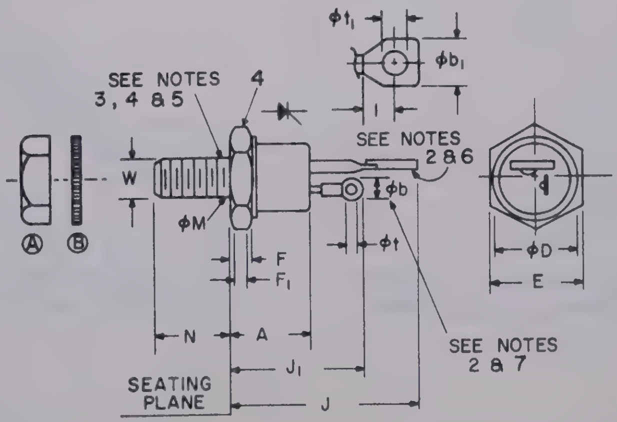
Values apply for gate terminal open-circuited. (Negative gate bias is permissible.)

Maximum case-to-ambient thermal resistance for which maximum V_{DRM} and V_{RRM} ratings apply equals 5.0°C per watt for full sine wave or full-wave rectified sinusoidal voltage waveform. (3.0°C per watt is maximum case-to-ambient thermal resistance for pure dc voltage waveform.)

Turn-off time is not 100% factory tested. Special selections are available upon request. Consult factory. The test conditions shown represent standard factory test conditions for special selections.

OUTLINE DRAWING

(COMPLIES WITH JEDEC TO-48)



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	.330	.505	8.38	12.83	
φb	.115	.140	2.92	3.56	2
φb₁	.210	.300	5.33	7.62	2
φD		.544		13.82	
E	.544	.562	13.82	14.27	
F	.113	.200	2.87	5.08	4
F₁	.060		1.52		
J		1.193		30.30	
J₁		.875		22.23	
I	.120		3.05		
φM					1
N	.422	.453	10.72	11.51	
φt	.060	.075	1.52	1.91	
φt₁	.125	.165	3.18	4.19	
W					3

OTES:

Complete threads to extend within 2½ threads of seating plane. Diameter of unthreaded portion. 249" (6.32MM) Maximum, .220" (5.59MM) Minimum.

Angular orientation of these terminals is undefined.

¼-28 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter .2268" (5.76MM), minimum pitch diameter .2225" (5.66MM), reference: screw thread standards for Federal Service 1957, Handbook H28, 1957, P1.

A chamfer (or undercut) on one or both ends of hexagonal portions is optional.

Case is anode connection.

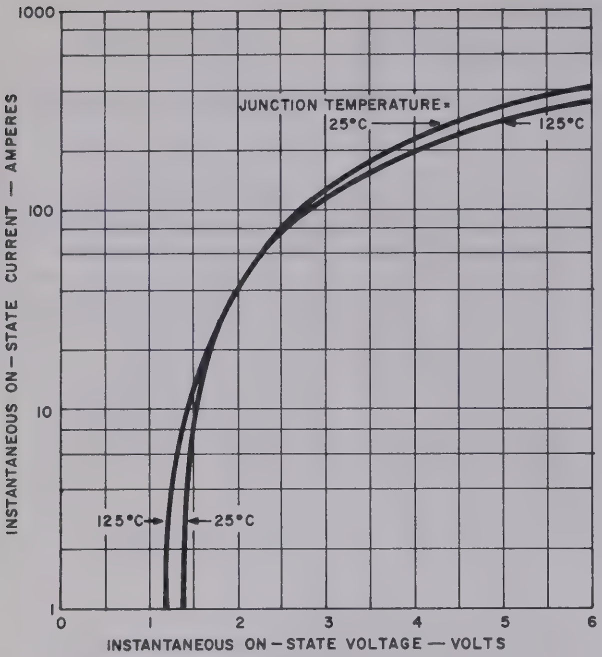
Large terminal is cathode connection.

Small terminal is gate connection.

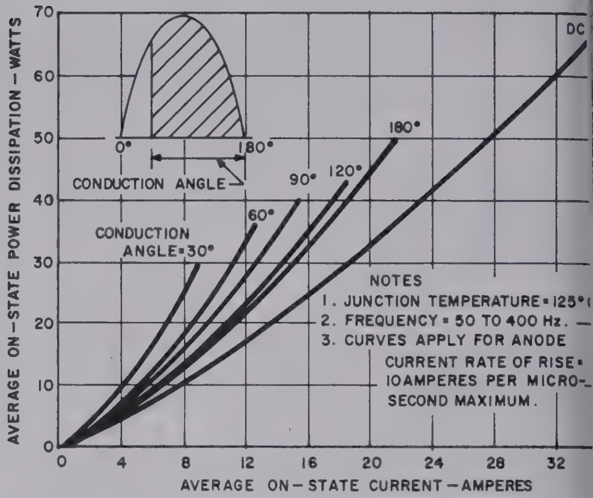
Insulating kit available upon request.

¼-28 steel nut, Ni. plated, .178 min. thk.

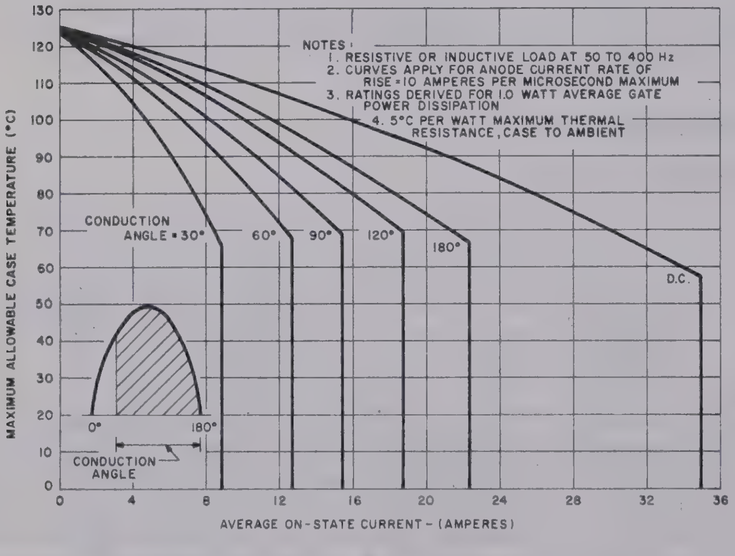
Ext. tooth lockwasher, steel, Ni. plated, .023 min. thk.



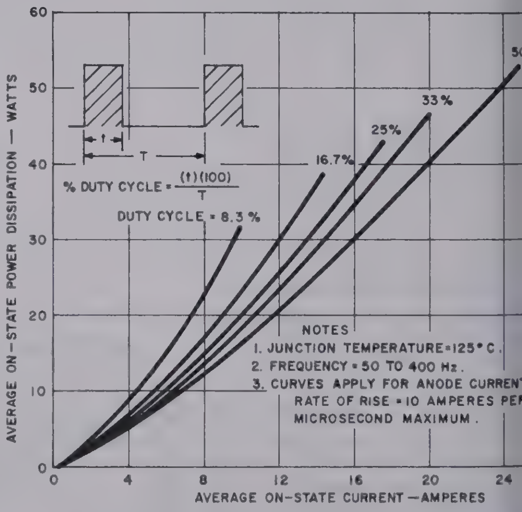
1. MAXIMUM ON-STATE CHARACTERISTICS



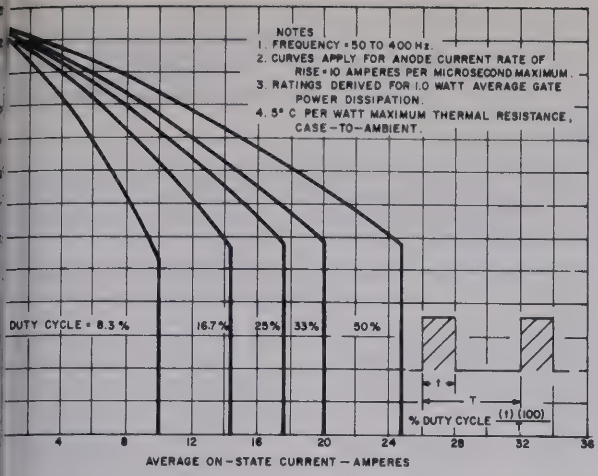
2. MAXIMUM ON-STATE POWER DISSIPATION FO
HALF WAVE RECTIFIED SINE WAVE OF CURREN



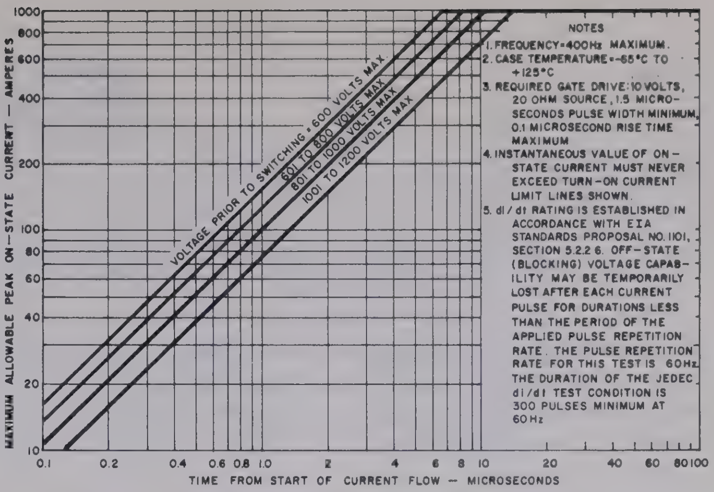
3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR
HALF WAVE RECTIFIED SINE WAVE OF CURRENT



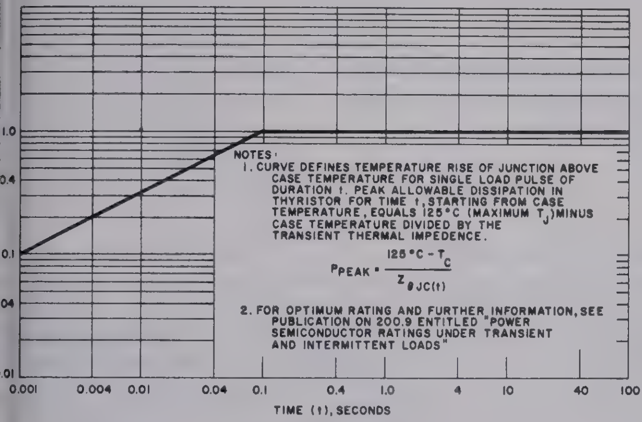
4. MAXIMUM ON-STATE POWER DISSIPAT
FOR RECTANGULAR CURRENT WAVEFO



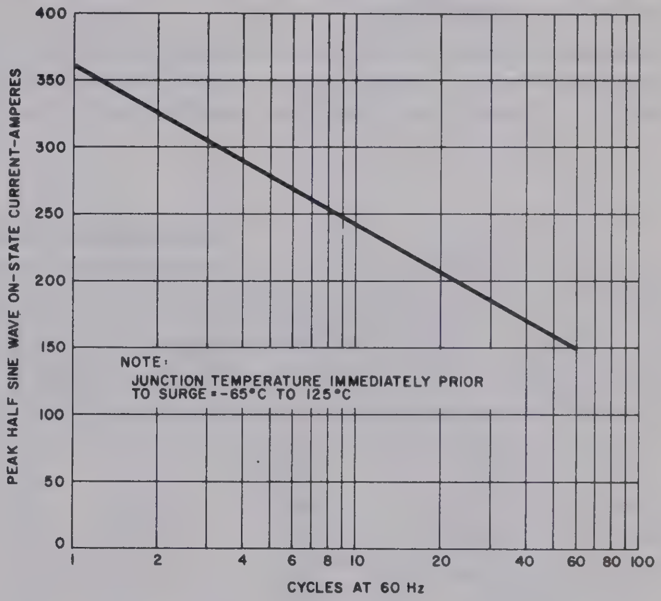
MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



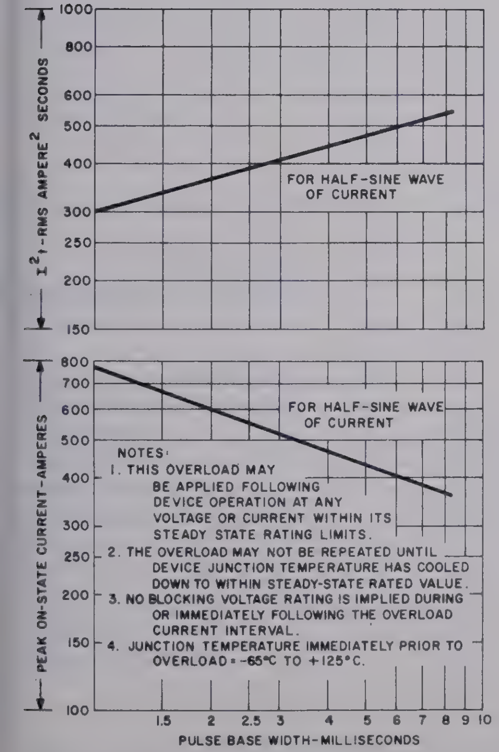
6. TURN-ON CURRENT LIMIT



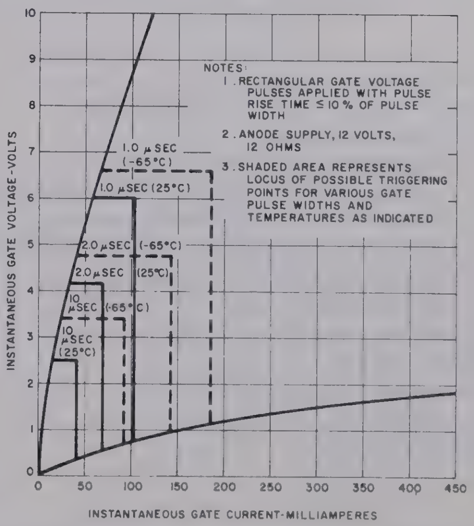
7. MAXIMUM TRANSIENT THERMAL IMPEDANCE, JUNCTION-TO-CASE



8. MAXIMUM ALLOWABLE SURGE (NON-REPETITIVE) ON-STATE CURRENT



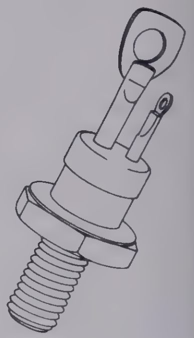
9. MAXIMUM ALLOWABLE SUB-CYCLE SURGE -REPETITIVE) ON-STATE CURRENT AND I²T RATING



10. PULSE GATE TRIGGER CHARACTERISTICS

SCR

The General Electric C138 and C139 Series of Silicon Controlled Rectifiers are reverse blocking triode thyristor semiconductor devices designed primarily for high-frequency power switching applications which require blocking voltages from 500 to 800 volts and load currents up to 35 amperes RMS, at frequencies up to 25 kHz. Refer to C140 and C141 series for blocking voltages from 100 to 400 volts.



The C138, C139 family of inverter SCR's utilizes a new voltage rating system which, for the first time allows high voltage blocking capability with the short turn-off time characteristics of a low blocking voltage SCR.

Equipment designers can use the C138 and C139 SCR's in demanding applications such as: choppers, inverters, regulated power supplies, cycloconverters, ultrasonic generators, high frequency lighting, sonar transmitters, radar transmitters, and induction heaters.

MAXIMUM ALLOWABLE RATINGS

Type (1)	Repetitive Peak Off-State Voltage, V_{DRM} (2)(3), $T_C = -65°C$ to $+125°C$	Peak or DC Switching Voltage V_{DM} or V_D (2)(3) $T_C = -65°C$ to $+125°C$	Repetitive Peak Reverse Voltage V_{RRM} (2)(3) $T_C = -65°C$ to $+125°C$	Non-Rep. Peak Reverse Voltage V_{RSM} (2)(4) $T_C = -65°C$ to $+125°C$
C139E10E, C139E20E	500 Volts	500 Volts	500 Volts	600 Volts
C138E10E, C138E20E	500	500	50	–
C139M10M, C139M20M	600	600	600	720
C138M10M, C138M20M	600	600	50	–
C139S10M, C139S20M	700	600	600	720
C138S10M, C138S20M	700	600	50	–
C139N10M, C139N20M	800	600	600	720
C138N10M, C138N20M	800	600	50	–

RMS On-State Current, $I_{T(RMS)}$	35 Amperes (all conduction angles)
Critical Rate-of-Rise of On-State Current, di/dt: (5)	
Gate triggered operation:	
Switching from 500 volts (500 volt types)	100 Amperes per microsecond
Switching from 600 volts (600, 700, 800 volt types)	100 Amperes per microsecond
Peak One Cycle Surge (non-rep) On-State Current, I_{TSM}	200 Amperes
Peak Rectangular Pulse Surge (non-rep) On-State Current (5.0 Msec, t_r=50μsec) I_{TSM}	180 Amperes
I^2t (for fusing), for times ≧ 0.5 milliseconds	165 Ampere^2 seconds
Peak Gate Power Dissipation, P_{GM}	40 Watts for 100 Microseconds
Average Gate Power Dissipation, $P_{G(AV)}$	1.0 Watts
Peak Reverse Gate Voltage, V_{GM}	10 Volts
Storage Temperature, T_{STG}	−65°C to +150°C
Operating Temperature, T_j	−65°C to +125°C
Maximum Stud Torque	30 Lb-in (35 Kg-cm)

CHARACTERISTICS

Test	Symbol	Min.	Max.	Units	Test Conditions
Peak Off-State Current (2)(6)	I_{DRM}				T_C = −65°C to +125°C
C139E10E, C139E20E		–	4.7	mA	V_{DRM} = 500 Volts Peak
C138E10E, C138E20E		–	4.7		500 " "
C139M10M, C139M20M		–	4.0		600 " "
C138M10M, C138M20M		–	4.0		600 " "
C139S10M, C139S20M		–	4.0		700 " "
C138S10M, C138S20M		–	4.0		700 " "
C139N10M, C139N20M		–	4.0		800 " "
C138N10M, C138N20M		–	4.0		800 " "
Peak Reverse Current (2)(6)	I_{RRM}				T_C = −65°C to +125°C
C139E10E, C139E20E		–	8.5	mA	V_{RRM} = 500 Volts Peak
C138E10E, C138E20E		–	7.5		50 " "
C139M10M, C139M20M		–	7.5		600 " "
C138M10M, C138M20M		–	7.5		50 " "
C139S10M, C139S20M		–	7.5		600 " "
C138S10M, C138S20M		–	7.5		50 " "
C139N10M, C139N20M		–	7.5		600 " "
C138N10M, C138N20M		–	7.5		50 " "
Critical Rate of Rise of Off-State Voltage	dv/dt	200	–	Volts/μsec	T_C = 125°C, Rated V_{DRM}, Gate Open Circuited, Exponential Waveform
D.C. Gate Trigger Current	I_{GT}	–	180	mAdc	T_C = 25°C, V_D = 6Vdc, R_L = 4 ohms
			500		T_C = −65°C, V_D = 6Vdc, R_L = 2 ohms
D.C. Gate Trigger Voltage	V_{GT}	–	3.0	Vdc	T_C = 25°C, V_D = 6 Volts, R_L = 4 ohms
			4.5		T_C = −65°C, V_D = 6 Volts, R_L = 2 ohms
		0.25			T_C = 125°C, Rated V_{DRM}, R_L = 500 ohms
Peak On-State Voltage	V_{TM}	–	4.0	Volts	T_C = 25°C, I_{TM} = 100 A Peak, ≥ 1, ≤ 2 msec. wide pulse. Duty cycle ≦ 2%.
Holding Current	I_H	–	150	mAdc	Anode Source Voltage = 24 Vdc Peak Initiating On-State Current = 3A, 0.1 to 10 msec pulse. T_C = 25°C, Gate source = 10V, Open Circuit, 20 ohms, 100 μsec pulse
		–	350		T_C = −65°C, Gate source = 20V, Open Circuit, 20 ohms, 100 μsec pulse.
Pulse Circuit Commutated Turn-Off Time	t_q (pulse)				T_C = 115°C, I_{TM} = 100A Peak Approximately Sinusoidal Current Waveform. See Chart for time references. On-State Current Pulse Time to peak (t_2–t_1) = 1.0 μsec. On-State Current Pulse Base (t_3–t_1) = 2.0 μsec (+0.5–0 μsec).Repetition Rate = 400 PPS. PRV (t_5) = 250 Volts max. Reverse voltage (t_6): C138 (with inv. para. diode) = 1 Volt. C139 = 30 Volts. Peak Off-State Voltage (t_8) = Rated V_{DRM}. Peak Off-State Voltage (t_o) equals: 500 Volts for 500 Volt types; 600 Volts for 600, 700 and 800 Volt types. Rate of Rise of Re-applied Off-State Voltage (Linear Ramp): (t_6 to t_8) = 200 Volts per μsec. Gate Trigger Pulse = 20 Volts, 20 ohms. Gate Trigger Pulse Width (90% points) = 1.5 μsec. Gate Trigger Pulse Rise Time (10% to 90%) = 0.1 μsec. Gate Bias during Turn-Off time interval = 0 Volts, 20 ohms.
C138 - 10, C139 - 10, Types		–	10	μsec	
C138 - 20, C139 - 20, Types		–	20	μsec	

CHARACTERISTICS (Contd)

Test	Symbol	Min.	Max.	Units	Test Conditions
Steady State Thermal Resistance	$R_{\theta JC}$	–	1.0	°C/Watt	Junction to Case
Conventional Circuit Commutated Turn-Off Time	t_q				$T_C = 125°$, $I_{TM} = 10A$ Peak Rectangular Current Pulse, 50 µsec duration. DI/DT < 10 Amps per microsecond. Commutation Rate ≤ 5A per µsec. PRV = Rated V_{RRM} Volts max. Reverse Voltage at end of Turn-Off Time interval: C139 = 15 volts. C138 (with inv. para. diode) = 1 volt. Repetition Rate = 60 PPS. Rate of Rise of Re-applied Off-State Voltage (dv/dt) = 200V/µsec. Off-State Voltage = Rated V_{DRM} Volts. Gate Bias during Turn-Off Time interval = 0 Volts. 100 ohms.
C138 - 10 -, C139 - 10 -, Types			10	µsec	
C138 - 20 -, C139 - 20 -, Types			20	µsec	

NOTES:

(1) Type designations are defined as follows, using C139S20M as an example:

C 1 3 9 S 20 M
- M — Rated Switching Voltage
- 20 — Maximum Turn-Off Time (10 = 10µsec; 20 = 20 µsec.)
- S — Rated Repetitive Peak Off-State Voltage

C138 and C139 types differ in reverse voltage rating only.

(2) Values apply for gate terminal open circuited. (Negative gate bias is permissible).

(3) Maximum case to ambient thermal resistance for which maximum voltage ratings apply equals 1.2C degrees per watt for V_D (DC voltage), 3.0C degrees per watt for V_{DRM} and V_{RRM}. See paragraph, "Basis for Voltage Rating" for further information.

(4) Half sine wave voltage pulse, 10 millisecond max. duration.

(5) di/dt rating is established in accordance with JEDEC Suggested Standard No. 7, Section 5.1.2.4 Off State (blocking) voltage capability may be temporarily lost immediately after each current pulse for duration less than the period of the applied pulse repetition rate. The pulse repetition rate for this test is 400 H_z. The duration of the JEDEC di/dt test condition is 5.0 seconds (minimum). Required gate drive = 20 volts, open circuit, 20 ohm source, 0.1 microsecond rise time, 1.5 microsecond pulse width. Repetitive di/dt capability is incorporated into peak current rating charts included in this specification sheet.

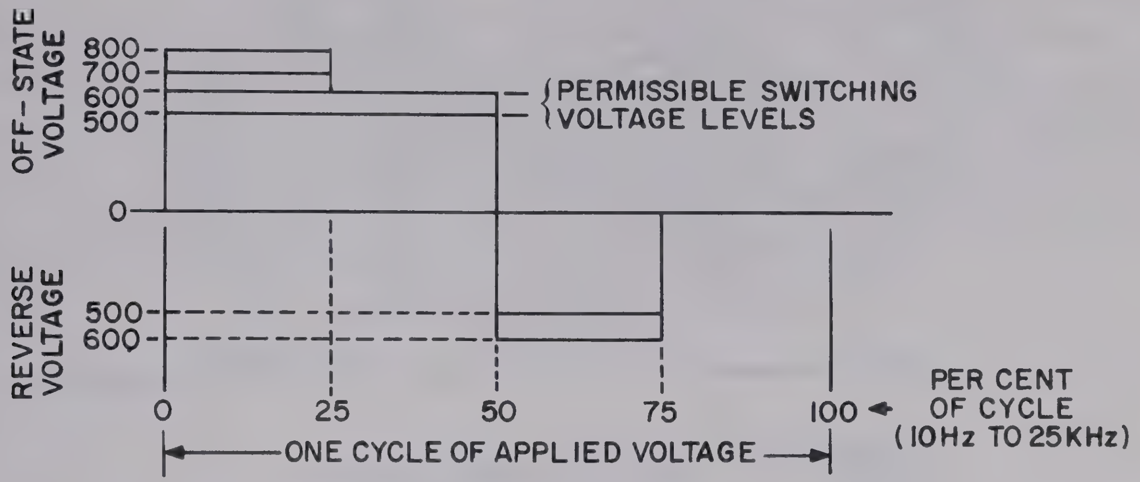
(6) Maximum case to ambient thermal resistance for which maximum V_{DRM} and V_{RRM} ratings apply equals 3.0 degrees C per watt. See paragraph entitled "Basis of Voltage Ratings", for further information.

PRELIMINARY DATA

These ratings and characteristics are not necessarily definitive and are based only on the tests and findings made to date. Inasmuch as further information may be acquired, General Electric Company reserves the right to change these preliminary data without notice. Please contact your local General Electric Electronic Component Sales Manager for the latest status of data prior to ordering devices to the limits indicated by the data.

BASIS OF VOLTAGE RATINGS
For The C139 and C138 Thyristors

The C139 and C138 thyristors are characterized primarily for inverter service. The voltage ratings, off-state current and reverse current values for the C139 are based on the voltage waveform shown below:



This waveform requires the use of a device case to ambient thermal resistance of 3.0 deg C per watt in order to assure thermal stability under maximum rated voltage and temperature conditions.

The waveforms of the actual application must stay within the envelope shown for each voltage type. If the actual waveforms do not stay within the envelopes shown for each voltage type then a heat sink with less than 3.0 deg C per watt must be used. Consult factory for assistance in heat sink selection to assure thermal stability.

The C138 type thyristor has a rated PRV of 50 volts. It is intended for use in applications where an inverse parallel rectifier diode (sometimes called a feedback diode) is connected across the C138 which will limit the applied reverse voltage to the forward drop of the inverse parallel diode. Therefore in the waveform envelopes shown above for the C139 the reverse voltage portion does not apply for the C138. For the C138 it is permissible for the off-state voltage at the switching voltage level to be extended from 50% to 95% of the total cycle time.

OUTLINE DRAWING

OTES:

Complete threads to extend to within 2½ threads of seating plane. Diameter of unthreaded portion .249" (6.32MM) Maximum, .220" (5.59MM) Minimum.

Angular orientation of these terminals is undefined.

¼-28 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter .2268" (5.76MM), minimum pitch diameter .2225" (5.66MM), reference: screw thread standards for Federal Service 1957, Handbook H28, 1957, P1.

A chamfer (or undercut) on one or both ends of hexagonal portions is optional.

Case is anode connection.

Large terminal is cathode connection.

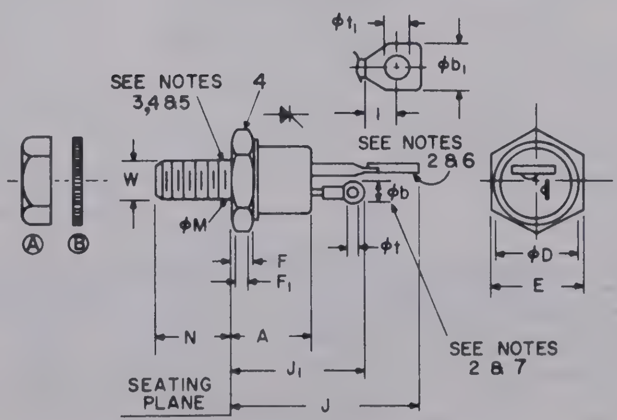
Small terminal is gate connection.

Insulating kit available upon request.

¼-28 steel nut, Ni. plated, .178 min. thk.

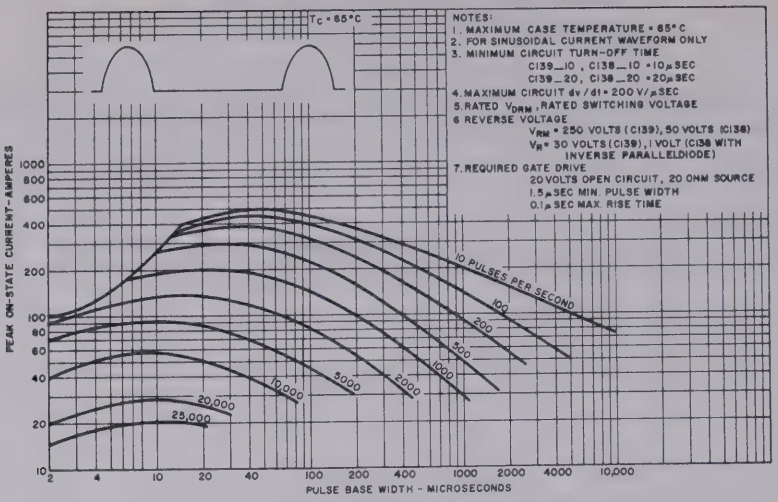
Ext. tooth lockwasher, steel, Ni. plated, .023 min. thk.

(COMPLIES WITH JEDEC TO-48)

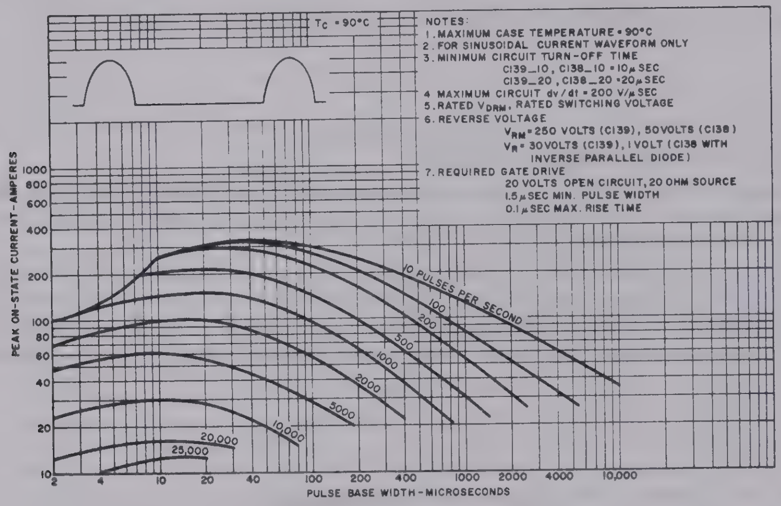


SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	330	.505	8.38	12.83	
ϕb	.115	.140	2.92	3.56	2
ϕb_1	.210	.300	5.33	7.62	2
ϕD		.544		13.82	
E	.544	.562	13.82	14.27	
F	.113	.200	2.87	5.08	4
F_1	.060		1.52		
J		1.193		30.30	
J_1		.875		22.23	
I	.120		3.05		
ϕM					1
N	.422	.453	10.72	11.51	
ϕt	.060	.075	1.52	1.91	
ϕt_1	.125	.165	3.18	4.19	
W					3

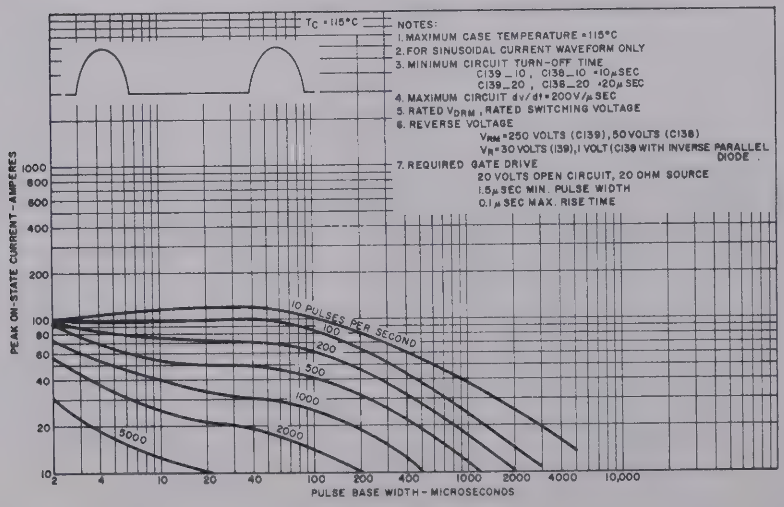
SINE WAVE DATA



1. Maximum allowable peak on-state current vs. pulse width ($T_C = 65°C$)

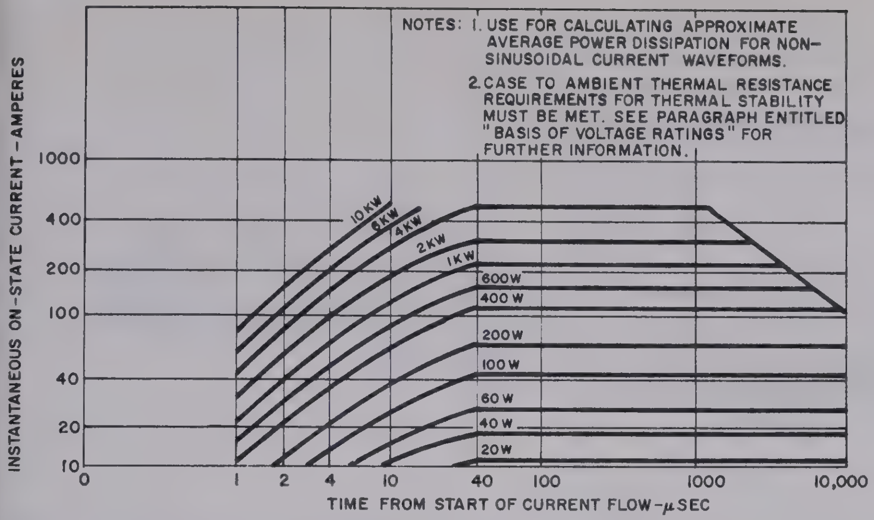


2. Maximum allowable peak on-state current vs. pulse width ($T_C = 90°C$)



3. Maximum allowable peak on-state current vs. pulse width ($T_C = 115°C$)

Charts 1, 2 and 3 give the maximum value of peak on-state current at which the specified turn-off-time and dv/dt still apply.



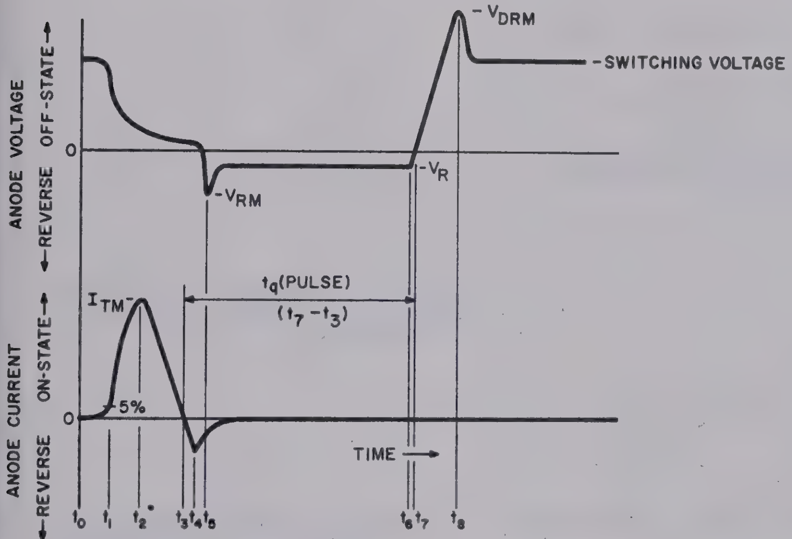
NOTES: 1. USE FOR CALCULATING APPROXIMATE AVERAGE POWER DISSIPATION FOR NON-SINUSOIDAL CURRENT WAVEFORMS.

2. CASE TO AMBIENT THERMAL RESISTANCE REQUIREMENTS FOR THERMAL STABILITY MUST BE MET. SEE PARAGRAPH ENTITLED "BASIS OF VOLTAGE RATINGS" FOR FURTHER INFORMATION.

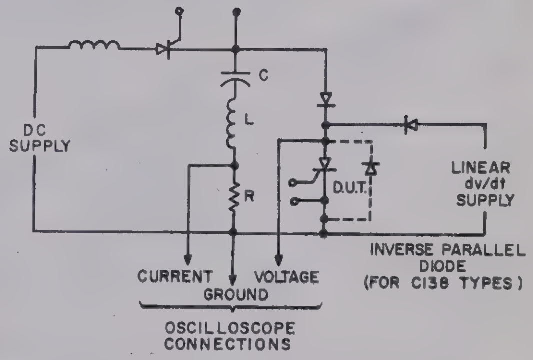
4. Instantaneous On-State Power Dissipation

This chart gives the instantaneous power dissipated within the SCR as a function of time from start of current flow and the instantaneous value of on-state anode current. Used as follows, this chart yields average dissipation information for any anode current wave-shapes:

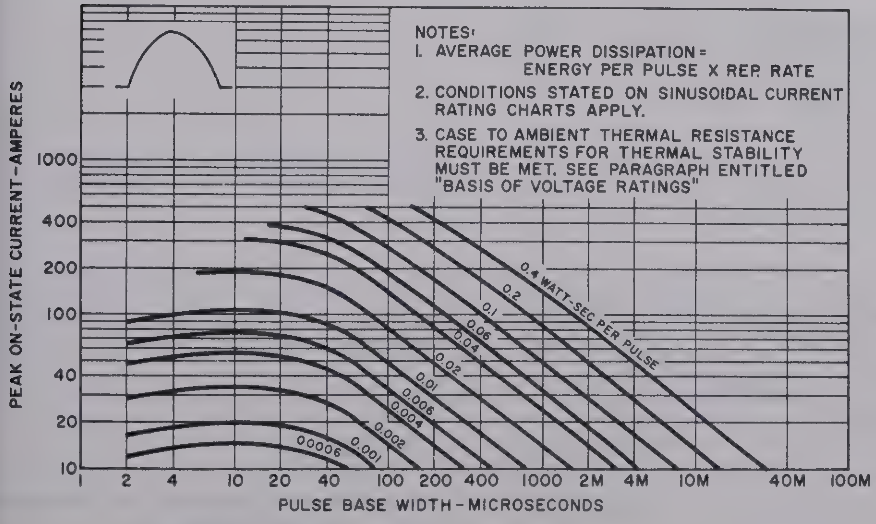
1. Plot the anode current waveform on this chart.
2. On linear paper, replot instantaneous on-state power dissipation versus time. The area under the curve gives watt seconds of energy dissipated per anode current pulse.
3. Multiply the energy by the repetition rate to give average power dissipation.



5. Waveforms For Pulse Turn-Off Time Test



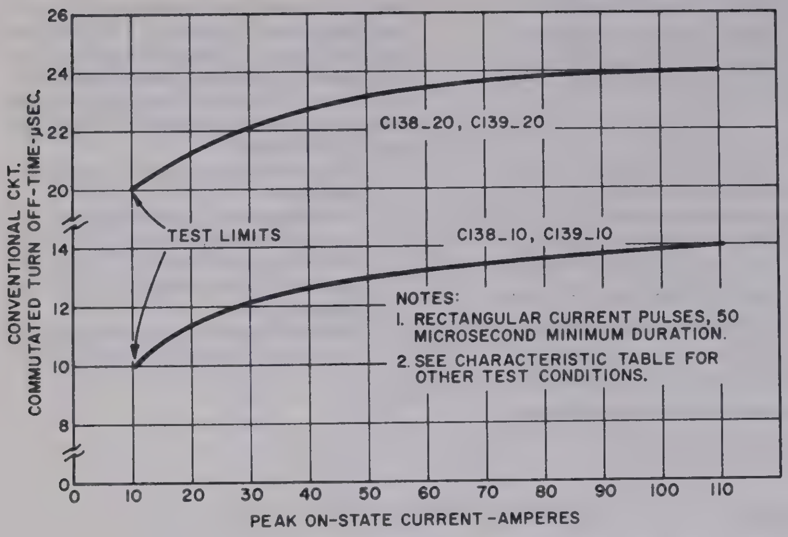
6. Pulse Turn-Off Time Basic Test Circuit



NOTES:
1. AVERAGE POWER DISSIPATION = ENERGY PER PULSE X REP. RATE
2. CONDITIONS STATED ON SINUSOIDAL CURRENT RATING CHARTS APPLY.
3. CASE TO AMBIENT THERMAL RESISTANCE REQUIREMENTS FOR THERMAL STABILITY MUST BE MET. SEE PARAGRAPH ENTITLED "BASIS OF VOLTAGE RATINGS"

7. Energy Per Pulse For Sinusoidal Pulses

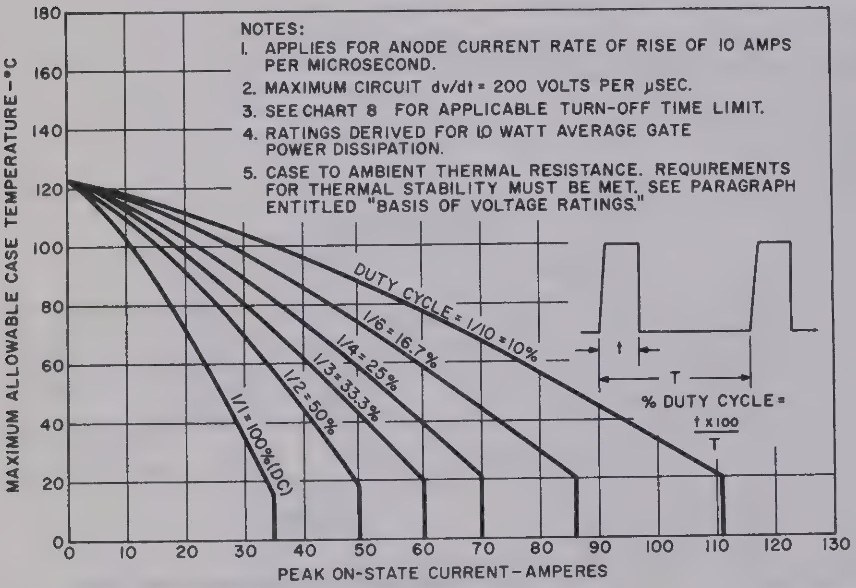
This chart provides a rapid means of determining anode dissipation with half-sine-wave pulses. Multiply the energy per pulse by the repetition rate to obtain average anode dissipation.



NOTES:
1. RECTANGULAR CURRENT PULSES, 50 MICROSECOND MINIMUM DURATION.
2. SEE CHARACTERISTIC TABLE FOR OTHER TEST CONDITIONS.

This chart gives the guaranteed maximum turn-off time of the C138 and C139 as a function of the on-state current. The use of this chart is necessary for rectangular anode current pulses of the specified pulse width and frequency.

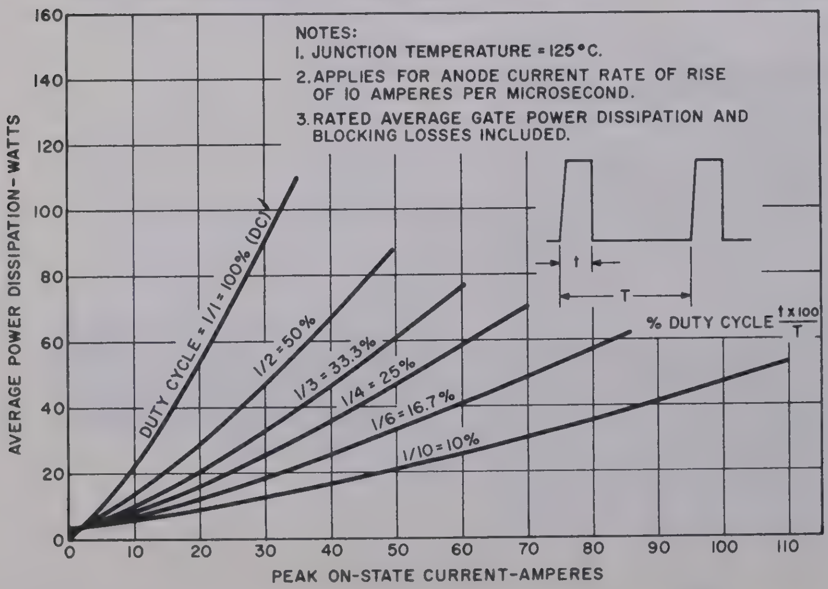
8. Maximum Conventional Circuit-Commutated Turn-Off Time vs Peak On-State Current



NOTES:
1. APPLIES FOR ANODE CURRENT RATE OF RISE OF 10 AMPS PER MICROSECOND.
2. MAXIMUM CIRCUIT dv/dt = 200 VOLTS PER μSEC.
3. SEE CHART 8 FOR APPLICABLE TURN-OFF TIME LIMIT.
4. RATINGS DERIVED FOR 1.0 WATT AVERAGE GATE POWER DISSIPATION.
5. CASE TO AMBIENT THERMAL RESISTANCE. REQUIREMENTS FOR THERMAL STABILITY MUST BE MET. SEE PARAGRAPH ENTITLED "BASIS OF VOLTAGE RATINGS."

This chart is used when the SCR is carrying rectangular current with no significant turn-on switching duty.

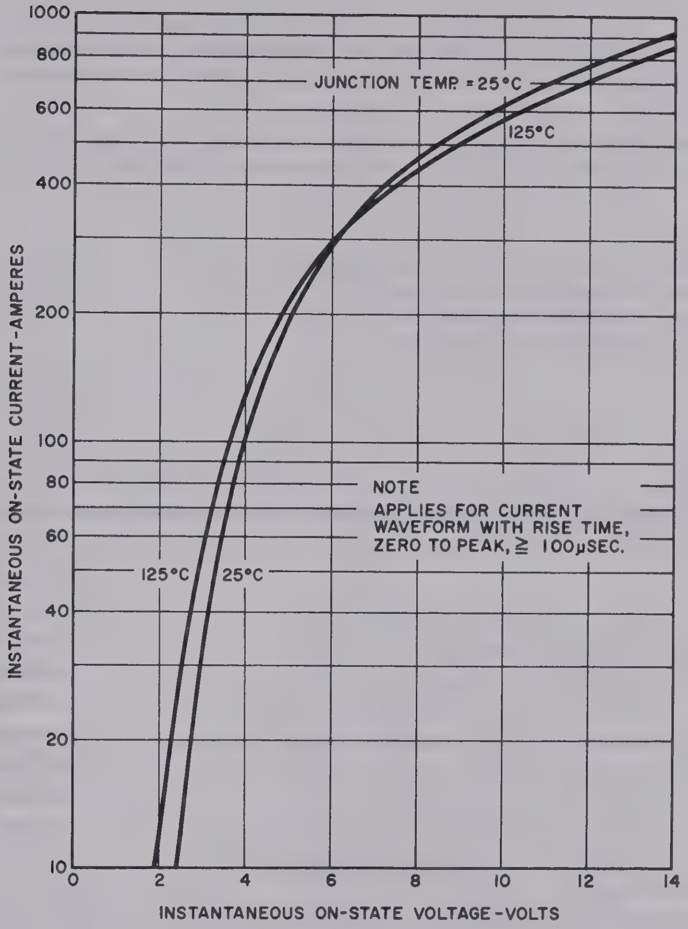
9. Maximum Allowable Case Temperature For Rectangular Current Waveform



NOTES:
1. JUNCTION TEMPERATURE = 125°C.
2. APPLIES FOR ANODE CURRENT RATE OF RISE OF 10 AMPERES PER MICROSECOND.
3. RATED AVERAGE GATE POWER DISSIPATION AND BLOCKING LOSSES INCLUDED.

This chart provides a rapid means of determining SCR dissipation with low values of di/dt.

10. Average Power Dissipation For Rectangular Current Waveform



NOTE
APPLIES FOR CURRENT WAVEFORM WITH RISE TIME, ZERO TO PEAK, ≧ 100μSEC.

11. Maximum On-State Characteristics

SCR

C140(2N3649-53

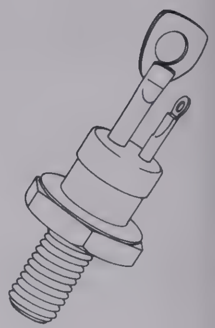
C141(2N3654-58

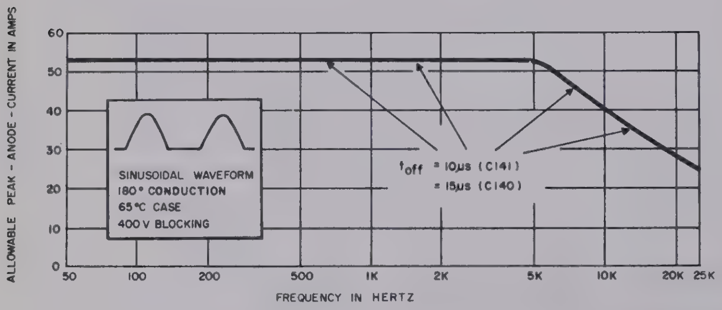
The General Electric C140 and C141 Series of Silicon Controlled Rectifiers are reverse blocking triode thyristor semiconductor devices designed primarily for high-frequency power switching applications which require blocking voltages up to 400 volts and load currents up to 35 amperes RMS, at frequencies up to 25 kHz.

For line commutated applications (phase control, AC switching) at power line frequencies, up to 35 amperes RMS, the following preferred SCR types are recommended: C35 (Pub. #160.20), and C137 (Pub. #160.45).

The C140 and C141 Series feature:

- Contoured junction surfaces for high-voltage stability
- Shorted emitters for high dv/dt (200V/μsec)
- Gold diffusion for short turn-off times
- Distributed gates for high di/dt (400A/μsec)





The improved dynamic characteristics and the interdynamic balance of these characteristics permit the operation of these General Electric SCR's up to 25 kHz with specified turn-off times and dv/dt maintained.

Equipment designers can use the C140 and C141 SCR's in demanding applications such as:

- Choppers
- Inverters
- Regulated power supplies
- Cycloconverters
- Ultrasonic generators
- High frequency lighting
- Sonar transmitters
- Induction heaters
- Radio transmitters

This specification sheet uses a simpligied and easy-to-use rating system which graphically presents:

- Case Temperature
- Peak Anode Current
- dv/dt and Turn-off Times

for rectangular and sinusoidal anode-current waveforms

MAXIMUM ALLOWABLE RATINGS

TYPE	DC FORWARD BLOCKING VOLTAGE V_{FO} (1) $T_C = -65°C$ to $+120°C$	PEAK FORWARD VOLTAGE PFV (1) $T_C = -65°C$ to $+120°C$	DC REVERSE VOLTAGE V_{RO} (1) $T_C = -65°C$ to $+120°C$	NON-REPETITIVE PEAK REVERSE VOLTAGE (Half Sine Wave) V_{ROM} (non-rep) (1) $T_C = -65°C$ to $+120°C$
C140F (2N3649) C141F (2N3654)	50 volts*	50 volts*	50 volts*	75 volts*
C140A (2N3650) C141A (2N3655)	100 volts*	100 volts*	100 volts*	150 volts*
C140B (2N3651) C141B (2N3656)	200 volts*	200 volts*	200 volts*	300 volts*
C140C (2N3652) C141C (2N3657)	300 volts*	300 volts*	300 volts*	400 volts*
C140D (2N3653) C141D (2N3658)	400 volts*	400 volts*	400 volts*	500 volts*

Turn-On Current Limit (See Chart 10)	400 amperes per μsec*
RMS Forward Current, On-State	35 amperes
DC Forward Current, On-State, $T_C = 40°C$	25 amperes*
Peak Rectangular Surge Forward Current (5.0msec width, $t_r = 50\mu sec$) I_{FM} (surge)	180 amperes*
I^2t (for fusing)	165 ampere^2 seconds (for times $\geqq 1.0$ millisecond)
Peak Gate Power Dissipation, P_{GM}	40 watts*
Average Gate Power Dissipation, $P_{G(AV)}$	1.0 watt*
Peak Reverse Gate Voltage, V_{GRM}	10 volts*
Peak Forward Gate Current, I_{GFM}	6.4 amperes*
Reverse Recovery Energy	0.002 watt sec.
Storage Temperature, T_{stg}	−65°C to +150°C*
Operating Temperature, T_C	−65°C to +120°C*
Stud Torque	30 Lb-in (35 Kg-Cm)

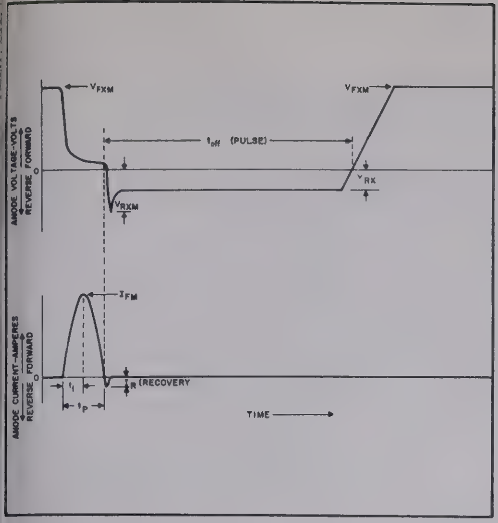
CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
PULSE CIRCUIT COMMUTATED TURN-OFF TIME	t_{off} (pulse)					See Charts 1 and 4. $T_C = +115°C$, $I_{FM} = 100$ amps, Approx. Sinusoidal current waveform ($t_1 = 1.0$ μsec, $t_p = 2.05 {}^{+0.5}_{-0}$ μsec), No delay reactor, Pulse rep. rate = 400 Hz. V_{FXM} = Rated, $V_{RXM} \leqq 200$ volts, $v_{RX} = 30$ volts. Rate of rise of reapplied forward blocking voltage (dv/dt) = 200 volts/μsec (linear ramp). Gate supply: 20 volts open circuit, 20 ohms, 1.5 μsec square wave pulse, Rise time = 0.1 μsec max.
C140 (2N3649-53)		—	—	15*	μsec	
C141 (2N3654-58)		—	—	10*	μsec	
CONVENTIONAL CIRCUIT COMMUTATED TURN-OFF TIME	t_{off}					$T_C = +120°C$, $I_{FM} = 10$ amps (50 μsec pulse), Rectangular current waveform, Test repetition rate = 60 Hz. V_{FXM} = Rated, V_{RXM} = Rated (see Chart 1), $v_{RX} = 15$ volts (see Chart 1). Rate of rise of current < 10 amps/μsec. Rate of fall of current $\leqq 5$ amps/μsec. Rate of rise of reapplied forward blocking voltage (dv/dt) = 200 volts/μsec (linear ramp). Gate bias = 0 volts, 100 ohms (during turn-off time internal).
C140 (2N3649-53)						
C141 (2N3654-58)		—	—	15*	μsec	
		—	—	10*	μsec	

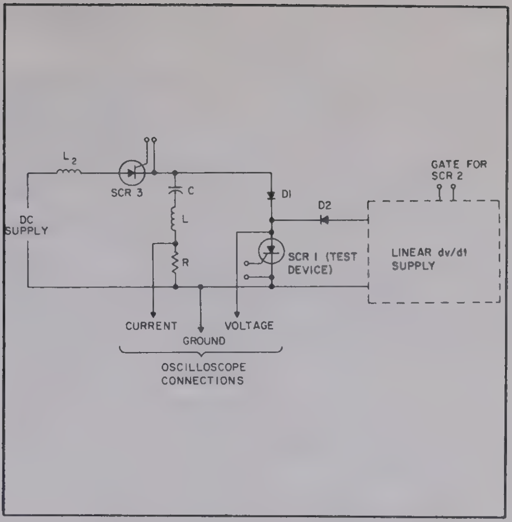
CHARACTERISTICS (Cont.)

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC REVERSE OR FORWARD BLOCKING CURRENT (1)	I_{RO} or I_{FO}					$T_C = +25^\circ C$
C140F (2N3649) C141F (2N3654)		—	1.0	6.0	mAdc	$V_{RO} = V_{FO} = 50V$ DC
C140A (2N3650) C141A (2N3655)		—	1.0	6.0	mAdc	$V_{RO} = V_{FO} = 100V$ DC
C140B (2N3651) C141B (2N3656)		—	1.0	6.0	mAdc	$V_{RO} = V_{FO} = 200V$ DC
C140C (2N3652) C141C (2N3657)		—	1.0	5.5	mAdc	$V_{RO} = V_{FO} = 300V$ DC
C140D (2N3653) C141D (2N3658)		—	1.0	4.0	mAdc	$V_{RO} = V_{FO} = 400V$ DC
DC REVERSE OR FORWARD BLOCKING CURRENT (1)	I_{RO} or I_{FO}					$T_C = +120^\circ C$
C140F (2N3649) C141F (2N3654)		—	5.0	6.0*	mAdc	$V_{RO} = V_{FO} = 50V$ DC
C140A (2N3650) C141A (2N3655)		—	5.0	6.0*	mAdc	$V_{RO} = V_{FO} = 100V$ DC
C140B (2N3651) C141B (2N3656)		—	5.0	6.0*	mAdc	$V_{RO} = V_{FO} = 200V$ DC
C140C (2N3652) C141C (2N3657)		—	5.0	5.5*	mAdc	$V_{RO} = V_{FO} = 300V$ DC
C140D (2N3653) C141D (2N3658)		—	3.5	4.0*	mAdc	$V_{RO} = V_{FO} = 400V$ DC
GATE TRIGGER CURRENT	I_{GT}	—	80	180	mAdc	$T_C = +25^\circ C$, $V_{FX} = 6Vdc$, $R_L = 4$ ohms
		—	150	500*	mAdc	$T_C = -65^\circ C$, $V_{FX} = 6Vdc$, $R_L = 2$ ohms
GATE TRIGGER VOLTAGE	V_{GT}	—	1.5	3.0	Vdc	$T_C = +25^\circ C$, $V_{FX} = 6$ Vdc, $R_L = 4$ ohms
		0.25*	—	—	Vdc	$T_C = +120^\circ C$, $V_{FX} =$ Rated, $R_L = 200$ ohms
		—	2.0	4.5*	Vdc	$T_C = -65^\circ C$, $V_{FX} = 6Vdc$, $R_L = 2$ ohms
PEAK ON-VOLTAGE	V_F	—	1.8	2.05*	V	$T_C = +25^\circ C$, $I_{FM} = 25A$ 1msec. pulse. Duty cycle = 1%
HOLDING CURRENT	I_{HO}					Anode supply = 24Vdc Initial forward current pulse, 0.1ms to 10ms wide, = 3.0A
		—	75	150	mAdc	$T_C = +25^\circ C$. Gate supply: 10V open circuit, 20 ohms, 45 μsec min. pulse width.
		—	150	350*	mAdc	$T_C = -65^\circ C$. Gate supply: 20V open circuit, 20 ohms, 45 μsec min. pulse width.
EFFECTIVE THERMAL RESISTANCE (DC)	θ_{J-C}	—	0.85	1.7*	°C/watt	
RATE OF RISE OF FORWARD BLOCKING VOLTAGE THAT WILL NOT TURN ON SCR	dv/dt	200*	—	—	volts/ μsec	$T_C = +120^\circ C$. Gate open circuited. $V_{FO} =$ Rated

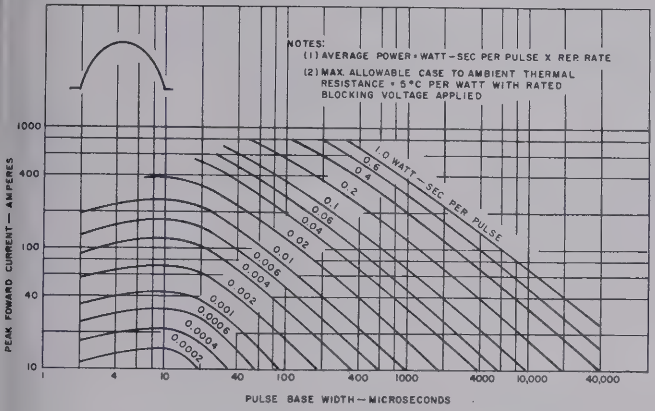
(1) Maximum case to ambient thermal resistance for which maximum V_{FO}, V_{RO} ratings apply equals 5°C/watt.
*Indicates values included in Jedec Type Number Registration.



1. WAVEFORMS FOR PULSE TURN-OFF TIME TEST

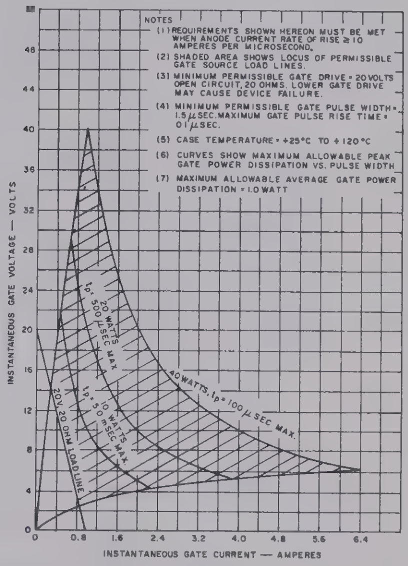

L2
SCR 3
C
DI
D2
GATE FOR SCR 2
DC SUPPLY
L
R
SCR I (TEST DEVICE)
LINEAR dv/dt SUPPLY
CURRENT
GROUND
VOLTAGE
OSCILLOSCOPE CONNECTIONS

2. PULSE TURN-OFF TIME BASIC TEST CIRCUIT



3. ENERGY PER PULSE FOR SINUSOIDAL PULSES

This chart provides a rapid means of determining anode dissipation with half-sine-wave pulses. Multiply the energy per pulse by the repetition rate to obtain average anode dissipation.



4. GATE TRIGGER REQUIREMENTS FOR HIGH FREQUENCY AND HIGH di/dt OPERATION

OUTLINE DRAWING
(COMPLIES WITH JEDEC TO-48)

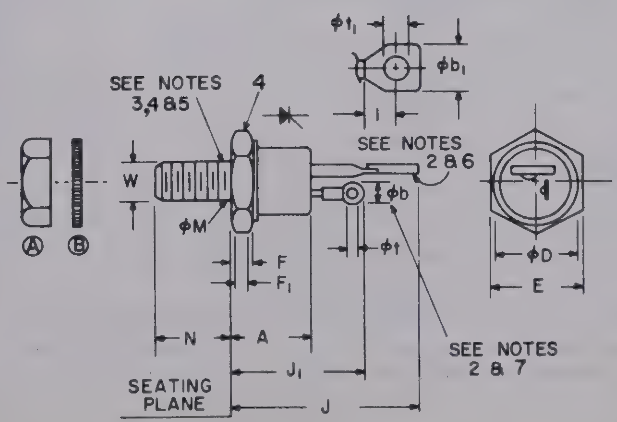
NOTES:

1. Complete threads to extend to within 2½ threads of seating plane. Diameter of unthreaded portion .249″ (6.32MM) Maximum, .220″ (5.59MM) Minimum.
2. Angular orientation of these terminals is undefined.
3. ¼-28 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter .2268″ (5.76MM), minimum pitch diameter .2225″ (5.66MM), reference: screw thread standards for Federal Service 1957, Handbook H28, 1957, P1.
4. A chamfer (or undercut) on one or both ends of hexagonal portions is optional.
5. Case is anode connection.
6. Large terminal is cathode connection.
7. Small terminal is gate connection.
8. Insulating kit available upon request.

A. ¼-28 steel nut, Ni. plated, .178 min. thk.

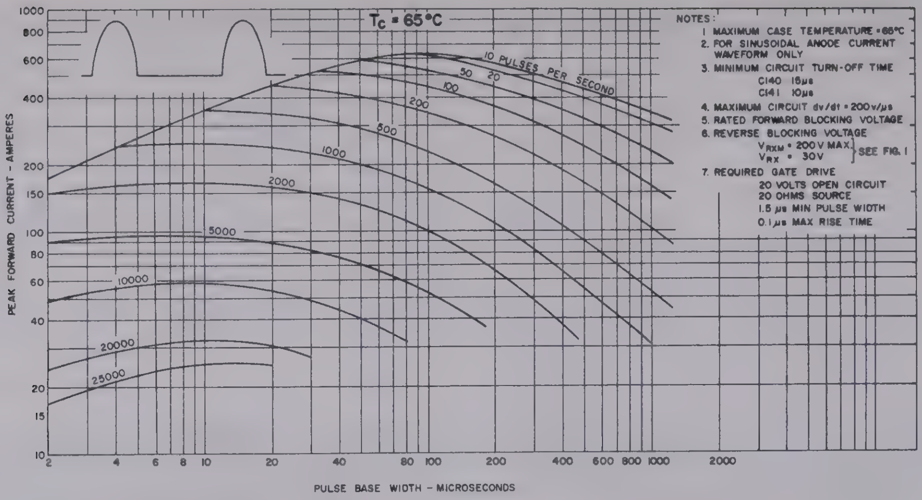
B. Ext. tooth lockwasher, steel, Ni. plated, .023 min. thk.

(COMPLIES WITH JEDEC TO-48)

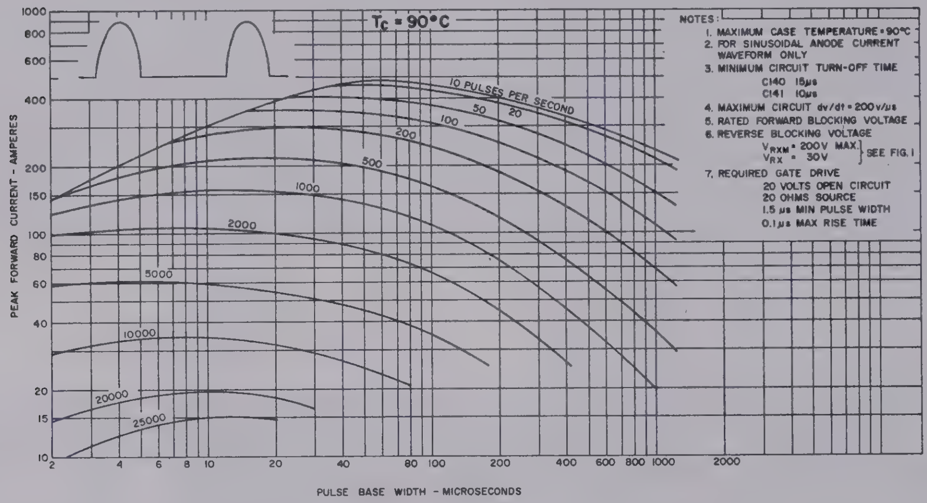

φt₁
φb₁
I
SEE NOTES 3,4 & 5
4
SEE NOTES 2 & 6
W
φb
φM
F
F₁
φt
Ⓐ
Ⓑ
φD
E
N
A
J₁
J
SEATING PLANE
SEE NOTES 2 & 7

SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	330	.505	8.38	12.83	
φb	.115	.140	2.92	3.56	2
φb₁	.210	.300	5.33	7.62	2
φD		.544		13.82	
E	.544	.562	13.82	14.27	
F	.113	.200	2.87	5.08	4
F₁	.060		1.52		
J		1.193		30.30	
J₁		.875		22.23	
I	.120		3.05		
φM					1
N	.422	.453	10.72	11.51	
φt	.060	.075	1.52	1.91	
φt₁	.125	.165	3.18	4.19	
W					3

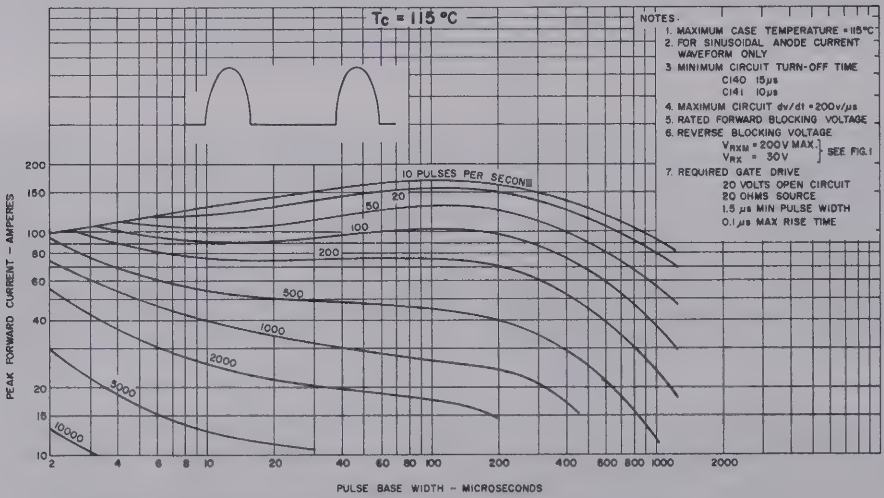
SINE WAVE DATA



5. MAXIMUM ALLOWABLE PEAK FORWARD CURRENT vs PULSE WIDTH ($T_C = 65°C$)



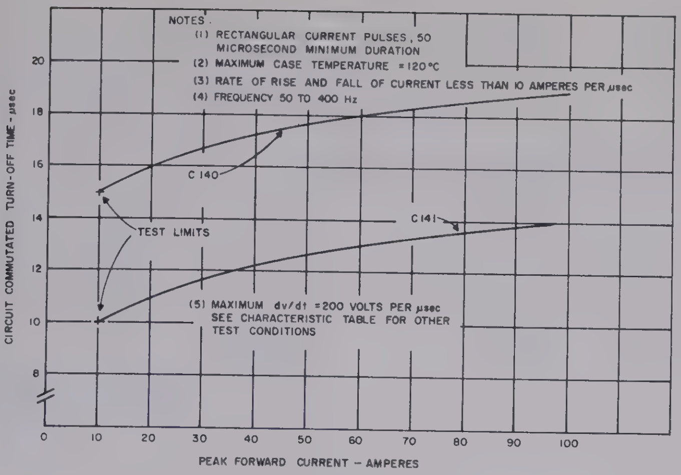
6. MAXIMUM ALLOWABLE PEAK FORWARD CURRENT vs PULSE WIDTH ($T_C = 90°C$)



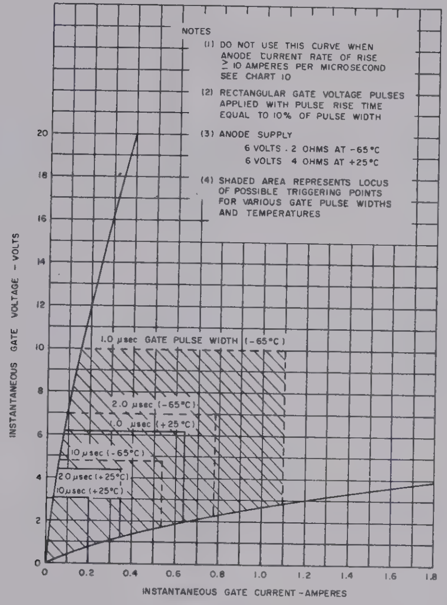
7. MAXIMUM ALLOWABLE PEAK FORWARD CURRENT vs PULSE WIDTH ($T_C = 115°C$)

Charts 5, 6 and 7, for three case temperatures 65°C, 90°C, and 115°C, give the maximum value of peak forward current at which the specified turn-off time and dv/dt still apply. The specified gate drive requirements *must* be adhered to.

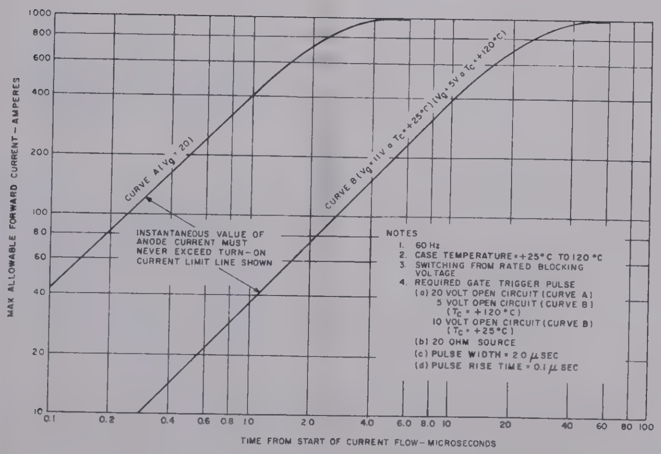
LOW REPETITION RATE DATA



8. MAXIMUM CONVENTIONAL CIRCUIT-COMMUTATED TURN-OFF TIME vs PEAK FORWARD CURRENT, ON-STATE



9. PULSE GATE TRIGGER CHARACTERISTICS



10. TURN-ON CURRENT LIMIT

This chart gives the guaranteed maximum turn-off time of the C140 and C141 as a function of the forward current. The use of this chart is necessary for rectangular anode current pulses of the specified pulse width and frequency.

Specification Sheets

140.12	1N3879 Series (6 amp) Fast Recovery Diode
140.22	1N3889 Series (12 amp) Fast Recovery Diode
140.23	A28 Series (12 amp) Very Fast Recovery Diode
140.47	1N3899 Series (20 amp) Fast Recovery Diode
140.48	1N3909 Series (30 amp) Fast Recovery Diode
145.55	A96 Series (250 amp) Fast Recovery Diode
160.35	C140 Series (35A) 50-400V High Speed SCR
160.39	C144 Series (35A) 500-800V High Speed SCR
170.35	C154-7 Series (110 amp) High Speed SCR
170.36	C158, 9 Series (110 amp) High Speed SCR
170.37	C385 Series (250 amp) High Speed SCR
170.38	C358 Series (225A) High Speed SCR
170.42	C395 Series (550A) up to 600V, High Speed SCR
170.44	C388, C387 Series (550A) High Speed SCR
170.45	C398, C397 Series (700A) High Speed SCR
170.53	C185 Series (235 amp) High Speed SCR
170.57	C354, 5 Series (115 amp) High Speed SCR
170.76	C506 Series (625 amp) High Speed SCR
170.80	C510 Series (625 amp) High Speed SCR

Application Notes

200.38	"Application of Fast Recovery Rectifiers"
200.41	"Simple Circuits For Triggering SCR's Into Fast-Rising Load Currents"
200.42	"Commutation Behavior of Diffused High Current Rectifier Diodes"
200.49	"A Low Cost Ultrasonic Frequency Inverter Using A Single SCR"

Technical Paper Reprints

660.13	"The Rating and Application of SCR's Designed for Switching at High Frequencies"
660.14	"Basic Magnetic Functions in Converters and Inverters Including New Soft Commutations"
660.15	"SCR Inverter Commutated By An Auxiliary Impulse"
660.16	"An SCR Inverter With Good Regulation and Sine Wave Output"

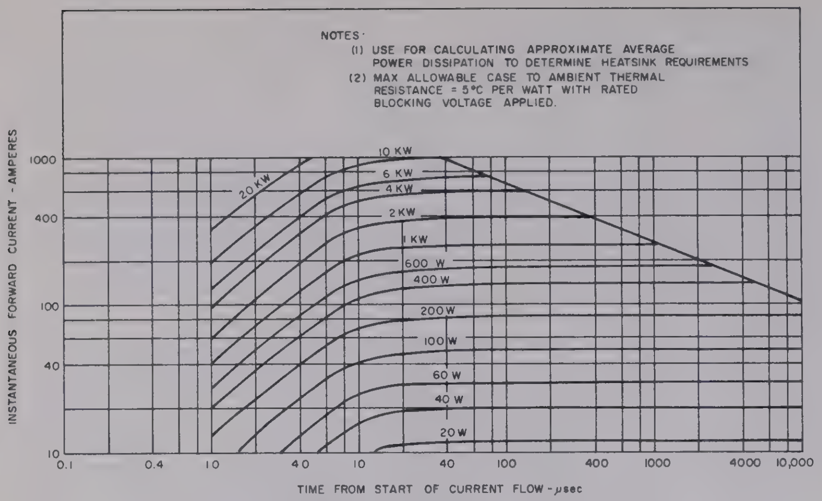
Seminar Notes

671.4	"The Widening World of The Fast Recovery Rectifier Diode"
671.15	"The Amplifying Gate SCR"

***For copies of any published information, please order by decimal publication number from: General Electric Company, Distribution Services, 1 River Road, Schenectady, N. Y. 12305.**

In no circumstances may the SCR anode current waveform, when plotted in this curve, cross the turn-on current limit line. If it does, the SCR may be destroyed. Two lines are given; one for required gate drive in high di/dt applications and the other for gate drive that will just turn the SCR on. The user must take care that, in a circuit capable of producing high di/dt anode current, no gate pulses of insufficient magnitude (due to noise for example) triggers, and thus possibly damages, the SCR.

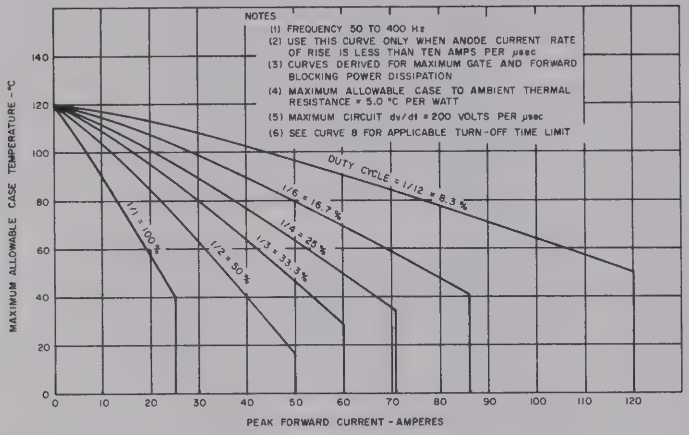
LOW REPETITION RATE DATA



11. INSTANTANEOUS FORWARD POWER DISSIPATION

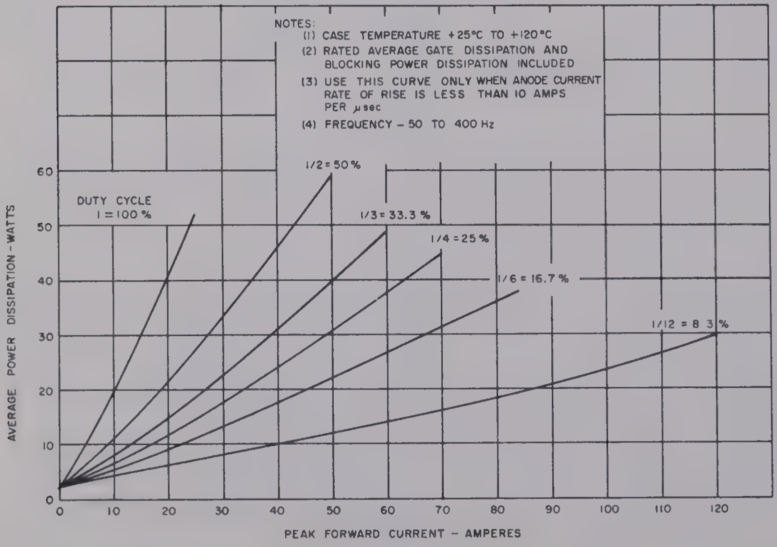
This chart gives the instantaneous power dissipated within the SCR as a function of time from start of current flow and the instantaneous value of forward anode current. Used as follows, this chart yields average dissipation information for any anode current waveshapes:

1. Plot the anode current waveform on this chart.
2. On linear paper, replot instantaneous forward power dissipation versus time. The area under the curve gives watt seconds of energy dissipated per anode current pulse.
3. Multiply the energy by the repetition rate to give average power dissipation.



12. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM

This chart is used when the SCR is carrying rectangular current with no significant turn-on switching duty at a repetition rate between 50 and 400 pulses per second.



13. AVERAGE POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM

This chart provides a rapid means of determining SCR dissipation with low values of di/dt. It is applicable only between 50 Hz and 400 Hz.

HOW TO USE THIS SPECIFICATION SHEET

EXAMPLE I. (High Frequency Sinusoidal Pulse)

Problem:

Find the maximum allowable average anode current that can be carried by a C141 if the pulse is 50 μseconds wide and the repetition rate is 5000 Hz. The case is held at 80°C. What is the dissipation in the SCR? Find the maximum permitted thermal resistance between case and cooling air at 45°C. Assume the gate and blocking losses total 1 watt.

Answer:

From Chart 5 (65°C) the maximum permitted peak current at 5000 Hz, 50 μsec pulse width is 72 amperes; Chart 6 (90°C), 45 amperes; Chart 7 (115°C), 10 amperes. Interpolation gives the permitted peak current at 80°C as 55 amperes peak.

$$\text{The average current} = I_{pk} \times \frac{2}{\pi} \times \frac{\text{Pulse Width}}{\text{Pulse Period}}$$

$$= 55 \times \frac{2}{\pi} \times \frac{50}{200} = 8.8 \text{ amps average}$$

From Chart 3 at 50 μseconds pulse width and 55 amperes peak current the energy dissipated per pulse is 0.004 watt-seconds per pulse. The average anode dissipation is 0.004 × 5000 = 20 watts.

From this information the heatsink can be chosen using the equation:

$$\text{Maximum case to cooling fluid thermal resistance}$$

$$= \frac{\text{Case Temperature} - \text{Cooling Fluid Temp.}}{\text{Anode Dissipation} + \text{Gate \& Blocking Losses}}$$

$$= \frac{80 - 45}{20 + 1} = 1.7^\circ\text{C/watt.}$$

Note that a turn-off of 10 μseconds and a dv/dt of 200 volts/μsecond can be applied concurrently to the C141 at the above current and temperature conditions.

EXAMPLE II. (Low Frequency, Low di/dt Pulse)

Problem:

A C140 is carrying a 20 amp rectangular pulse, 833 μseconds wide at a repetition rate of 400 pulses per second. The initial di/dt is 5 amps per μsecond. What is the maximum allowable case temperature? What is the power dissipation? What turn-off time and dv/dt may be applied to the C140?

Answer:

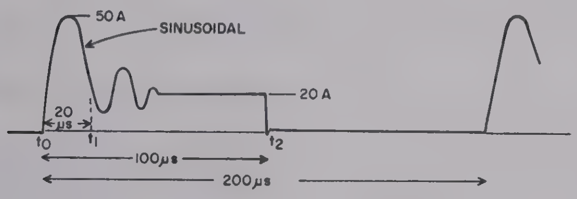
An 833 μsecond pulse in a 2.5 ms period gives a duty cycle of $\frac{833}{2500} \times 100 = 30\%$. Chart 12 shows that with this duty cycle a 20 amp rectangular pulse has a maximum allowable case temperature of 98°C. Chart 13 gives the total dissipation as 13.5 watts.

From Chart 8, 20 amps forward current permits a turn-off time of 16 μseconds and a dv/dt of 200 volts/μsecond to be applied concurrently.

EXAMPLE III. (High Frequency, Irregular Pulses)

Problem:

What is the maximum allowable case temperature for a C141 carrying the following anode current waveform: What turn-off time and dv/dt may be applied?



Answer:

No rigorous method has yet been developed for handling this case. The following method is approximate only but provides a conservative answer.

The di/dt of the initial pulse imposes the most severe strain on the SCR during the cycle. Use the initial half cycle to establish a case temperature and then lower the case temperature by an amount = effective thermal resistance (DC) of the SCR × wattage dissipated during the rest of the cycle (t_1 to t_2) to establish the maximum permitted case temperature.

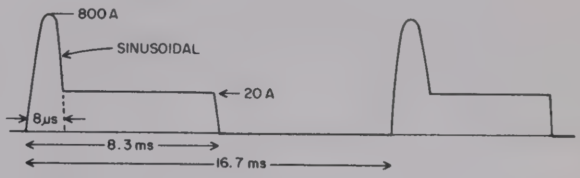
The average anode dissipation (time t_1 to t_2) can be found by means of Chart 11 (for method see Example IV). The energy dissipated per pulse is 0.0032 watt-seconds. The average anode dissipation = 0.0032 watt-seconds × 5000 pulses per second = 16 watts.

Chart 6 shows that a 5000 Hertz, 50 ampere, 20 μsecond pulse requires a case temperature of less than 90°C. Subtract from this case temperature a temperature of 1.7 °C/watt × 16 watts = 27°C to give the maximum permitted case temperature, with the given waveform, of 90°C − 27°C = 63°C. As the end of the current pulse is rectangular, Chart 8 will have to be used to find the required turn-off time which is 16μseconds. The concurrent dv/dt is 200 volts/μsecond.

EXAMPLE IV. (Low Frequency, Irregular Pulses With High Initial di/dt)

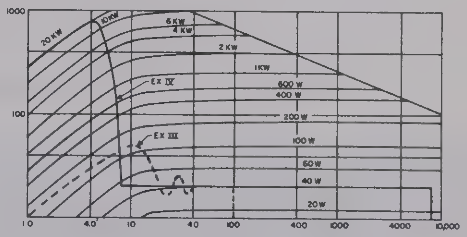
Problem:

What is the maximum allowable case temperature for a C141 carrying the following anode current waveform?

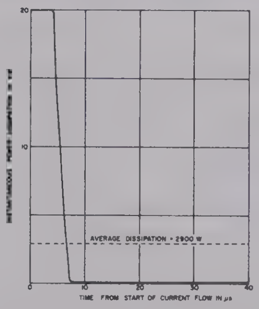


Answer:

Check the initial di/dt by plotting the first 10 μseconds of current flow on Chart 10. The waveform is found to be within safe limits provided that the high gate pulse shown on Chart 4 is used. Note that an inadequate gate pulse could destroy the SCR. To find the anode dissipation, plot the anode current waveform on Chart 11.



Replot the intersections of anode current with the instantaneous power lines. In this case it is convenient to replot the first 40 μseconds of current flow separately in order to use a convenient scale.



By graphical integration, the energy per pulse for the first 40 μseconds is seen to be 0.12 watt-second. To this must be added the energy dissipated during the rectangular portion of the pulse which is 40 watts × 8.3 ms = 0.33 watt-seconds.

Thus the total energy dissipated per pulse is 0.12 + 0.33 = 0.45 watt-seconds. The average dissipation due to anode current flow is 0.45 watt-seconds × 60 pulses per second = 27 watts.

As the repetition rate is within the limits of 50 to 400 Hz a convenient way of ascertaining the maximum permitted case temperature is to convert the high di/dt irregular waveform to a low di/dt rectangular pulse with the same dissipation.

From Chart 13, a 27 watt, 50% duty cycle pulse gives an average anode current of 25 amperes peak.

From Chart 12, a 25 ampere, 50% duty cycle current gives a maximum allowable case temperature of 75°C.

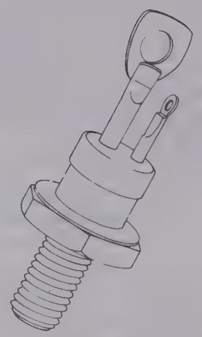
Note: For repetition rates lower than 50 Hz, the temperature excursion within the SCR each cycle becomes too high for the use of Charts 12 and 13. The procedure for dealing with these very-low-frequency pulses is discussed in the General Electric SCR Manual, 3rd Edition, Chapter 3.

SCR

The General Electric C144 Silicon Controlled Rectifier is a reverse blocking triode thyristor semiconductor device designed primarily for high-frequency power switching applications which requires blocking voltages from 500 to 800 volts and load currents up to 35 amperes RMS, at frequencies up to 10 kHz. The C144 is characterized for rectangular and sine wave operation.

The C144 utilizes a new voltage rating system which allows high voltage blocking capability while approaching the short turn-off time characteristics of a low blocking voltage SCR.

Equipment designers can use the C144 SCR in demanding applications such as: choppers, inverters, regulated power supplies, cycloconverters, ultrasonic generators, high frequency lighting, induction heaters, radar and sonar transmitters, laser pulsers, pulse modulators.



MAXIMUM ALLOWABLE RATINGS

Type (1)	Repetitive Peak Off-State Voltage, V_{DRM} (2)(3), $T_C = -65°C$ to $+125°C$	Peak or DC Switching Voltage V_{DM} or V_D (2)(3) $T_C = -65°C$ to $+125°C$	Repetitive Peak Reverse Voltage V_{RRM} (2)(3) $T_C = -65°C$ to $+125°C$	Non-Rep. Peak Off-State and Reverse Voltage V_{DSM} and V_{RSM} (2)(4) $T_C = -65°C$ to $+125°C$
C144E15E, C144E30E	500 Volts	500 Volts	500 Volts	600 Volts
C144M15M, C144M30M	600	600	600	720
C144S15M, C144S30M	700	600	700	840
C144N15M, C144N30M	800	600	800	1000

RMS On-State Current, $I_{T(RMS)}$	35 Amperes (all conduction angles)
Critical Rate-of-Rise of On-State Current, di/dt: (5)	
Gate triggered operation:	
Switching from 500 volts (500 volt types)	100 Amperes per microsecond
Switching from 600 volts (600, 700, 800 volt types)	100 Amperes per microsecond
Peak One Cycle Surge (non-rep) On-State Current, I_{TSM}	250 Amperes
Peak Rectangular Pulse Surge (non-rep) On-State Current (5.0 Msec, t_r=50μsec) I_{TSM}	225 Amperes
I^2t (for fusing), for times ≧ 0.5 milliseconds	165 Ampere^2 seconds
Peak Gate Power Dissipation, P_{GM}	40 Watts for 100 Microseconds
Average Gate Power Dissipation, $P_{G(AV)}$	1.0 Watts
Peak Negative Gate Voltage, V_{EM}	10 Volts
Storage Temperature, T_{stg}	−65°C to +150°C
Operating Temperature, T_J	−65°C to +125°C
Maximum Stud Torque	30 Lb-in (35 Kg-cm)

CHARACTERISTICS

Test	Symbol	Min.	Max.	Units	Test Conditions
Peak Reverse and Off-State Current (2)(6)	I_{RRM} or I_{DRM}	– – – –	5.5 4.6 3.9 3.3	mA	T_C = –65°C to +125°C V_{RRM} = V_{DRM} = 500 Volts Peak 600 " " 700 " " 800 " "
Critical Rate of Rise of Off-State Voltage	dv/dt	200	–	Volts/ μsec	T_C = 125°C, Rated V_{DRM}, Gate Open Circuited, Exponential Waveform
D.C. Gate Trigger Current	I_{GT}	–	150 400	mAdc	T_C = 25°C, V_D = 6Vdc, R_L = 4 ohms T_C = –65°C, V_D = 6Vdc, R_L = 2 ohms
D.C. Gate Trigger Voltage	V_{GT}	– 0.25	3.0 4.5	V_{DC}	T_C = 25°C, V_D = 6 Volts, R_L = 4 ohms T_C = –65°C, V_D = 6 Volts, R_L = 2 ohms T_C = 125°C, Rated V_{DRM}, R_L = 500 ohms
Peak On-State Voltage	V_{TM}	–	3.0	Volts	T_C = 25°C, I_{TM} = 100 A Peak, ≥ 1, ≤ 2 msec. wide pulse. Duty cycle ≦ 2%.
Holding Current	I_H	– –	125 325	mAdc	Anode Source Voltage = 24 Vdc. Peak Initiating On-State Current = 3A, 0.1 to 10 msec pulse. T_C = 25°C, Gate source = 10V, Open Circuit, 20 ohms, 100 μsec pulse T_C = –65°C, Gate source = 20V, Open Circuit, 20 ohms, 100 μsec pulse.
Pulse Circuit Commutated Turn-Off Time	t_q (pulse)				T_C = 115°C, I_{TM} = 100A Peak. Approximately Sinusoidal Current Waveform. See Chart II for time references. On-State Current Pulse Time to peak (t_2–t_1) = 7.5 μsec. On-State Current Pulse Base (t_3–t_1) = 15. μsec (+1.5-0 μsec). Repetition Rate = 400 PPS. PRV (t_5) = 500 Volts max. Reverse Voltage (t_6) = 30 Volts. Peak Off-State Voltage (t_8) = Rated V_{DRM}. Peak Off-State Voltage (t_0) equals: 500 Volts for 500 Volt types; 600 Volts for 600, 700 and 800 Volt types. Rate of Rise of Re-applied Off-State Voltage (Linear Ramp): (t_6 to t_8) = 200 Volts per μsec. Gate Trigger Pulse = 20 Volts, 20 ohms. Gate Trigger Pulse Width (90% points) = 1.5 μsec. Gate Trigger Pulse Rise Time (10% to 90%) = 0.1 μsec. Gate Bias during Turn-Off Time interval = 0 Volts, 20 ohms.
C144-15- Types		–	15	μsec	
C144-30- Types		–	30	μsec	

CHARACTERISTICS (Contd)

Test	Symbol	Min.	Max.	Units	Test Conditions
Steady State Thermal Resistance	$R_{\theta JC}$	–	1.0	°C/ Watt	Junction to Case
Conventional Circuit Commutated Turn-Off Time	t_q				T_C = 125°, I_{TM} = 10A Peak Rectangular Current Pulse, 50 μsec duration. DI/DT < 10 Amps per microsecond. Commutation Rate ≤ 5A per μsec. PRV = Rated V_{RRM} Volts max. Reverse Voltage at end of Turn-Off Time interval = 15 volts. Repetition Rate = 60 PPS. Rate of Rise of Re-applied Off-State Voltage (dv/dt) = 200V/μsec. Off-State Voltage = Rated V_{DRM} Volts. Gate Bias during Turn-Off Time interval = 0 Volts, 100 ohms.
C144-15- Types			15	μsec	
C144-30- Types			30	μsec	

NOTES:

(1) Type designations are defined as follows, using C144N30M as an example:

C 1 4 4 N 30 M
Rated Switching Voltage
Maximum Turn-Off Time (30 = 30 μsec; 15 = 15 μsec)
Rated Repetitive Peak Off-State and Reverse Voltage

(2) Values apply for gate terminal open circuited. (Negative gate bias is permissible).

(3) Maximum case to ambient thermal resistance for which maximum voltage ratings apply equals 3.0C degrees per watt for V_D (DC voltage), 5.0C degrees per watt for V_{DRM} and V_{RRM}. See paragraph, "Basis for Voltage Rating" for further information.

(4) Half sine wave voltage pulse, 10 millisecond max. duration.

(5) di/dt rating is established in accordance with JEDEC Suggested Standard No. 7, Section 5.1.2.4 Off State (blocking) voltage capability may be temporarily lost immediately after each current pulse for duration less than the period of the applied pulse repetition rate. The pulse repetition rate for this test is 400 H_Z. The duration of the JEDEC di/dt test condition is 5.0 seconds (minimum). Required gate drive = 20 volts, open circuit, 20 ohm source, 0.1 microsecond rise time, 1.5 microsecond pulse width. Repetitive di/dt capability is incorporated into peak current rating charts included in this specification sheet.

(6) Maximum case to ambient thermal resistance for which maximum V_{DRM} and V_{RRM} ratings apply equals 5.0 degrees C per watt. See paragraph entitled "Basis of Voltage Ratings", for further information.

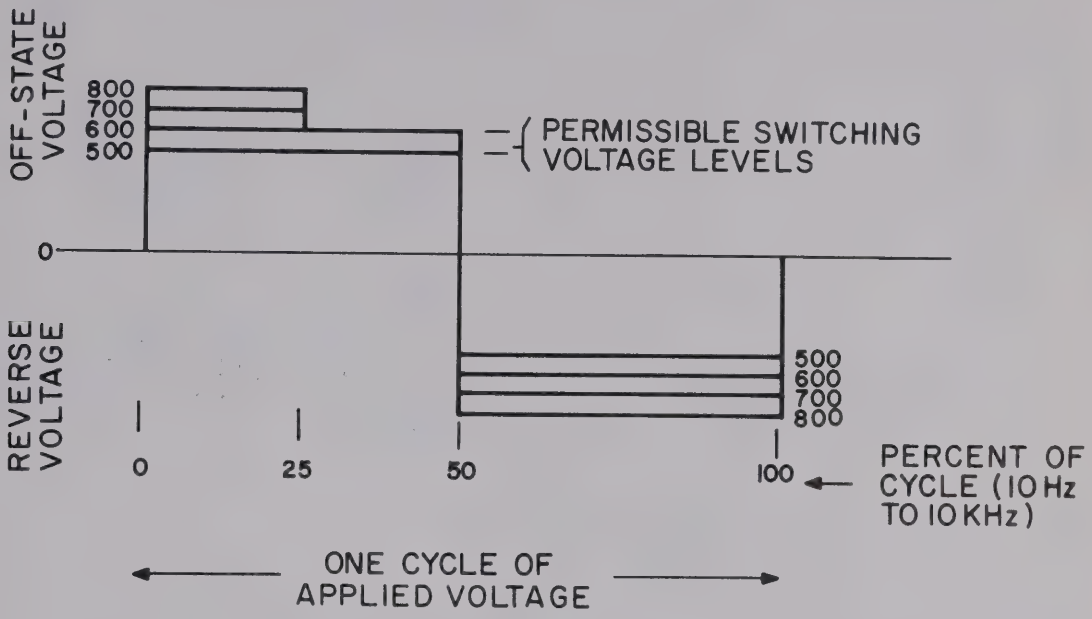
PRELIMINARY DATA

These ratings and characteristics are not necessarily definitive and are based only on the tests and findings made to date. Inasmuch as further information may be acquired, General Electric Company reserves the right to change these preliminary data without notice. Please contact your local General Electric Electronic Component Sales Manager for the latest status of data prior to ordering devices to the limits indicated by the data.

BASIS OF VOLTAGE RATINGS
For The C144 Thyristor

The C144 Thyristor is characterized for both inverter service and phase controlled service. Voltage ratings are given applicable to both types of service.

For inverter service, the off-state and reverse voltage ratings are based on the waveform shown below:



This waveform requires the use of a device case to ambient thermal resistance of 3.0 deg C per watt in order to assure thermal stability under maximum rated voltage and temperature conditions.

The waveforms of the actual application must stay within the envelope shown for each voltage type. If the actual waveforms do not stay within the envelopes shown for each voltage type then a heat sink with less than 3.0 deg C per watt must be used. Consult factory for assistance in heat sink selection to assure thermal stability.

For phase controlled service, sinusoidal voltage waveform is assumed. A device case to ambient thermal resistance of 5.0 deg C per watt maximum is required to assure thermal stability at maximum rated voltage and temperature conditions.

It should be noted that the above thermal stability criteria apply even when no on-state conduction losses are present.

OUTLINE DRAWING
(COMPLIES WITH JEDEC TO-48)

OTES:

Complete threads to extend to within 2½ threads of seating plane. Diameter of unthreaded portion .249″ (6.32MM) Maximum, .220″ (5.59MM) Minimum.

Angular orientation of these terminals is undefined.

¼-28 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter .2268″ (5.76MM), minimum pitch diameter .2225″ (5.66MM), reference: screw thread standards for Federal Service 1957, Handbook H28, 1957, P1.

A chamfer (or undercut) on one or both ends of hexagonal portions is optional.

Case is anode connection.

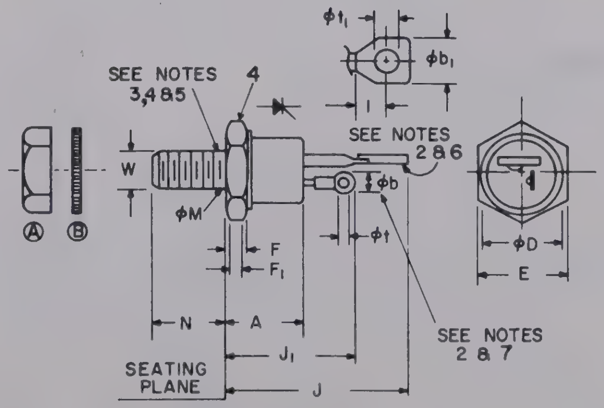
Large terminal is cathode connection.

Small terminal is gate connection.

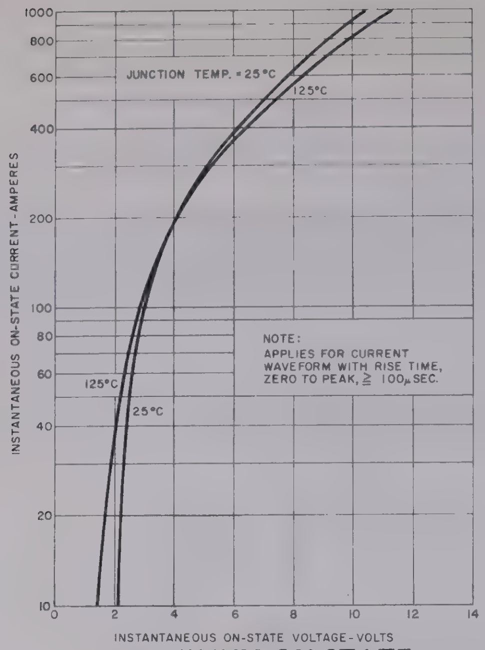
Insulating kit available upon request.

¼-28 steelnut, Ni. plated, .178 min. thk.

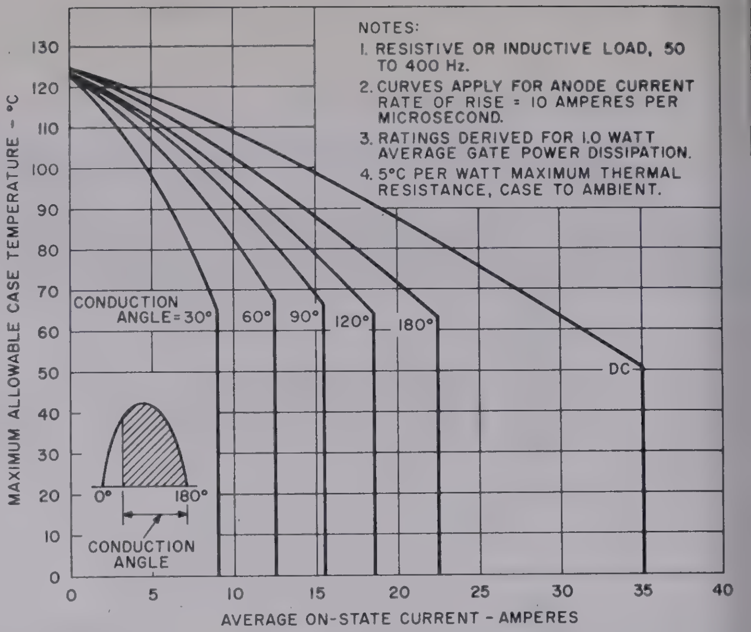
Ext. tooth lockwasher, steel , Ni. plated, .023 min. thk.



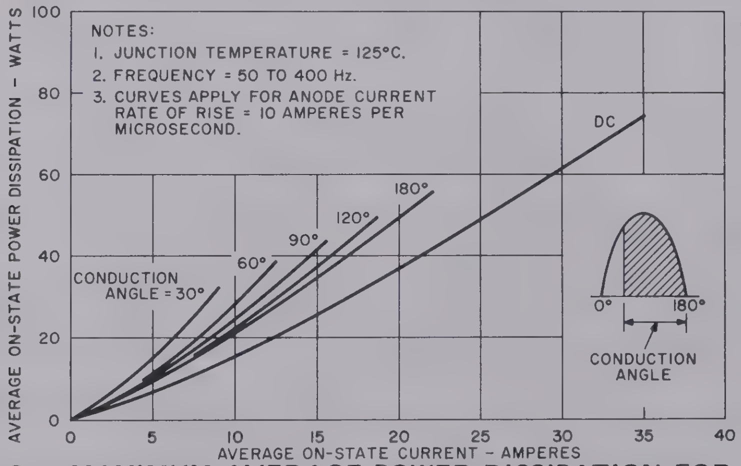
SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	330	.505	8.38	12.83	
ϕb	.115	.140	2.92	3.56	2
$ϕb_1$	.210	.300	5.33	7.62	2
ϕD		.544		13.82	
E	.544	.562	13.82	14.27	
F	.113	.200	2.87	5.08	4
F_1	.060		1.52		
J		1.193		30.30	
J_1		.875		22.23	
I	.120		3.05		
ϕM					1
N	.422	.453	10.72	11.51	
ϕt	.060	.075	1.52	1.91	
$ϕt_1$	.125	.165	3.18	4.19	
W					3



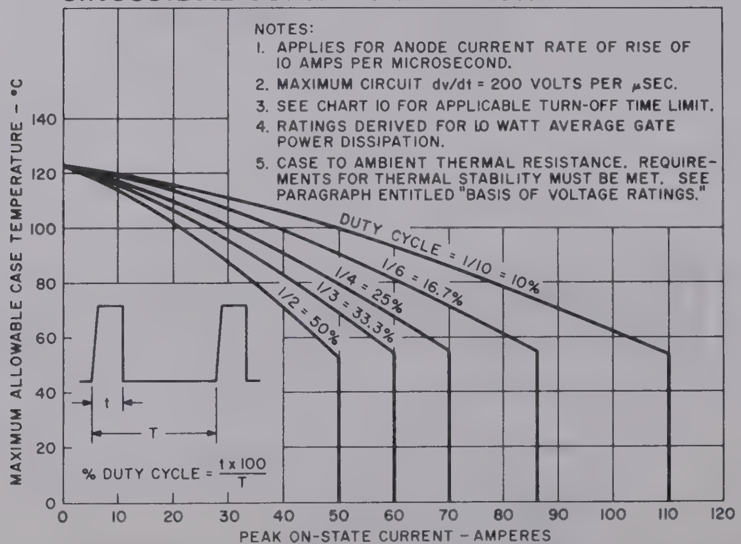
1. MAXIMUM ON-STATE CHARACTERISTICS



2. MAXIMUM ALLOWABLE CASE TEMPERATURE VS. ON-STATE CURRENT FOR SINUSOIDAL CURRENT WAVEFORM.

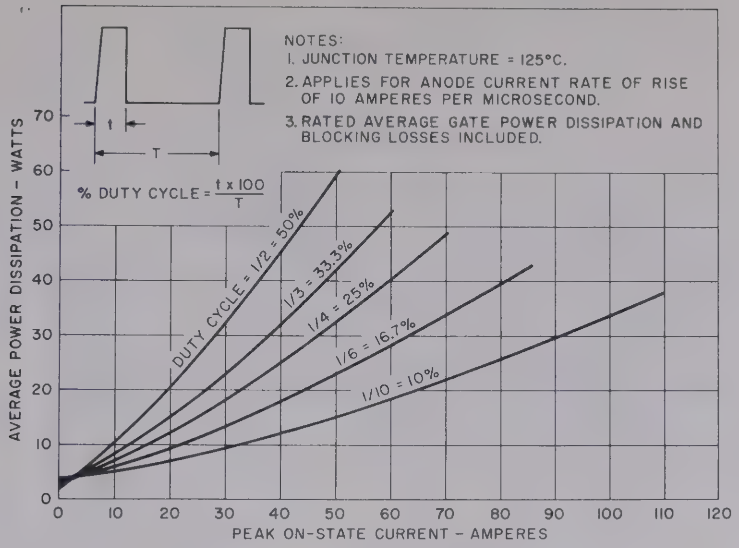


3. MAXIMUM AVERAGE POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



This chart is used when the SCR is carrying rectangular current with no significant turn-on switching duty.

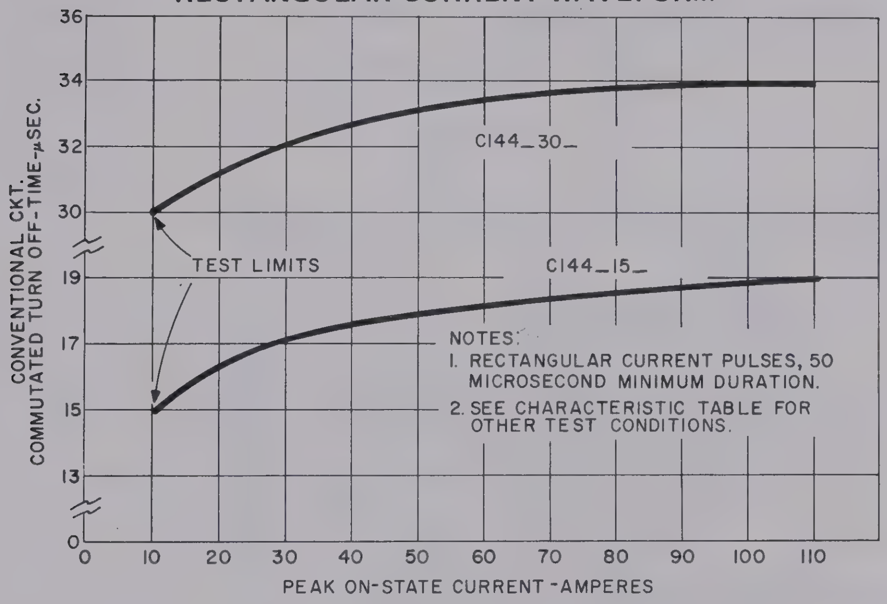
4. MAXIMUM ALLOWABLE CASE TEMPERATURE VS. ON-STATE CURRENT FOR RECTANGULAR WAVEFORM



NOTES:
1. JUNCTION TEMPERATURE = 125°C.
2. APPLIES FOR ANODE CURRENT RATE OF RISE OF 10 AMPERES PER MICROSECOND.
3. RATED AVERAGE GATE POWER DISSIPATION AND BLOCKING LOSSES INCLUDED.

This chart provides a rapid means of determining SCR dissipation with low values of di/dt.

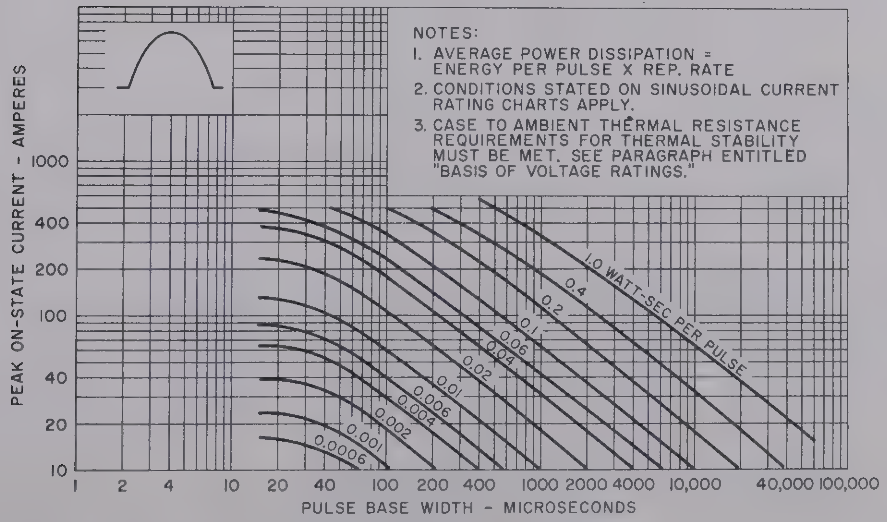
5. MAXIMUM AVERAGE POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



NOTES:
1. RECTANGULAR CURRENT PULSES, 50 MICROSECOND MINIMUM DURATION.
2. SEE CHARACTERISTIC TABLE FOR OTHER TEST CONDITIONS.

This chart gives the guaranteed maximum turn-off time of the C144 as a function of the forward current. The use of this chart is necessary for rectangular anode current pulses of the specified pulse width and frequency.

6. MAXIMUM CONVENTIONAL CIRCUIT-COMMUTATED TURN-OFF TIME VS. PEAK ON-STATE CURRENT.

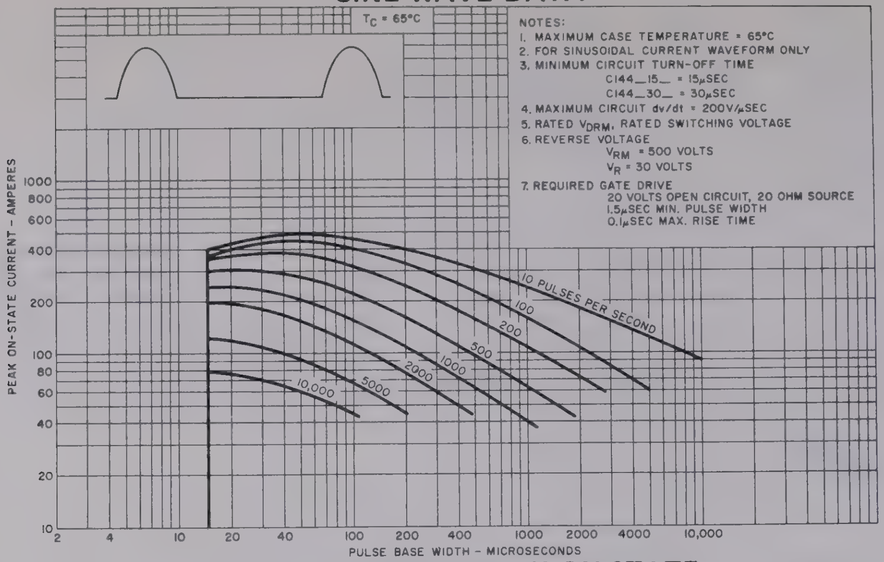


NOTES:
1. AVERAGE POWER DISSIPATION = ENERGY PER PULSE X REP. RATE
2. CONDITIONS STATED ON SINUSOIDAL CURRENT RATING CHARTS APPLY.
3. CASE TO AMBIENT THERMAL RESISTANCE REQUIREMENTS FOR THERMAL STABILITY MUST BE MET. SEE PARAGRAPH ENTITLED "BASIS OF VOLTAGE RATINGS."

This chart provides a rapid means of determining anode dissipation with half-sine-wave pulses. Multiply the energy per pulse by the repetition rate to obtain average anode dissipation.

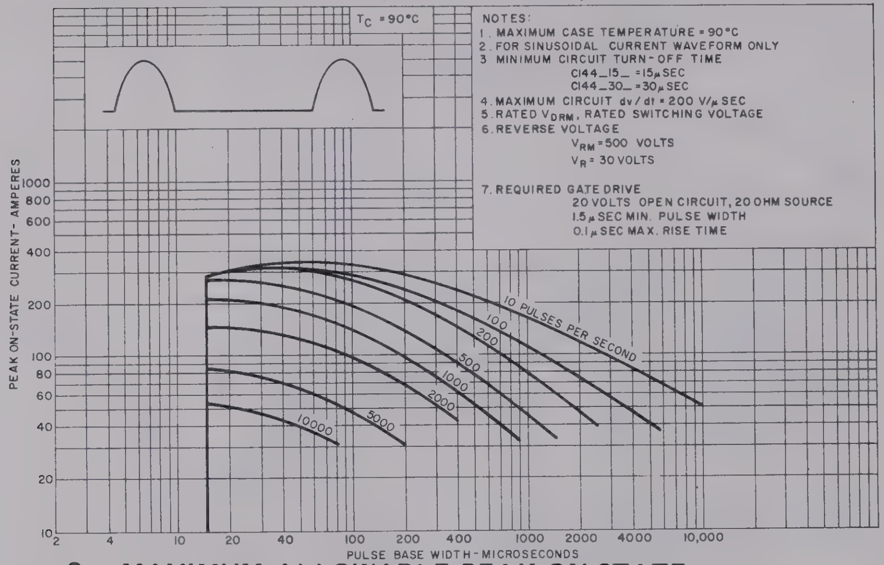
7. ENERGY PER PULSE FOR SINUSOIDAL PULSES

SINE WAVE DATA



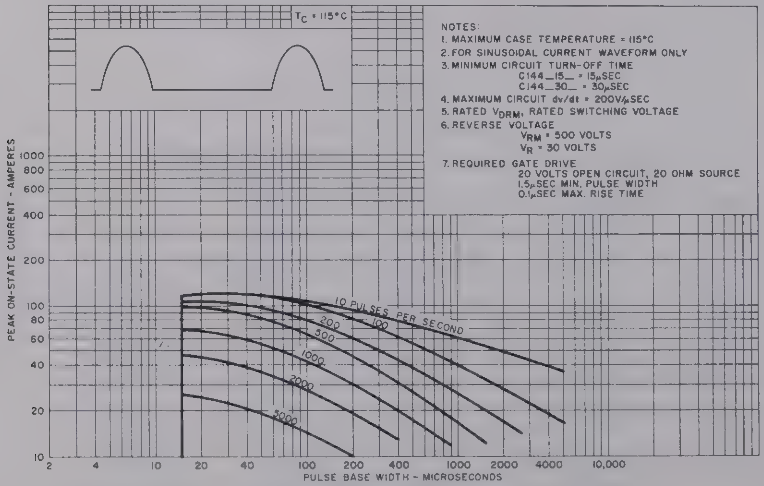
NOTES:
1. MAXIMUM CASE TEMPERATURE = 65°C
2. FOR SINUSOIDAL CURRENT WAVEFORM ONLY
3. MINIMUM CIRCUIT TURN-OFF TIME
C144_15_ = 15μSEC
C144_30_ = 30μSEC
4. MAXIMUM CIRCUIT dv/dt = 200V/μSEC
5. RATED V_{DRM}, RATED SWITCHING VOLTAGE
6. REVERSE VOLTAGE
V_{RM} = 500 VOLTS
V_R = 30 VOLTS
7. REQUIRED GATE DRIVE
20 VOLTS OPEN CIRCUIT, 20 OHM SOURCE
1.5μSEC MIN. PULSE WIDTH
0.1μSEC MAX. RISE TIME

8. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 65°C)



NOTES:
1. MAXIMUM CASE TEMPERATURE = 90°C
2. FOR SINUSOIDAL CURRENT WAVEFORM ONLY
3 MINIMUM CIRCUIT TURN-OFF TIME
C144_15_ = 15μSEC
C144_30_ = 30μSEC
4. MAXIMUM CIRCUIT dv/dt = 200 V/μSEC
5. RATED V_{DRM}, RATED SWITCHING VOLTAGE
6. REVERSE VOLTAGE
V_{RM} = 500 VOLTS
V_R = 30 VOLTS
7. REQUIRED GATE DRIVE
20 VOLTS OPEN CIRCUIT, 20 OHM SOURCE
1.5μSEC MIN. PULSE WIDTH
0.1μSEC MAX. RISE TIME

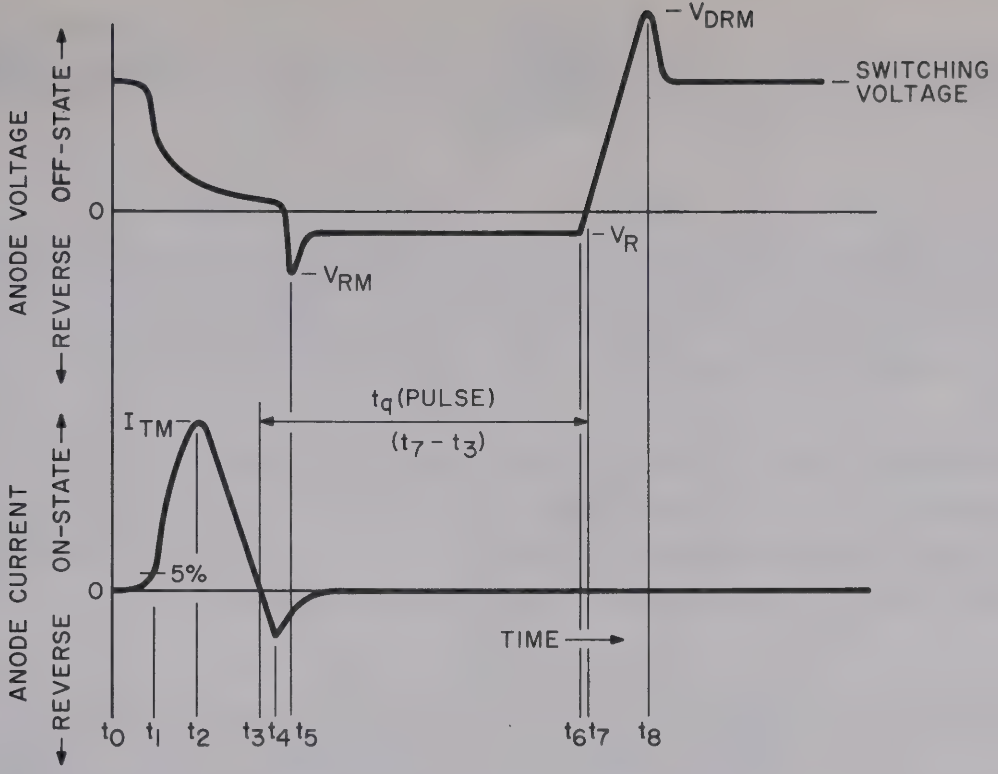
9. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 90°C)



NOTES:
1. MAXIMUM CASE TEMPERATURE = 115°C
2. FOR SINUSOIDAL CURRENT WAVEFORM ONLY
3. MINIMUM CIRCUIT TURN-OFF TIME
C144_15_ = 15μSEC
C144_30_ = 30μSEC
4. MAXIMUM CIRCUIT dv/dt = 200V/μSEC
5. RATED V_{DRM}, RATED SWITCHING VOLTAGE
6. REVERSE VOLTAGE
V_{RM} = 500 VOLTS
V_R = 30 VOLTS
7. REQUIRED GATE DRIVE
20 VOLTS OPEN CIRCUIT, 20 OHM SOURCE
1.5μSEC MIN. PULSE WIDTH
0.1μSEC MAX. RISE TIME

10. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 115°C)

Charts 8, 9 and 10 give the maximum value of peak on-state current at which the specified turn-off-time and dv/dt still apply.



11. WAVEFORMS FOR PULSE CIRCUIT-COMMUTATED TURN-OFF TIME TEST.

Specification Sheets

140.12	1N3879 Series (6 amp) Fast Recovery Diode
140.22	1N3889 Series (12 amp) Fast Recovery Diode
140.23	A28 Series (12 amp) Very Fast Recovery Diode
140.47	1N3899 Series (20 amp) Fast Recovery Diode
140.48	1N3909 Series (30 amp) Fast Recovery Diode
145.55	A96 Series (250 amp) Fast Recovery Diode
160.35	C140 Series (35A) 50-400V High Speed SCR
160.39	C144 Series (35A) 500-800V High Speed SCR
170.35	C154-7 Series (110 amp) High Speed SCR
170.36	C158, 9 Series (110 amp) High Speed SCR
170.37	C385 Series (250 amp) High Speed SCR
170.38	C358 Series (225A) High Speed SCR
170.42	C395 Series (550A) up to 600V, High Speed SCR
170.44	C388, C387 Series (550A) High Speed SCR
170.45	C398, C397 Series (700A) High Speed SCR
170.53	C185 Series (235 amp) High Speed SCR
170.57	C354, 5 Series (115 amp) High Speed SCR
170.76	C506 Series (625 amp) High Speed SCR
170.80	C510 Series (625 amp) High Speed SCR

Application Notes

200.38	"Application of Fast Recovery Rectifiers"
200.41	"Simple Circuits For Triggering SCR's Into Fast-Rising Load Currents"
200.42	"Commutation Behavior of Diffused High Current Rectifier Diodes"
200.49	"A Low Cost Ultrasonic Frequency Inverter Using A Single SCR"

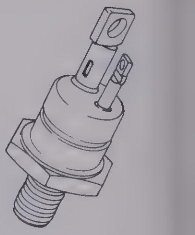
Technical Paper Reprints

660.13	"The Rating and Application of SCR's Designed for Switching at High Frequencies"
660.14	"Basic Magnetic Functions in Converters and Inverters Including New Soft Commutations"
660.15	"SCR Inverter Commutated By An Auxiliary Impulse"
660.16	"An SCR Inverter With Good Regulation and Sine Wave Output"

Seminar Notes

671.4	"The Widening World of The Fast Recovery Rectifier Diode"
671.15	"The Amplifying Gate SCR"

The General Electric C145 silicon controlled rectifier, considerably smaller in size than comparable high-power SCR's, is a compact device with outstanding dynamic characteristics and high voltage capability.



FEATURES:

- Maximum di/dt rating of 200 amps/μsec when switching from 600 V.
- Minimum dv/dt rating of 200 volts/μsec.
- Reduced package size, mounted on ¾ inch hex.
- High-voltage, high-current, and improved dynamic characteristics.

MAXIMUM ALLOWABLE RATINGS

Type	Repetitive Peak Off-State Voltage, V_{DRM} $T_C = -40°C$ to $+125°C$	Repetitive Peak Reverse Voltage $V_{RRM}^{(1)}$ $T_C = -40°C$ to $+125°C$	Non-repetitive Peak Reverse Voltage, $V_{RSM}^{(1)\,(2)}$ $T_C = -40°C$ to $+125°C$
C145E	500 Volts	500 Volts	600 Volts
C145M	600	600	720
C145S	700	700	840
C145N	800	800	960
C145T	900	900	1080
C145P	1000	1000	1200
C145PA	1100	1100	1320
C145PB	1200	1200	1440

(1) Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for which maximum V_{DRM} and maximum V_{RRM} ratings apply equals 1.3°C/watt.

(2) Half sine wave voltage pulse, 10 millisecond maximum duration.

RMS On-State Current, $I_{t(rms)}$ ....55 Amperes (all conduction angles)
Average On-State Current, $I_{T\ (AV)}$ ....Depends on conduction angle (see Charts 2 and 3)
Critical Rate-Of-Rise of On-State Current, di/dt:*
  Gate triggered operation ....(see Chart 10)
    Switching from 1200 volts ....100 Amperes per microsecon
    Switching from 600 volts ....200 Amperes per microsecon
  Breakover voltage triggered operation .... 20 Amperes per microsecon
Peak One Cycle Surge (non-rep) On-State Current, I_{TSM} ....700 Ampere
I^2t (for fusing), for times ≥ 1.0 milliseconds ....2000 Ampere² second
Peak Gate Power Dissipation, P_{GM} ....100 Watts for 150 microseconds (see Chart 7)
Average Gate Power Dissipation, $P_{G(AV)}$ ....2.0 Watt
Peak Negative Gate Voltage, V_{GM} ....10 Volt
Storage Temperature, T_{stg} ....−40°C to +125°C
Operating Temperature, T_J ....−40°C to +125°C
Maximum Stud Torque ....50 Lb-in (58 Kg-cm)

*di/dt rating is established in accordance with JEDEC Suggested Standard No. 7, Section 5.1.2.4. Off-state (blocking) voltag capability may be temporarily lost immediately after each current pulse for duration less than the period of the applied puls repetition rate. The pulse repetition rate for this test is 400 Hz. The duration of the JEDEC di/dt test condition is 5.0 second (minimum).

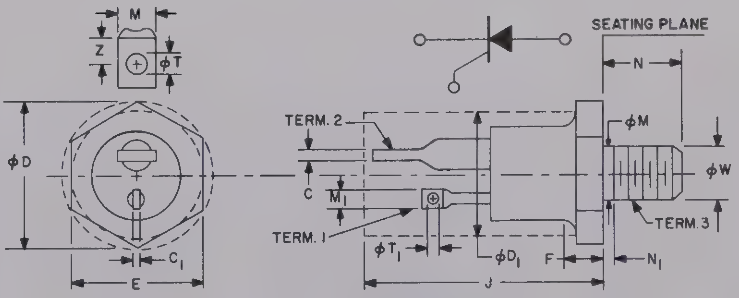
CHARACTERISTICS

Test	Symbol	Min.	Max.	Units	Test Conditions
Peak Off-State or Reverse Current*	I_{DRM} or I_{RRM}			mA	T_C = −40° to +125°C
C145E		—	10.0		$V_{DRM} = V_{RRM}$ = 500 Volts Peak
C145M		—	10.0		600
C145S		—	10.0		700
C145N		—	9.0		800
C145T		—	8.0		900
C145P		—	7.0		1000
C145PA		—	6.5		1100
C145PB		—	6.0		1200
D.C. Gate Trigger Current	I_{GT}	—	150	mAdc	T_C = 25°C, V_D = 12 Vdc, R_L = 12 ohms
		—	300	mAdc	T_C = −40°C, V_D = 12 Vdc, R_L = 12 ohms
D.C. Gate Trigger Voltage	V_{GT}	—	3.0	Vdc	T_C = 25°C, V_D = 12 Vdc, R_L = 12 ohms
		—	3.5	Vdc	T_C = −40°C, V_D = 12 Vdc, R_L = 12 ohms
		0.25	—	Vdc	T_C = +125°C, Rated V_{DRM}, R_L = 1000 ohms
Peak On-State Voltage	V_{TM}	—	2.4	Volts	T_C = +25°C, I_{TM} = 110 amperes peak, 1 millisecond wide pulse. Duty cycle ≦ 1%.
Holding Current	I_H	—	500	mAdc	T_C = +25°C, Anode Supply = 24 Vdc, Gate Supply = 10 V, 20 ohms, Initial Forward Current Pulse = 2.0 amperes, 0.1 millisecond to 10.0 milliseconds wide.
Critical Rate of Rise of Forward Blocking Voltage. (Higher values may cause device switching).	dv/dt	200	—	Volts/μsec	T_C = +125°C, Rated V_{DRM}, Gate open circuited.
Effective Thermal Resistance (DC)	Θ_{J-C}	—	0.4	°C/watt	

*Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for which maximum V_{DRM} and V_{RRM} ratings apply equals 1.3°C per watt.

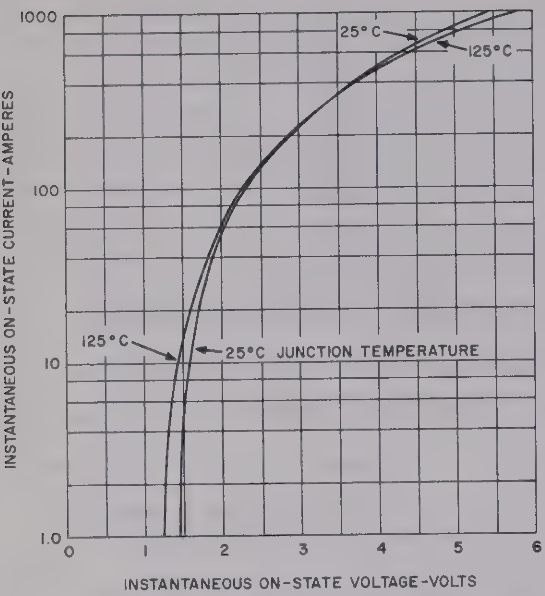
OUTLINE

(Conforms to JEDEC TO-103 Outline)

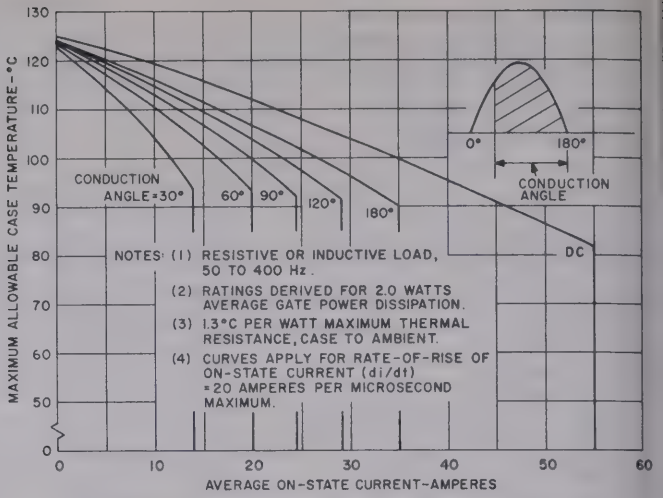


SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
C	.065	.100	1.66	2.54	1,7
C_1	.025	.075	.64	1.90	1,7
ØD	-	.866	-	21.99	
ØD_1	-	.728	-	18.49	2
E	.728	.750	18.50	19.05	
F	.125	.205	3.18	5.20	3
J	1.200	1.560	30.48	39.62	2
M	.220	.375	5.59	9.52	1,7
M_1	.125	.187	3.18	4.75	1,7
ØM	.280	.310	7.12	7.87	
N	.485	.515	12.32	13.08	
N_1	-	.100	-	2.54	4
ØT	.140	.155	3.56	3.93	
ØT_1	.050	.070	1.27	1.77	
ØW	.2806	.2854	7.127	7.249	5
Z	.140	-	3.56	-	6

NOTES:
1. CONTOUR AND ANGULAR ORIENTATION OF FIXED TERMINAL LUGS ARE UNDEFINED.
2. THE BODY AND TERMINALS OF THE DEVICE LIE WITHIN THE CYLINDER DEFINED BY ØD_1 AND LENGTH J.
3. A CHAMFER (OR UNDERCUT) ON ONE OR BOTH ENDS OF THE HEXAGONAL PORTION IS OPTIONAL.
4. LENGTH OF INCOMPLETE OR UNDERCUT THREADS OF ØM.
5. PITCH DIAMETER OF 5/16-24 UNF-2A (COATED) THREADS (ASA B1.1-1960)
6. MINIMUM FLAT.
7. POSITION OF TERMINALS 1 AND 2 IN RELATION TO HEXAGON IS NOT CONTROLLED.

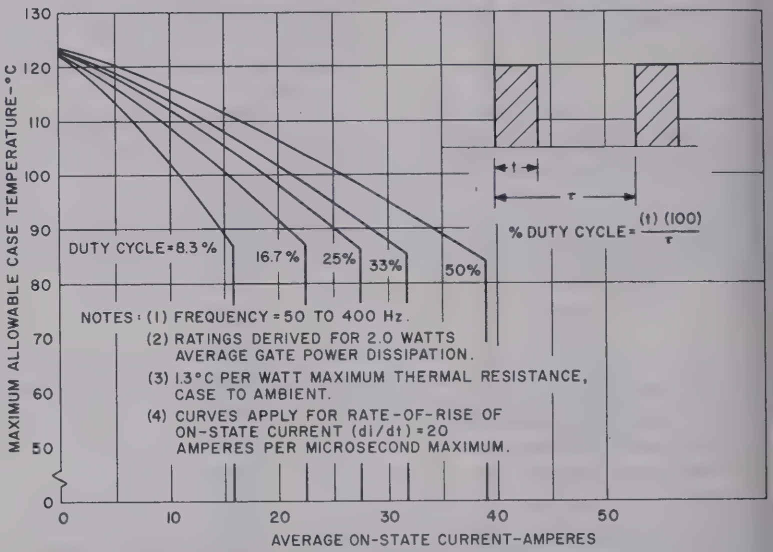


1. MAXIMUM ON-STATE CHARACTERISTICS



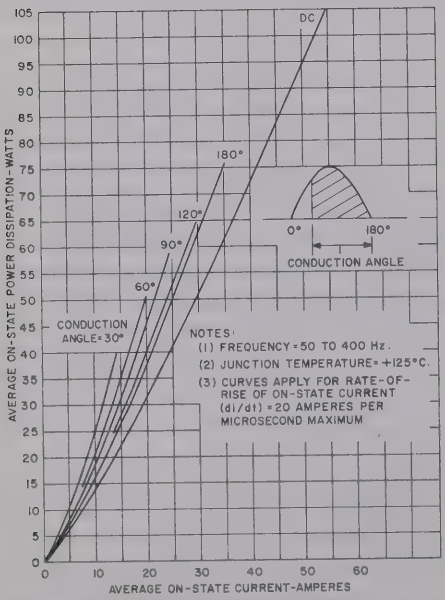
NOTES: (1) RESISTIVE OR INDUCTIVE LOAD, 50 TO 400 Hz.
(2) RATINGS DERIVED FOR 2.0 WATTS AVERAGE GATE POWER DISSIPATION.
(3) 1.3°C PER WATT MAXIMUM THERMAL RESISTANCE, CASE TO AMBIENT.
(4) CURVES APPLY FOR RATE-OF-RISE OF ON-STATE CURRENT (di/dt) =20 AMPERES PER MICROSECOND MAXIMUM.

2. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR HALF-WAVE RECTIFIED SINE WAVE OF CURRENT



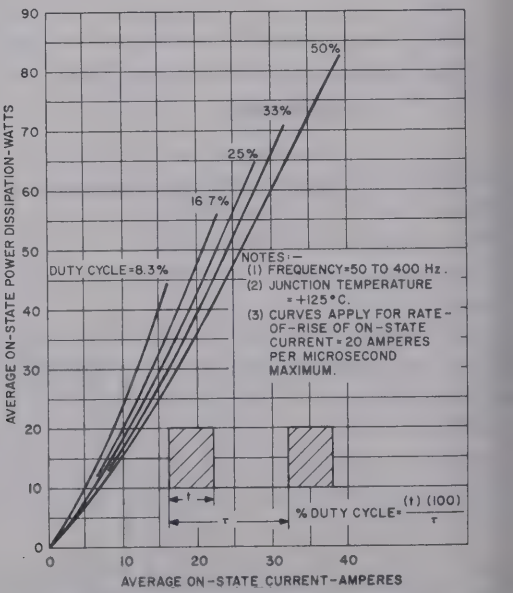
NOTES: (1) FREQUENCY = 50 TO 400 Hz.
(2) RATINGS DERIVED FOR 2.0 WATTS AVERAGE GATE POWER DISSIPATION.
(3) 1.3°C PER WATT MAXIMUM THERMAL RESISTANCE, CASE TO AMBIENT.
(4) CURVES APPLY FOR RATE-OF-RISE OF ON-STATE CURRENT (di/dt) = 20 AMPERES PER MICROSECOND MAXIMUM.

3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



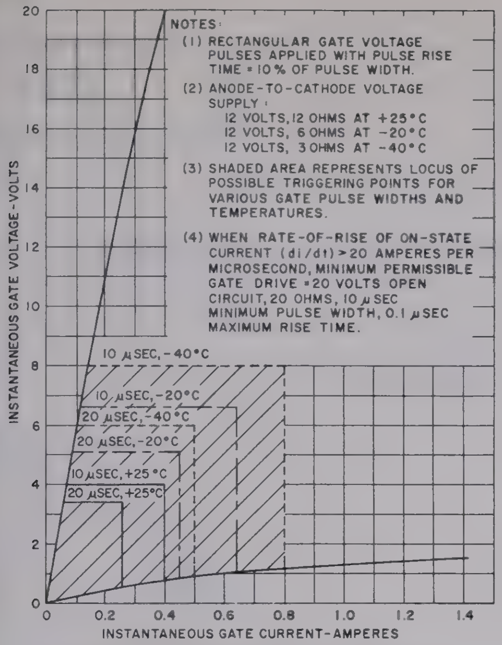
NOTES:
(1) FREQUENCY = 50 TO 400 Hz.
(2) JUNCTION TEMPERATURE = +125°C.
(3) CURVES APPLY FOR RATE-OF-RISE OF ON-STATE CURRENT (di/dt) = 20 AMPERES PER MICROSECOND MAXIMUM

4. MAXIMUM ON-STATE POWER DISSIPATION FOR HALF-WAVE RECTIFIED SINE WAVE OF CURRENT



NOTES:—
(1) FREQUENCY=50 TO 400 Hz.
(2) JUNCTION TEMPERATURE = +125°C.
(3) CURVES APPLY FOR RATE-OF-RISE OF ON-STATE CURRENT = 20 AMPERES PER MICROSECOND MAXIMUM.

5. MAXIMUM ON-STATE POWER DISSIPATION FOR REC-TANGULAR CURRENT WAVEFORM



NOTES:

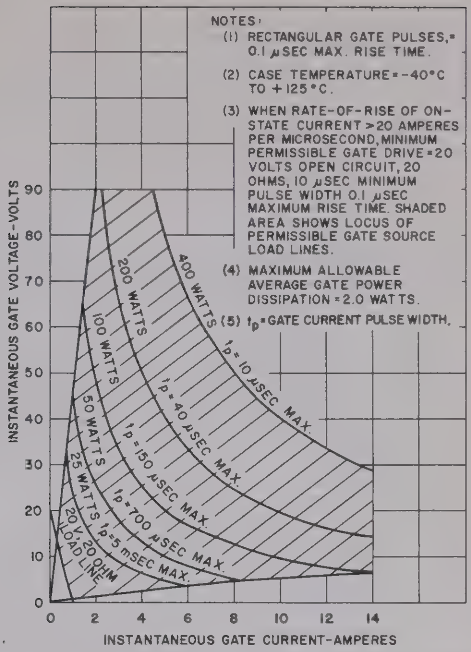
(1) RECTANGULAR GATE VOLTAGE PULSES APPLIED WITH PULSE RISE TIME = 10% OF PULSE WIDTH.

(2) ANODE-TO-CATHODE VOLTAGE SUPPLY:
12 VOLTS, 12 OHMS AT +25°C
12 VOLTS, 6 OHMS AT -20°C
12 VOLTS, 3 OHMS AT -40°C

(3) SHADED AREA REPRESENTS LOCUS OF POSSIBLE TRIGGERING POINTS FOR VARIOUS GATE PULSE WIDTHS AND TEMPERATURES.

(4) WHEN RATE-OF-RISE OF ON-STATE CURRENT (di/dt) > 20 AMPERES PER MICROSECOND, MINIMUM PERMISSIBLE GATE DRIVE = 20 VOLTS OPEN CIRCUIT, 20 OHMS, 10 μSEC MINIMUM PULSE WIDTH, 0.1 μSEC MAXIMUM RISE TIME.

6. PULSE GATE TRIGGER CHARACTERISTICS



NOTES:

(1) RECTANGULAR GATE PULSES, = 0.1 μSEC MAX. RISE TIME.

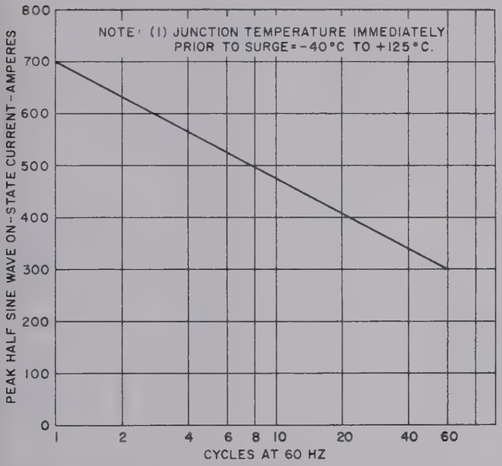
(2) CASE TEMPERATURE = -40°C TO +125°C.

(3) WHEN RATE-OF-RISE OF ON-STATE CURRENT > 20 AMPERES PER MICROSECOND, MINIMUM PERMISSIBLE GATE DRIVE = 20 VOLTS OPEN CIRCUIT, 20 OHMS, 10 μSEC MINIMUM PULSE WIDTH 0.1 μSEC MAXIMUM RISE TIME. SHADED AREA SHOWS LOCUS OF PERMISSIBLE GATE SOURCE LOAD LINES.

(4) MAXIMUM ALLOWABLE AVERAGE GATE POWER DISSIPATION = 2.0 WATTS.

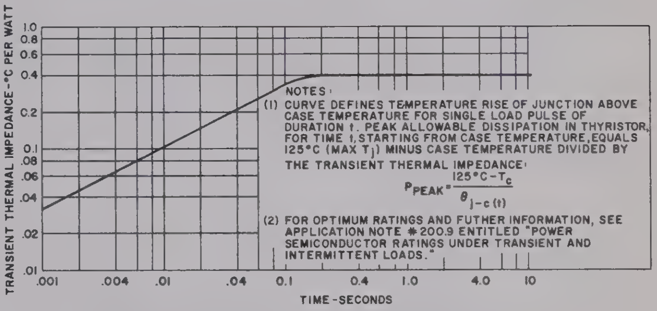
(5) t_p = GATE CURRENT PULSE WIDTH.

7. MAXIMUM ALLOWABLE PEAK GATE POWER DISSIPATION VS. GATE PULSE WIDTH



NOTE: (1) JUNCTION TEMPERATURE IMMEDIATELY PRIOR TO SURGE = -40°C TO +125°C.

8. MAXIMUM ALLOWABLE SURGE (NON-REPETITIVE) ON-STATE CURRENT



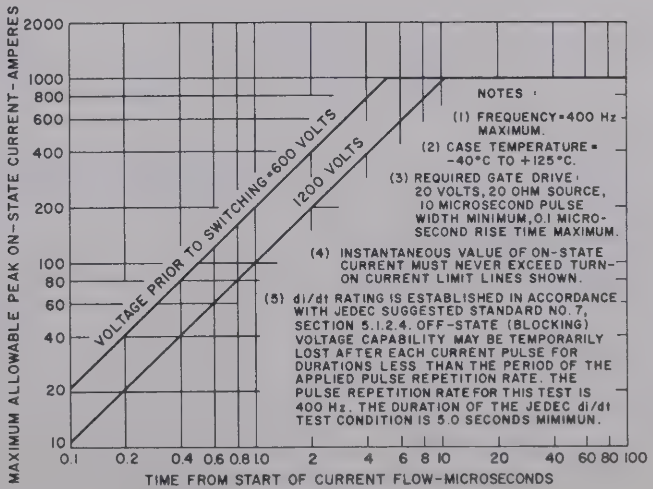
NOTES:

(1) CURVE DEFINES TEMPERATURE RISE OF JUNCTION ABOVE CASE TEMPERATURE FOR SINGLE LOAD PULSE OF DURATION t. PEAK ALLOWABLE DISSIPATION IN THYRISTOR, FOR TIME t, STARTING FROM CASE TEMPERATURE, EQUALS 125°C (MAX T_j) MINUS CASE TEMPERATURE DIVIDED BY THE TRANSIENT THERMAL IMPEDANCE:

$$P_{PEAK} = \frac{125°C - T_c}{\theta_{j-c(t)}}$$

(2) FOR OPTIMUM RATINGS AND FUTHER INFORMATION, SEE APPLICATION NOTE #200.9 ENTITLED "POWER SEMICONDUCTOR RATINGS UNDER TRANSIENT AND INTERMITTENT LOADS."

9. MAXIMUM TRANSIENT THERMAL IMPEDANCE, JUNCTION TO CASE



NOTES:

(1) FREQUENCY = 400 Hz MAXIMUM.

(2) CASE TEMPERATURE = -40°C TO +125°C.

(3) REQUIRED GATE DRIVE: 20 VOLTS, 20 OHM SOURCE, 10 MICROSECOND PULSE WIDTH MINIMUM, 0.1 MICROSECOND RISE TIME MAXIMUM.

(4) INSTANTANEOUS VALUE OF ON-STATE CURRENT MUST NEVER EXCEED TURN-ON CURRENT LIMIT LINES SHOWN.

(5) di/dt RATING IS ESTABLISHED IN ACCORDANCE WITH JEDEC SUGGESTED STANDARD NO. 7, SECTION 5.1.2.4. OFF-STATE (BLOCKING) VOLTAGE CAPABILITY MAY BE TEMPORARILY LOST AFTER EACH CURRENT PULSE FOR DURATIONS LESS THAN THE PERIOD OF THE APPLIED PULSE REPETITION RATE. THE PULSE REPETITION RATE FOR THIS TEST IS 400 Hz. THE DURATION OF THE JEDEC di/dt TEST CONDITION IS 5.0 SECONDS MIMIMUN.

10. TURN-ON CURRENT LIMIT

SCR

C147

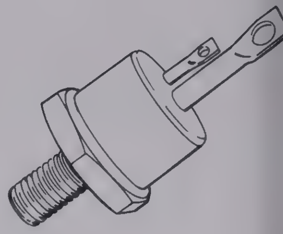
Prelim

63 RMS max. 100 to 1200 Volts 125°C max. Junction Temperature

The General Electric C147 silicon controlled rectifier, considerably smaller in size than comparable high-power SCR;s, is a compact device with outstanding dynamic characteristics and high voltage capability.

FEATURES:

- Reduced package size, ¼-28 stud
- Rugged hermetic seal
- Higher Surge and I²t capability
- Minimum dv/dt rating of 200 volts/usec.
- High-voltage, high-current and excellent dynamic characteristics



MAXIMUM ALLOWABLE RATINGS

Type	Repetitive Peak Off-State Voltage, V_{DRM} T_C = -40°C to + 125°C	Repetitive Peak Reverse Voltage V_{RRM} (1) T_C = -40°C to + 125°C	Non-repetitive Peak Reverse Voltage, V_{RSM} (1) (2) T_C = -40°C to + 125°C
C147A	100 Volts	100 Volts	150 Volts
C147B	200	200	300
C147C	300	300	400
C147D	400	400	500
C147E	500	500	600
C147M	600	600	720
C147S	700	700	840
C147N	800	800	960
C147T	900	900	1080
C147P	1000	1000	1200
C147PA	1100	1100	1320
C147PB	1200	1200	1440

(1) Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for which maximum V_{DRM} and maximum V_{RRM} ratings apply equals 1.3°C/watt.

(2) Half sine wave voltage pulse, 10 millisecond maximum duration.

RMS On-State Current, $I_{t(rms)}$ . . . . 63 Amperes (all conduction angles)
Average On-State Current, $I_{T\,(AV)}$ . . . . Depends on conduction angle
Breakover voltage triggered operation . . . . 20 Amperes per microsecond
Peak One-Cycle Surge (non-rep) On-State Current, I_{TSM} . . . . 1000 Amperes
I^2t (for fusing), for times $\geq$ 8.3 milliseconds . . . . 4000 Ampere² seconds
Peak Gate Power Dissipation, P_{GM} . . . . 100 Watts for 150 Microseconds
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 2.0 Watts
Peak Negative Gate Voltage, V_{GM} . . . . 10 Volts
Storage Temperature, T_{stg} . . . . —40°C to +125°C
Operating Temperature, T_J . . . . —40°C to +125°C
Maximum Stud Torque . . . . (30 Lb.-in-35 Kgcm)

*di/dt rating is established in accordance with JEDEC Suggested Standard No. 7, Section 5.1.2.4. Off-State (blocking) voltage capability may be temporarily lost immediately after each current pulse for duration less than the period of the applied pulse repetition rate. The pulse repetition rate for this test is 400 Hz. The duration of the JEDEC di/dt test condition is 5.0 seconds (minimum).

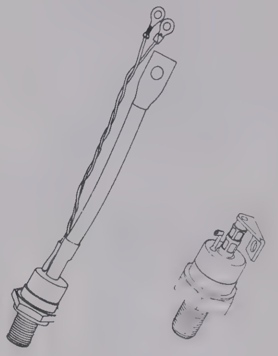
SCR

C150,1,2,3

The C150, C151, C152 and C153, 1300 volt 110 amp. series are new SCR'S Developed by the General Electric Company for use in industrial and military applications where high voltage and high performance are required. These SCR's feature:

- guaranteed minimum dv/dt (200 V / sec)
- guaranteed value of di/dt
- no PFV limit (1)

(1) These devices may be turned on in the forward direction by exceeding the breakover voltage (V FOM) with either a rapidly, or slowly rising wave form. This has been confirmed in the laboratory by using a 3 kv. open circuit voltage, a 4 amp. short circuit current, 0.1 sec. risetime supply, and a 60 cycle half-wave sine voltage waveform.



MAXIMUM ALLOWABLE RATINGS

TYPE	PEAK FORWARD BLOCKING VOLTAGE, V_{FOM} (2) $T_C = -40°C$ to $+120°C$	REPETITIVE PEAK REVERSE VOLTAGE, V_{ROM} (rep) (2) $T_C = -40°C$ to $+120°C$	TRANSIENT PEAK REVERSE VOLTAGE (Non-recurrent <5 Millisec.) V_{ROM} (non-rep) $T_C = -40°C$ to $+120°C$
C150, C151, C152, C153E	500 Volts	500 Volts	600 Volts
C150, C151, C152, C153M	600	600	720
C150, C151, C152, C153S	700	700	850
C150, C151, C152, C153N	800	800	950
C150, C151, C152, C153T	900	900	1075
C150, C151, C152, C153P	1000	1000	1200
C150, C151, C152, C153PA	1100	1100	1325
C150, — C152, — PB	1200	1200	1450
C150, — C152, — PC	1300	1300	1550

(2) Ratings apply for zero or negative gate voltage. Maximum heatsink thermal resistance for which maximum PRV ratings apply equal 1.1°C/watt.

*Supersedes ZJ260 Advance Specification 170.23 1/64.

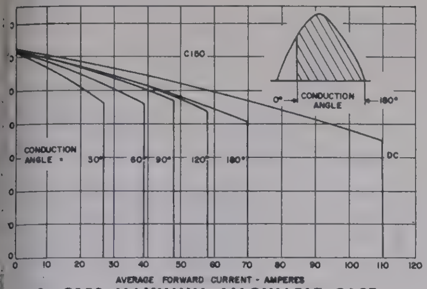
RMS Forward Current, On State		110 amperes (all conduction angles)
Average Forward Current, On State		Depends on conduction angle (See charts 1,4,7 &10)
Peak One-Cycle Surge Forward Current, I_{FM}(surge)	C151, C153	1000 amperes
	C150, C152	1500 amperes
Maximum Rate of Rise of Anode Current During Turn-On Interval (High Gate Drive Required, See chart 37)	E—P	75 amps/μsec
	PA—PC	50 amps/μsec
I^2t (for fusing) for times ≦ 1.5 milliseconds	C151, C153	4000 amp² secs
	C150, C152	7000 amp² secs
Peak Gate Power Dissipation, P_{GM}		10 Watts
Average Gate Power Dissipation, $P_{G(AV)}$		2 Watts
Peak Forward Gate Voltage, V_{GFM}		40 Volts
Peak Reverse Gate Voltage, V_{GRM}		5 Volts
Storage and Operating Temperature, T_J		−40°C to +125°C
Stud Torque		125 Lbs.-in. (min.), 150 Lbs.-in. (max.) 150 Kg.-cm. (min.), 175 Kg.-cm. (max.)

CHARACTERISTICS

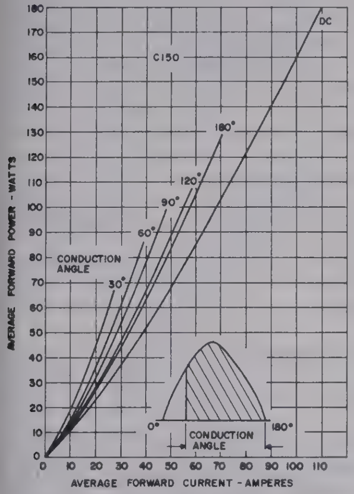
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Peak Reverse and Forward Blocking Current	I_{ROM} and I_{FOM}				ma	$T_C = +25°C$
C150, C151, C152, C153E		—	3	10		$V_{FOM} = V_{ROM} =$ 500 Volts peak
C150, C151, C152, C153M		—	3	10		600 Volts peak
C150, C151, C152, C153S		—	3	10		700 Volts peak
C150, C151, C152, C153N		—	3	10		800 Volts peak
C150, C151, C152, C153T		—	3	9		900 Volts peak
C150, C151, C152, C153P		—	3	7		1000 Volts peak
C150, C151, C152, C153PA		—	3	7		1100 Volts peak
C150, — C152, — PB		—	3	6		1200 Volts peak
C150, — C152, — PC		—	3	5		1300 Volts peak
Peak Reverse and Forward Blocking Current	I_{ROM} and I_{FOM}				ma	$T_C = 120°C$
C150, C151, C152, C153E		—	15	20		$V_{FOM} = V_{ROM} =$ 500 Volts peak
C150, C151, C152, C153M		—	15	20		600 Volts peak
C150, C151, C152, C153S		—	15	20		700 Volts peak
C150, C151, C152, C153N		—	15	20		800 Volts peak
C150, C151, C152, C153T		—	15	18		900 Volts peak
C150, C151, C152, C153P		—	12	15		1000 Volts peak
C150, C151, C152, C153PA		—	11	14		1100 Volts peak
C150, — C152, — PB		—	10	13		1200 Volts peak
C150, — C152, — PC		—	8	11		1300 Volts peak
Effective Thermal Resistance	θ_{J-C}	—	.2	.3	°C/watt	Junction to case (DC)
Critical Exponential Rate of Rise of Forward Blocking Voltage (Higher values may cause device switching)	dv/dt	200	500	—	V/μsec	V_{FOM} = Rated, $T_C = +120°C$, Gate open. $dv/dt = \frac{(V_{FOM})\ (.632)}{\tau}$.
Holding Current	I_{HO}	—	20	500	mAdc	$T_C = +25°C$, Anode supply = 24Vdc. Initial forward current = 2 amps.
Turn-On Time (Delay Time + Rise Time)	$t_d + t_r$	—	8	—	μsec	$T_C = +25°C$, I_F = 50Adc, V_{FXM} = Rated. Gate supply: 10 volt open circuit, 20 ohm, 0.1 μsec max. rise time.
Gate Pulse Width Necessary to Trigger		—	8	10	μsec	$T_C = +25°C$. Gate supply: 5 volt open circuit, 5 ohm, 0.1 μsec rise time.
Gate Trigger Current	I_{GT}	—	50	150	mAdc	$T_C = +25°C$, V_{FX} = 6Vdc, R_L = 12 ohms.
		—	75	200	mAdc	$T_C = -40°C$, V_{FX} = 6Vdc, R_L = 12 ohms.
		—	15	125	mAdc	$T_C = +120°C$, V_{FX} = 6Vdc, R_L = 12 ohms.
Gate Trigger Voltage	V_{GT}	—	1.25	3.0	Vdc	$T_C = -40°C$ to $+120°C$, V_{FX} = 6Vdc, R_L = 12 ohms.
		0.15	—	—	Vdc	$T_C = +120°C$, V_{FX} = Rated, R_L = 1000 ohms.
Peak On-Voltage	V_{FM}				Volts	$T_C = +25°C$, I_{FM} = 500A peak. Duty cycle ≦ .01%
C150, C152		—	2.0	2.6		
C151, C153		—	2.8	3.5		
Circuited Commutated Turn-Off Time**	t_{off}				μsec	(1) $T_C = +120°C$, (2) I_{FM} = 50A, (3) V_{rx} = 50 volts min., (4) V_{FXM} (reapplied) = Rated, (5) Rate of rise of reapplied forward blocking voltage = 20V/μsec linear.
C150, C152	t_{off}	—	100	—†		
C151, C153		—	30	50		

†Consult Factory if guaranteed Turn-Off Time is required

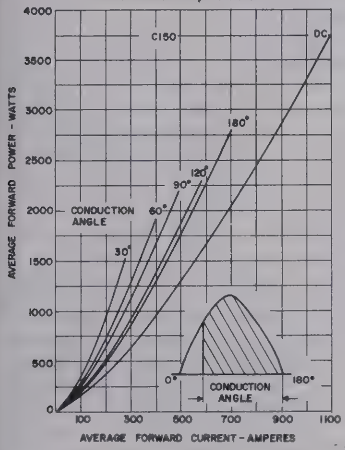
**Typical Turn-Off Time increases 30%, if I_{FM} is increased to 500A.



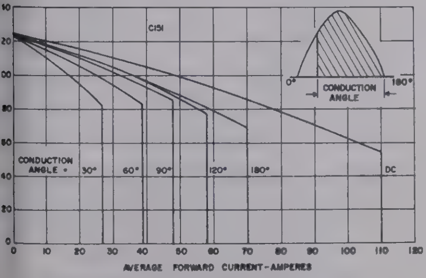
1. C150 MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM, 50 TO 400 CPS



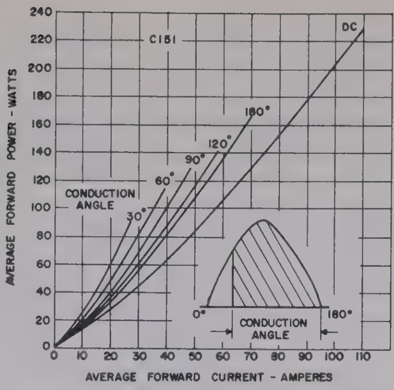
2. AVERAGE FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM, C150



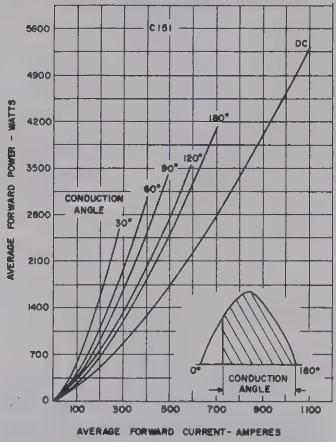
3. EXTENDED FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM, C151



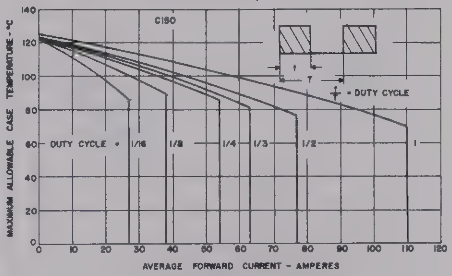
4. C151 MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM, 50 TO 400 CPS



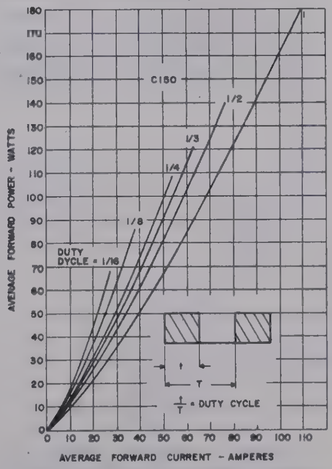
5. AVERAGE FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM, C151



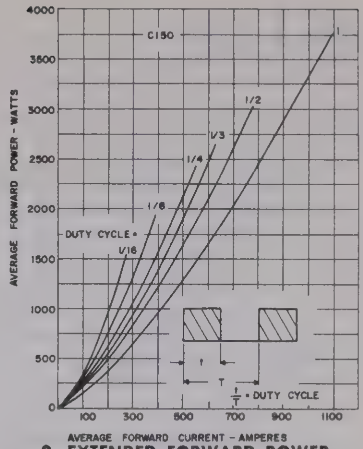
6. EXTENDED FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM, C151



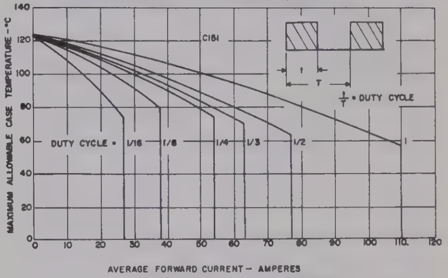
7. C150 MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM, 50 TO 400 CPS



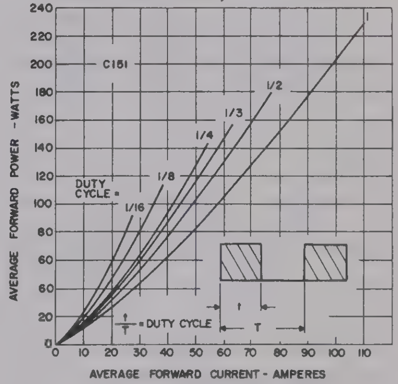
8. AVERAGE FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM, C151



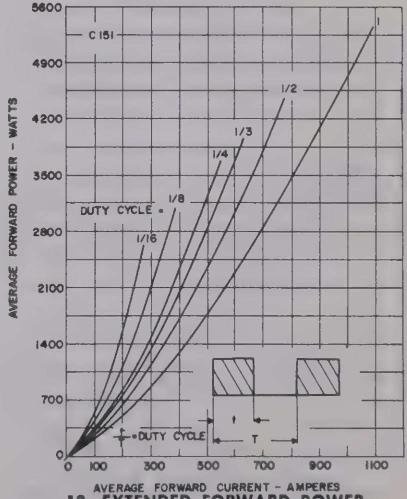
9. EXTENDED FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM, C151



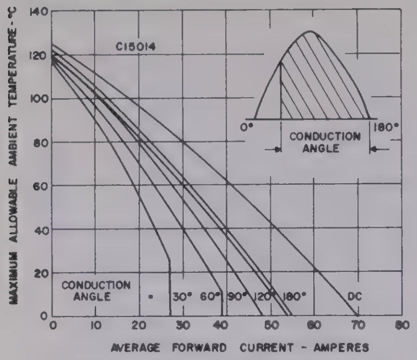
10. C151 MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM, 50 TO 400 CPS



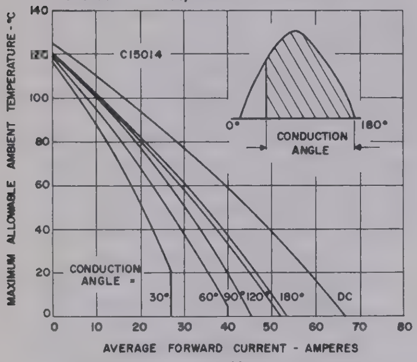
11. AVERAGE FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM, C151



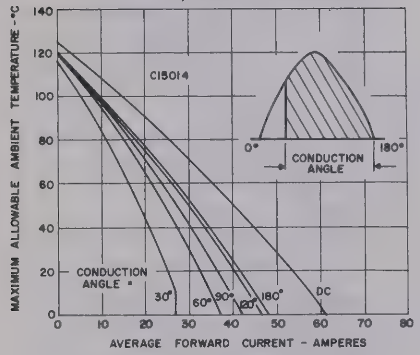
12. EXTENDED FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM, C151



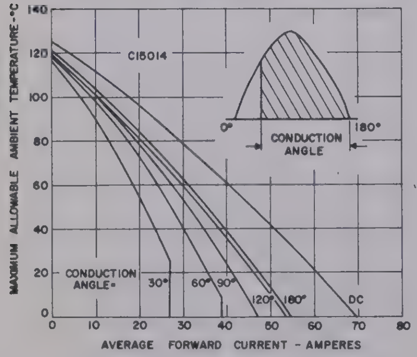
13. C15014 MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM, 50 TO 400 CPS, 1 AND 2 FIN, FREE CONVECTION



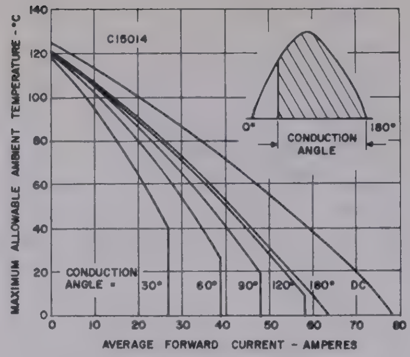
14. C15014 MAXIMUM ALLOWABLE AMBIENT TEMPERATURE OR SINUSOIDAL CURRENT WAVEFORM, 50 TO 400 CPS, 3 AND 4 FIN, FREE CONVECTION



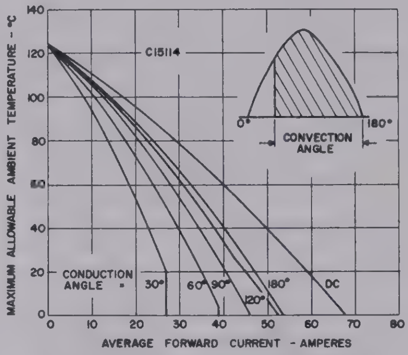
15. C15014 MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM, 50 TO 400 CPS, 5 AND 6 FIN, FREE CONVECTION



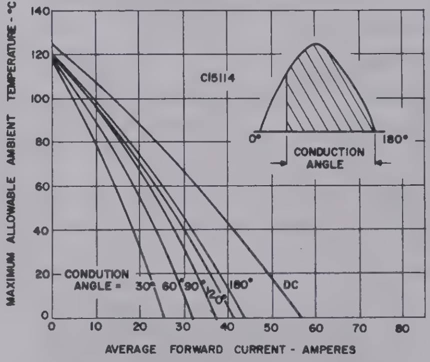
16. C15014 MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM, 50 TO 400 CPS, 1-6 FINS, 300 LFPM



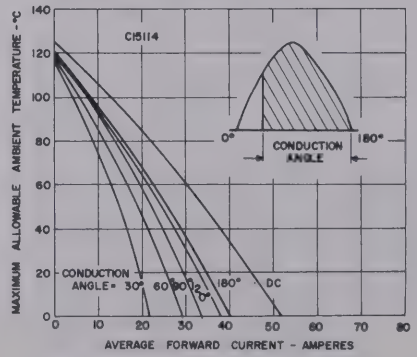
17. C15014 MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM, 50 TO 400 CPS, 1-6 FINS, 1000 LFPM



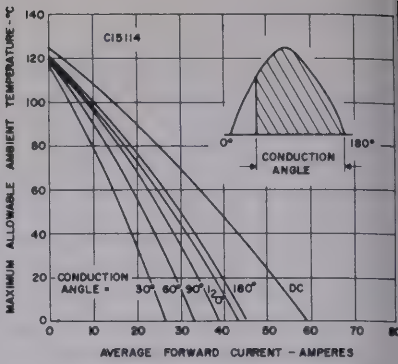
18. C15114 MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM, 50 TO 400 CPS, 1 AND 2 FIN, FREE CONVECTION



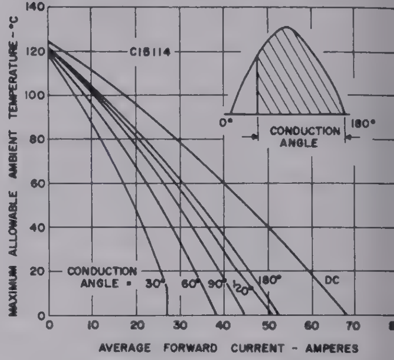
19. C15114 MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM, 50 TO 400 CPS, 3 AND 4 FIN, FREE CONVECTION



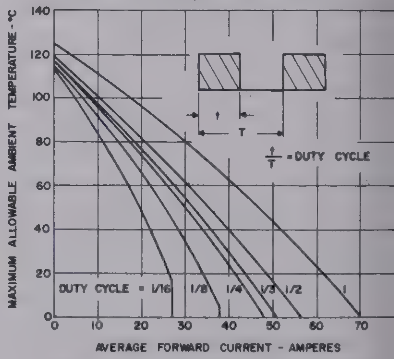
20. C15114 MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM, 50 TO 400 CPS, 5 AND 6 FIN, FREE CONVECTION



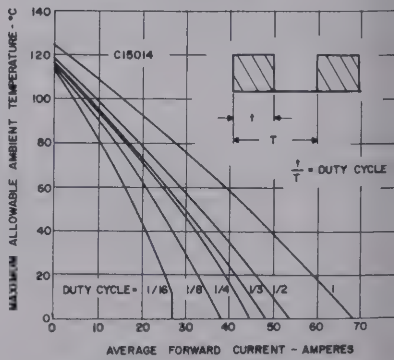
21. C15114 MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM, 50 TO 400 CPS, 1-6 FINS, 300 LFPM



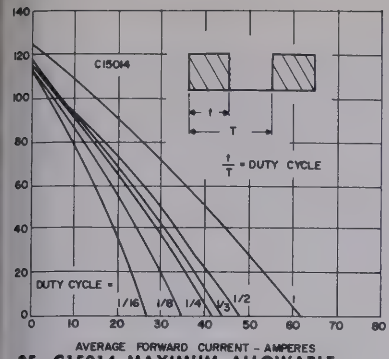
22. C15114 MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM, 50 TO 400 CPS, 1-6 FINS, 1000 LFPM



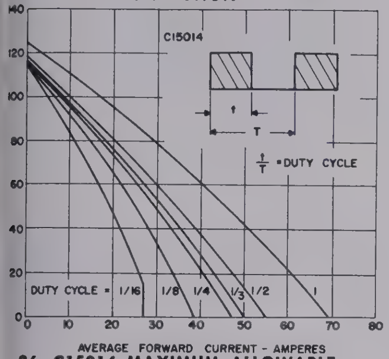
23. C15014 MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM, 50 TO 400 CPS, 1 AND 2 FIN, FREE CONVECTION



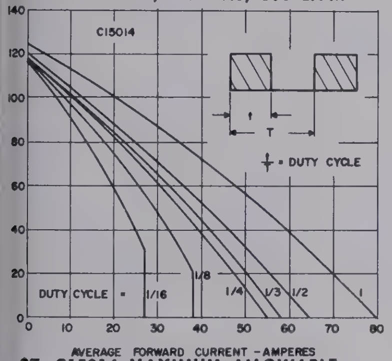
24. C15014 MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM, 50 TO 400 CPS, 3 AND 4 FIN, FREE CONVECTION



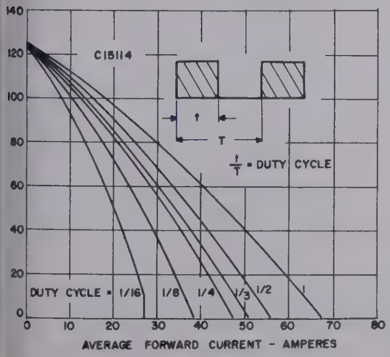
25. C15014 MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM, 50 TO 60 CPS, 5 AND 6 FIN, FREE CONVECTION



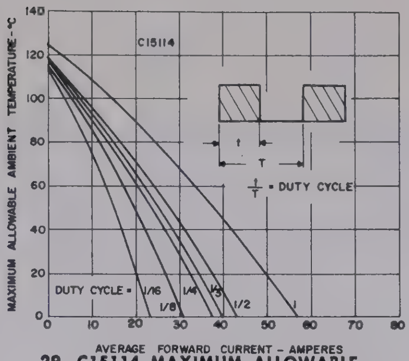
26. C15014 MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM, 50 TO 400 CPS, 1-6 FINS, 300 LFPM



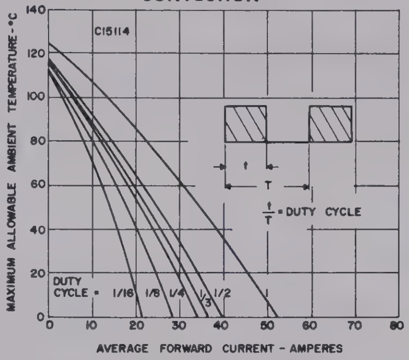
27. C15014 MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM, 50 TO 400 CPS, 1-6 FINS, 1000 LFPM



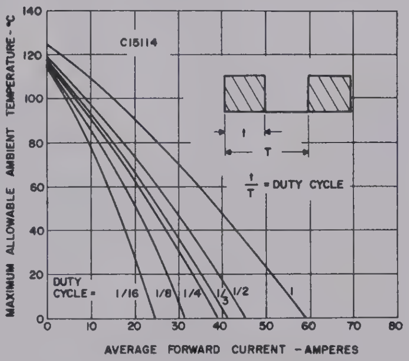
28. C15114 MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM, 50 TO 400 CPS, 1 AND 2 FIN, FREE CONVECTION



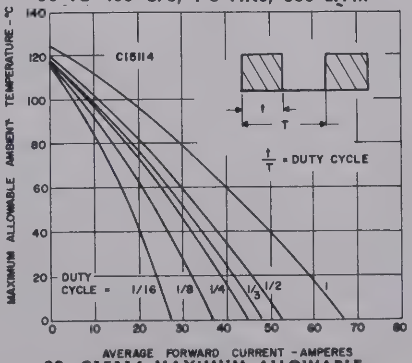
29. C15114 MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM, 50 TO 400 CPS, 3 AND 4 FIN, FREE CONVECTION



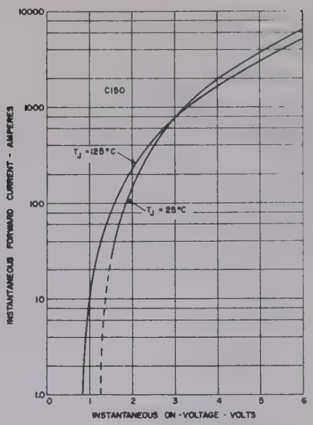
30. C15114 MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM, 50 TO 400 CPS, 5 AND 6 FIN, FREE CONVECTION



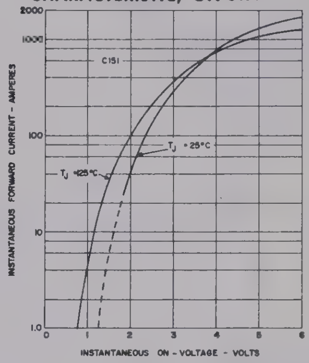
31. C15114 MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM, 50 TO 400 CPS, 1-6 FINS, 300 LFPM



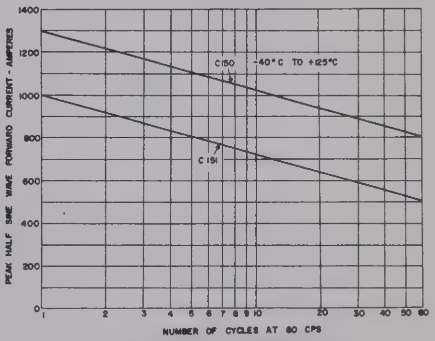
32. C15114 MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM, 50 TO 400 CPS, 1-6 FINS, 1000 LFPM



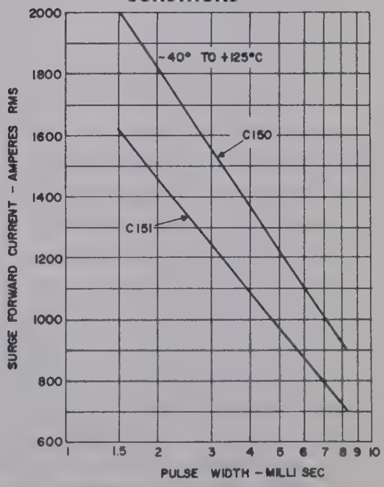
33. C150 FORWARD CONDUCTION CHARACTERISTIC, ON-STATE



34. C151 FORWARD CONDUCTION CHARACTERISTIC, ON-STATE

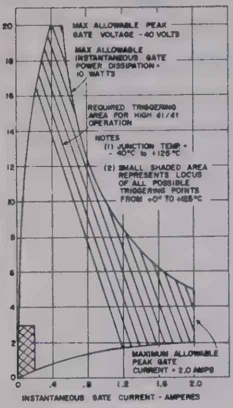


35. MAXIMUM ALLOWABLE SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS

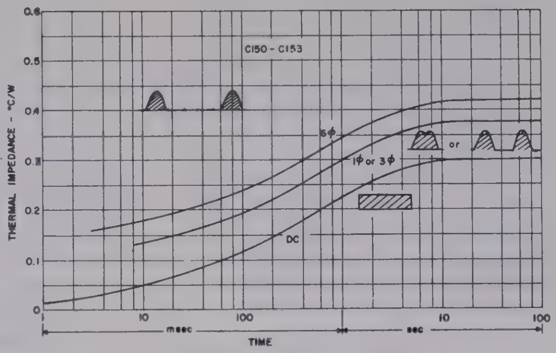


36. SUB-CYCLE SURGE RATING FOLLOWING RATED LOAD CONDITIONS

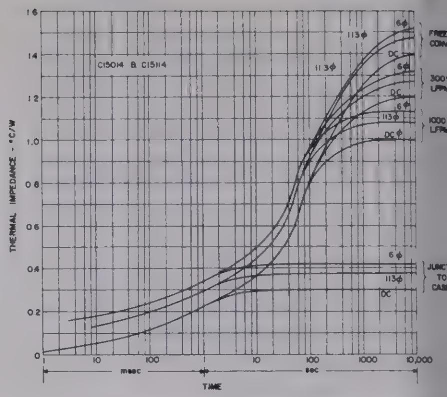
C150,1,2,3



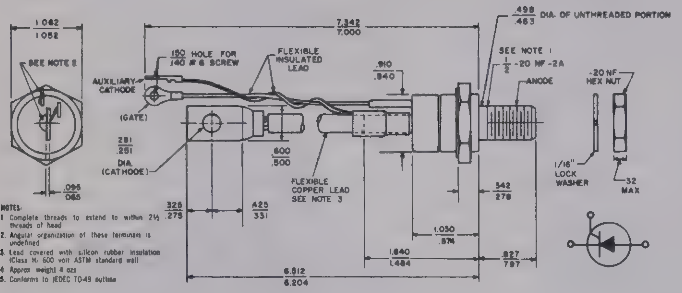
37. GATE TRIGGERING CHARACTERISTICS



38. TRANSIENT THERMAL IMPEDANCE, JUNCTION TO CASE



39. TRANSIENT THERMAL IMPEDANCE, JUNCTION TO AMBIENT, 5 AND 6 FIN CONFIGURATION

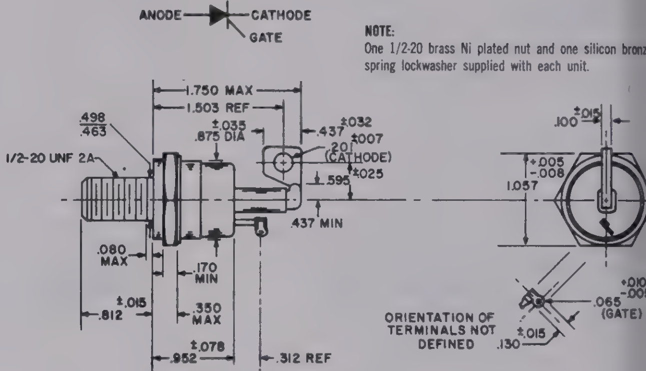

1.062
1.052
SEE NOTE 2
7.342
7.000
.150 HOLE FOR .140 #6 SCREW
FLEXIBLE INSULATED LEAD
AUXILIARY CATHODE
(GATE)
.281
.251
DIA (CATHODE)
.910
.840
.600
.500
FLEXIBLE COPPER LEAD SEE NOTE 3
.498
.463
DIA. OF UNTHREADED PORTION
SEE NOTE 1
1/2 -20 NF -2A
ANODE
-20 NF HEX NUT
1/16" LOCK WASHER
.32 MAX
.095
.085
.328
.275
.425
.331
.342
.278
1.030
.874
1.640
1.484
.827
.797
6.512
6.204

NOTES:
1. Complete threads to extend to within 2½ threads of head
2. Angular organization of these terminals is undefined
3. Lead covered with silicon rubber insulation (Class H, 600 volt ASTM standard wall
4. Approx weight 4 ozs
5. Conforms to JEDEC TO-49 outline

C150, C151

INCHES	MILLIMETERS
.080 ± .015	2.032 ± .381
.145 ± .005	3.683 ± .128
.170 min.	4.318 min.
.250 typ.	6.350 typ.
.266 ± .015	6.756 ± .381
.290 typ.	7.366
.300 ± .025	7.620 ± .635
.310 ± .032	7.874 ± .814
.550 ± .050	13.970 ± 1.270
.642 ± .046	16.306 ± 1.169
.678 ± .046	17.221 ± 1.169
.812 ± .015	20.624 ± .381
.875 ± .035	22.225 ± .890
$1.062\ {}^{+.000}_{-.010}$	$26.975\ {}^{+.000}_{-.255}$
1.562 ± .078	39.674 ± 1.982
4.530 ± .093	115.061 ± 2.363
6.358 ± .154	161.531 ± 3.912
7.171 ± .171	182.143 ± 4.344

NOTE — one ½-20 brass N_1 plated nut & one silicon bronze spring lockwasher supplied with each unit.


ANODE
CATHODE
GATE
1.750 MAX
1.503 REF
.498
.463
±.035 .875 DIA
.437 ±.032
.201 ±.007 (CATHODE)
.595 ±.025
1/2-20 UNF 2A
.437 MIN
.080 MAX
.170 MIN
±.015 .812
.350 MAX
±.078 .952
.312 REF
ORIENTATION OF TERMINALS NOT DEFINED
.100 ±.015
+.005 -.008
1.057
.065
(GATE)
±.015 .130

NOTE:
One 1/2-20 brass Ni plated nut and one silicon bronz
spring lockwasher supplied with each unit.

C152, C153

INCHES	MILLIMETERS
$.065\ {}^{+.010}_{-.005}$	$1.651\ {}^{+.254}_{-.127}$
.080 max.	2.032 max.
.100 ± .015	2.540 ± .381
.130 ± .015	3.302 ± .382
.170 min.	4.317
.201 ± .007	5.105 ± .178
.312 Ref.	7.925 Ref.
.350 max.	8.890 max.
.375 min.	9.524 min.
.437 ± .032	11.099 ± .813
.463	11.760
.498	12.649
.595 ± .025	15.112 ± .610
.812 ± .015	20.624 ± .381
.875 ± .035	22.225 ± .890
.952 ± .078	24.181 ± 1.981
$1.057\ {}^{+.005}_{-.008}$	$26.848\ {}^{+.127}_{-.204}$
1.503 Ref.	38.176 Ref.
1.750 max.	44.450 max.

HIGH SPEED
Silicon Controlled Rectifier

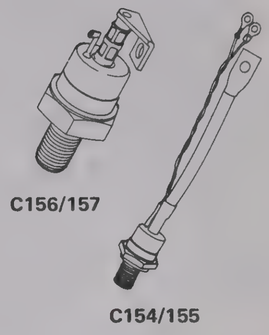
600 Volts **120 A RMS**

C154, C156
C155, C157

The General Electric C154, C155 Series of Silicon Controlled Rectifiers are reverse blocking triode thyristors designed primarily for power switching from 60–1000 Hz. This rugged SCR has been proven by 6 years field experience in applications like Battery Vehicle choppers, PWM motor controls, uninterruptible power supplies, and inverters.

For efficient operation in high speed applications, the C154/C155 SCR provides a superior mix of capabilities:

- Forward and reverse blocking voltage to 600 volts
- 10 μsec turn-off-time maximum (C154) with shorter turn-off-times available from factory on special request
- High di/dt and dv/dt at rated frequency
- Low switching losses



MAXIMUM ALLOWABLE RATINGS

Types	Repetitive Peak Off-State Voltage, V_{DRM} $T_C = -40°C$ to $+125°C$	Repetitive Peak Reverse Voltage, V_{RRM}(1) $T_C = -40°C$ to $+125°C$	Non-repetitive Peak Reverse Voltage, V_{RRM}(1)(2) $T_C = -40°C$ to $+125°C$
C154A, C155A, C156A, C157A	100 Volts	100 Volts	200 Volts
C154B, C155B, C156B, C157B	200	200	300
C154C, C155C, C156C, C157C	300	300	400
C154D, C155D, C156D, C157D	400	400	500
C154E, C155E, C156E, C157E	500	500	600
C155M, C157M	600	600	650

(1) Ratings apply for zero or negative gate voltage. Maximum case to ambient thermal resistance for which maximum V_{DRM} and maximum V_{RRM} ratings apply equals 1.1°C/watt.
(2) Half sine wave voltage pulse. 10 millisecond maximum duration.

Peak Positive Anode Voltage	None*
RMS On-State Current, $I_{t(rms)}$	110 Amperes
Average On-State Current, $I_{T(AV)}$	(See Charts)
Peak One Cycle Surge (non-rep) On-State Current, I_{TSM}	1,800 Amperes
I^2t (for fusing) for times $\geqq$ 1.5 milliseconds	9,500 Ampere^{2}seconds
I^2t (for fusing) for times $\geqq$ 8.3 milliseconds	13,000 Ampere^{2}seconds
Critical Rate-of-Rise of On-State Current, di/dt, During Turn-On Interval	100 Amperes per microsecond**
Peak Gate Power Dissipation, P_{GM} . . . (Pulse Width = 10 μsec)	400 Watts
Average Gate Power Dissipation, $P_{G(AV)}$	2 Watts
Peak Negative Gate Voltage, V_{GM}	20 Volts
Storage Temperature, T_{stg}	−40°C to +125°C
Operating Temperature, T_J	−40°C to +125°C
Stud Torque	150 Lb-in (Max), 125 Lb-in (Min) 175 Kg-cm (Max), 150 Kg-cm (Min)

* This SCR may be, non-repetitively, turned-on in the forward direction by exceeding the breakover voltage (V_{DRM}) with either a rapidly or slowly rising waveform. At breakover, di/dt must be limited to 20 amps/μsec and peak current to 1000 amperes.

** Required trigger source–20 volts, 20 ohms; maximum switching voltage–V_{DRM}: short-circuit gate supply current risetime–0.25 μsec. (This short-circuit current may be measured with a TEKTRONICS current probe.) RC Snubber circuit used across SCR–(see Figure 6).

di/dt rating is established in accordance with JEDEC Suggested Standard No. 7, Section 5.1.2.4. Immediately after each current pulse, off-state (blocking) voltage capability may be temporarily lost for durations less than the period of the applied pulse repetition rate. The pulse repetition rate for this test is 400 Hz. The duration of the JEDEC di/dt test condition is 5.0 seconds (minimum).

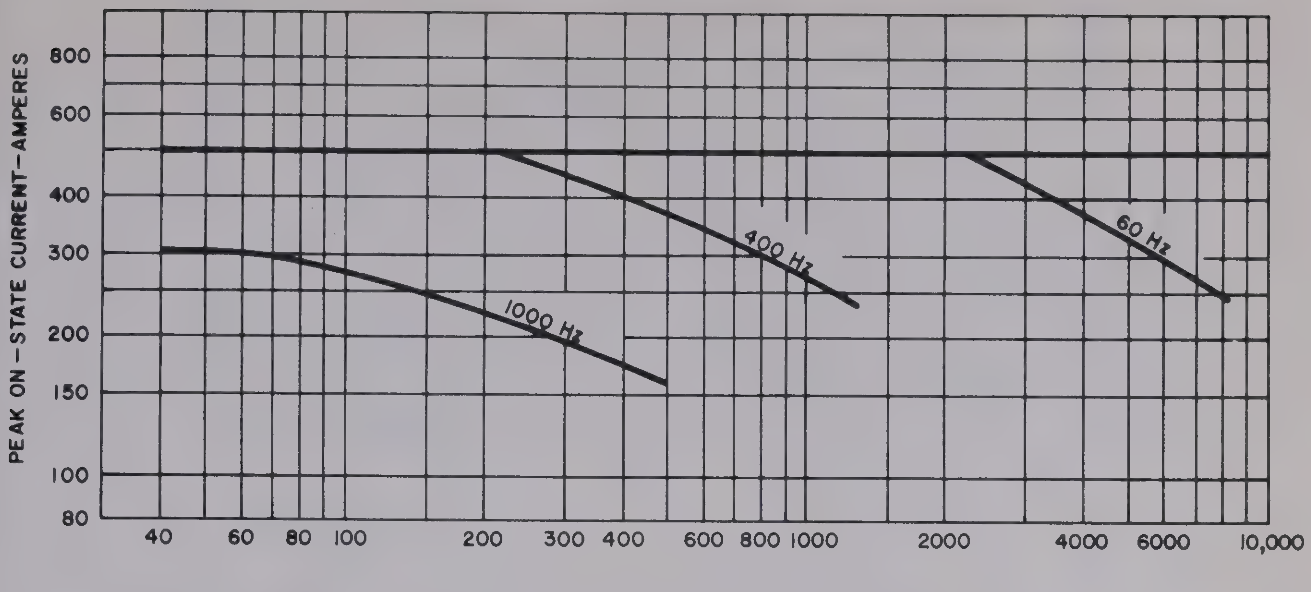
di/dt up to 100 amps/μsec at specified gate drive and switching voltage is part of the rectangular current wave ratings (see rating curves of Figures 12 through 35.) This is a repetitive, long term rating confirmed by life test.

CHARACTERISTICS

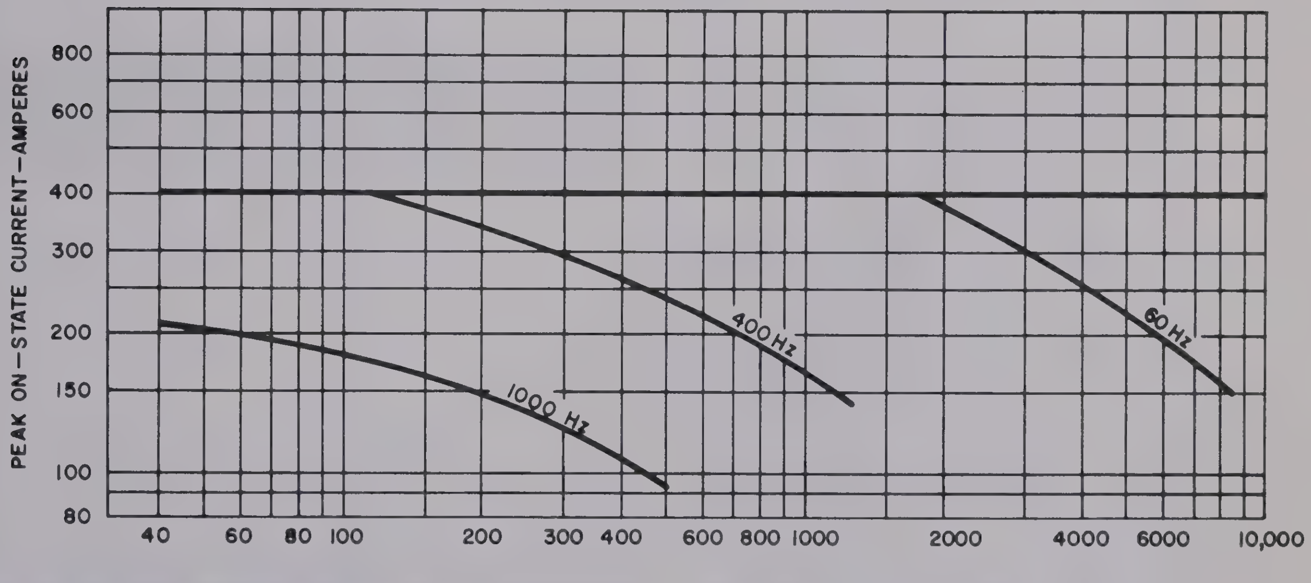
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Peak Reverse and Off-State Current	I_{DRM} and I_{RRM}				mA	T_C = +25°C
C154A, C155A, C156A, C157A		–	8	18		$V_{DRM} = V_{RRM}$ = 100 Volts peak
C154B, C155B, C156B, C157B		–	7	17		200 Volts peak
C154C, C155C, C156C, C157C		–	6	16		300 Volts peak
C154D, C155D, C156D, C157D		–	6	16		400 Volts peak
C154E, C155E, C156E, C157E		–	5	15		500 Volts peak
C155M, C157M		–	5	15		600 Volts peak
Peak Reverse and Off-State Current	I_{DRM} and I_{RRM}				mA	T_C = 125°C
C154A, C155A, C156A, C157A		–	14	18		$V_{DRM} = V_{RRM}$ = 100 Volts peak
C154B, C155B, C156B, C157B		–	13	17		200 Volts peak
C154C, C155C, C156C, C157C		–	12	16		300 Volts peak
C154D, C155D, C156D, C157D		–	12	16		400 Volts peak
C154E, C155E, C156E, C157E		–	10	15		500 Volts peak
C155M, C157M		–	10	15		600 Volts peak
Effective Thermal Resistance	$\theta_{J\text{-}C}$	–	.2	.3	°C/watt	Junction to case (DC)
Critical Exponential Rate of Rise of Forward Blocking Voltage (Higher values may cause device switching)	dv/dt				V/μsec	V_{DRM}, T_C = +125°C, Gate open
C154/C156		200	500	–		
C155/C157		100	300	–		
Holding Current	I_H	–	30	200	mAdc	T_C = +25°C, Anode supply = 24 Vdc. Initial forward current = 2 amps.
Pulse Gate Trigger Current and Voltage	$i_{GT(pulse)}$	–	1	2	Amps.	T_C = +25°C, t_p = 10 μsec.
	$V_{GT(pulse)}$	–	8	10	Volts	0.25 μsec rise time.
DC Gate Trigger Current	I_{GT}	–	50	150	mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 3 ohms.
		–	100	200	mAdc	T_C = –40°C, V_D = 6 Vdc, R_L = 3 ohms.
		–	30	120	mAdc	T_C = +125°C, V_D = 6 Vdc, R_L = 3 ohms.
DC Trigger Voltage	V_{GT}	–	1.25	3.0	Vdc	T_C = – 40°C to +125°C, V_D = 6 Vdc, R_L = 3 ohms.
		0.25	–	–	Vdc	T_C = +125°C, V_{DRM}, R_L = 1000 ohms.
Peak On-State Voltage	V_{TM}	–	2.2	3.0	Volts	T_C = +25°C, I_{TM} = 500A peak. Duty cycle ≦ .01%.
Delay Time	t_d	–	1	2	μsec	T_C = +25°C, I_T = 50 Adc, V_{DRM}, Gate supply: 10 volt open circuit, 20 ohms, 0.1 μsec max. rise time.
Conventional Circuit Commutated Turn-Off-Time (with Reverse Voltage)	t_q				μsec	(1) T_C = +125°C, (2) I_T = 50A, (3) V_R = 50 volts min., (4) V_{DRM} (reapplied), (5) Rate of rise reapplied forward blocking voltage = 20V/μsec (linear). (6) Commutation di/dt = 5 Amps/μsec. (7) Duty cycle ≦ .01%. (8) Gate bias during turn-off interval = 0 volts, 100 ohms.
C154/C156		–	8	10		
C155/C157		–	12	20		
Conventional Circuit Commutated Turn-Off-Time (with Feedback Diode)	$t_{q(diode)}$				μsec	(1) T_C = +125°C, (2) I_T = 150A, (3) V_R = 1 volt (Forward drop of GE A96 rectifier diode at I_T = 150A), (4) V_{DRM}, (5) Rate of rise reapplied forward blocking voltage = 20V/μsec (linear). (6) Commutation di/dt = 5 Amps/μsec. (7) Duty cycle ≦ .01%. (8) Gate bias during turn-off interval = 0 volts, 100 ohms.
C154/C156		–	12	–†		
C155/C157		–	15	–†		
Pulse Circuit Commutated Turn-Off-Time (with Reverse Voltage)	$t_{q(pulse)}$				μsec	(1) T_C = +125°C, V_{DRM} (reapplied), (2) Rate of rise of reapplied forward blocking voltage = 200V/μsec (linear) (C154), 100V/μsec (linear) (C155). (3) Rep. rate = 400 Hz., (4) Gate supply = 20 volts, 20 ohms, 0.25 μsec max. rise time, (5) I_T = 500A peak t_p = 3 μsec (half sine wave), (6) V_R = 50 volts min.
C154/C156		–	15	20		
C155/C157		–	25	30		
Pulse Circuit Commutated Turn-Off-Time (with Feedback Diode)	$t_{q(pulse)}$ (diode)				μsec	(1) T_C = +125°C, V_{DRM} (reapplied), (2) Rate of rise of reapplied forward blocking voltage = 20V/μsec (linear), (3) Rep. rate = 400 Hz., (4) Gate supply = 20 volts, 20 ohms, 0.25 μsec max. rise time. (5) I_T = 500A peak, t_p = 3 μsec (half sine wave), (6) V_R = 1.5 volt (Forward drop of GE A96 rectifier diode at I_T = 500A).
C154/C156		–	17	–†		
C155/C157		–	–	–†		

†Consult Factory for specified maximum Turn-Off-Time.

SINE WAVE DATA



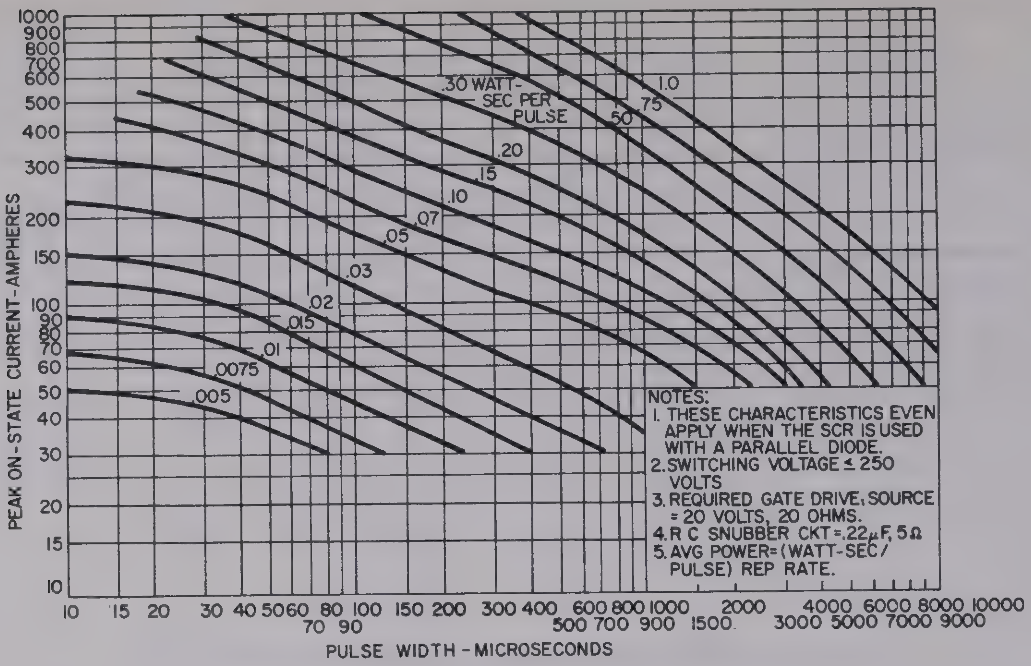
1. Maximum allowable peak on-state current vs. pulse width (T_C = 65°C)



2. Maximum allowable peak on-state current vs. pulse width (T_C = 90°C)

NOTES:
(1) Switching Voltage 250 Volts (2) Min. circuit turnoff time 20 μsec. (3) Max. circuit dv/dt 200 V/μsec (4) Required gate drive: source—20 volts, 20 ohms; rise time—.1 μsec. (5) RC Snubber—.22 μf, 50ohm.

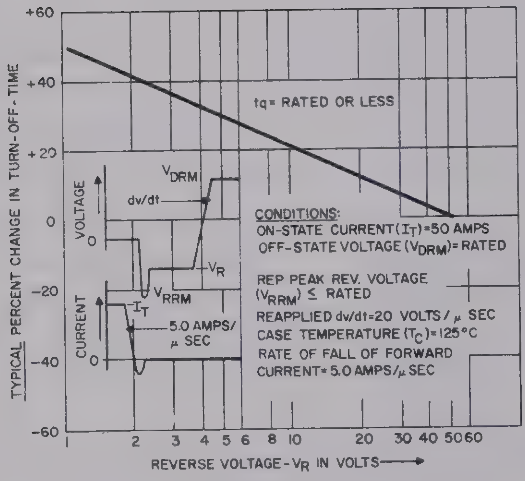
SINE WAVE DATA



NOTES:
1. THESE CHARACTERISTICS EVEN APPLY WHEN THE SCR IS USED WITH A PARALLEL DIODE.
2. SWITCHING VOLTAGE ≤ 250 VOLTS
3. REQUIRED GATE DRIVE: SOURCE = 20 VOLTS, 20 OHMS.
4. R C SNUBBER CKT = .22μF, 5Ω
5. AVG POWER = (WATT-SEC/PULSE) REP RATE.

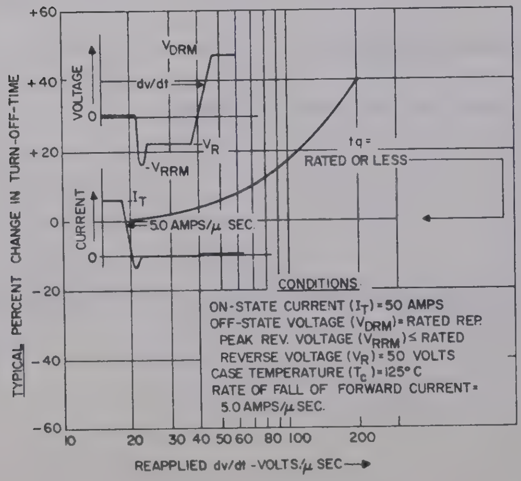
3. Energy per pulse for sinusoidal pulses

TURN-OFF-TIME DATA



CONDITIONS:
ON-STATE CURRENT (I_T) = 50 AMPS
OFF-STATE VOLTAGE (V_{DRM}) = RATED
REP PEAK REV. VOLTAGE (V_{RRM}) ≤ RATED
REAPPLIED dv/dt = 20 VOLTS/μ SEC
CASE TEMPERATURE (T_C) = 125°C
RATE OF FALL OF FORWARD CURRENT = 5.0 AMPS/μ SEC

4. This curve shows a typical variation of conventional circuit commutated SCR turn-off-time with applied reverse voltage (V_R) during the turn-off interval. Testing at V_R = "1 volt" is done with a GE A96 fast recovery diode in inverse parallel with the C154/C155. For SCR's with specified maximum turn-off-time with an inverse parallel diode—consult the factory.

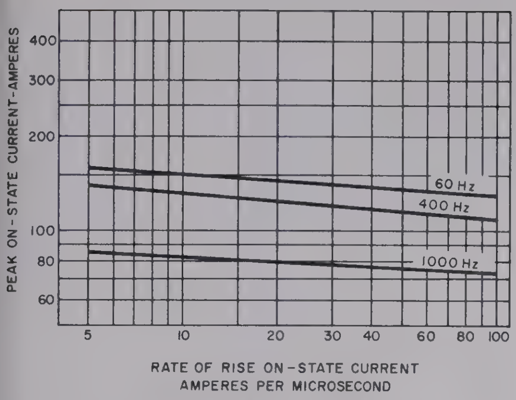


CONDITIONS
ON-STATE CURRENT (I_T) = 50 AMPS
OFF-STATE VOLTAGE (V_{DRM}) = RATED REP. PEAK REV. VOLTAGE (V_{RRM}) ≤ RATED
REVERSE VOLTAGE (V_R) = 50 VOLTS
CASE TEMPERATURE (T_C) = 125° C
RATE OF FALL OF FORWARD CURRENT = 5.0 AMPS/μ SEC.

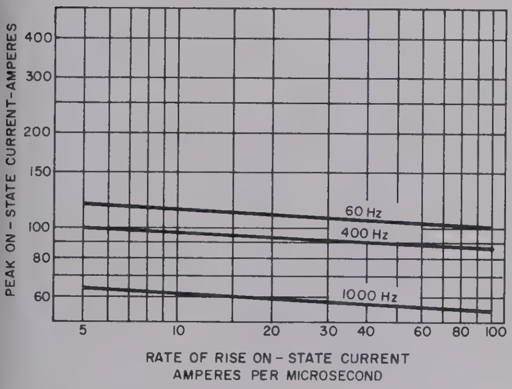
5. This curve shows a typical variation of conventional circuit commutated SCR turn-off-time with reapplied dv/dt. Specified turn-off-time is with reapplied dv/dt of 20 volts/μsec. Note turn-off-time increase at higher dv/dt. When requesting selected turn-off-time also specify maximum reapplied dv/dt.

RECTANGULAR WAVE DATA
SWITCHING VOLTAGE - 500 VOLTS

DUTY CYCLE–50%

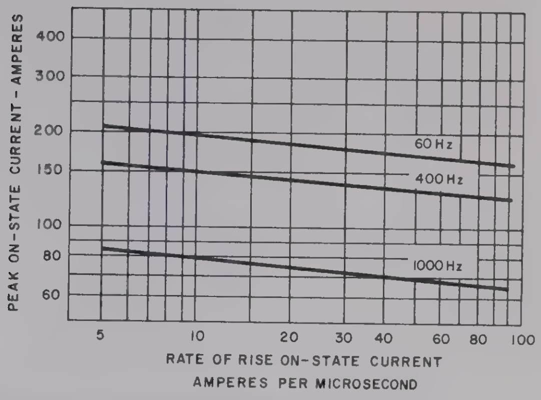


6. **Maximum allowable peak on-state current vs. di/dt (T_C = 65°C)**

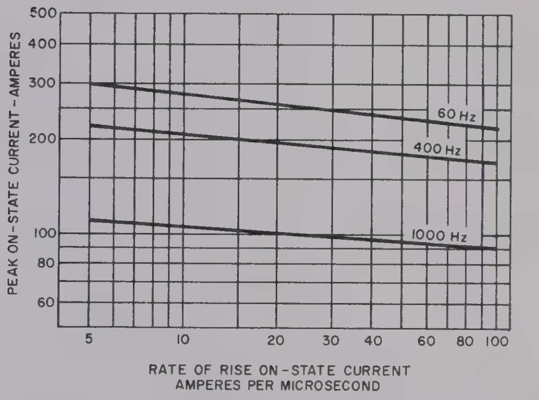


7. **Maximum allowable peak on-state current vs. di/dt (T_C = 90°C)**

DUTY CYCLE–25%

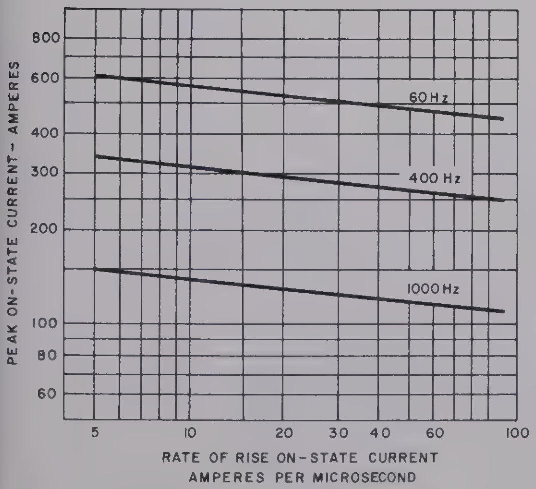


8. **Maximum allowable peak on-state current vs. di/dt (T_C = 65°C)**

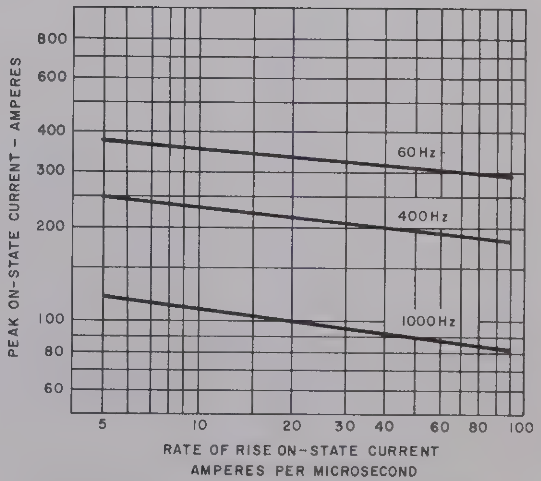


9. **Maximum allowable peak on-state current vs. di/dt (T_C = 90°C)**

DUTY CYCLE–10%

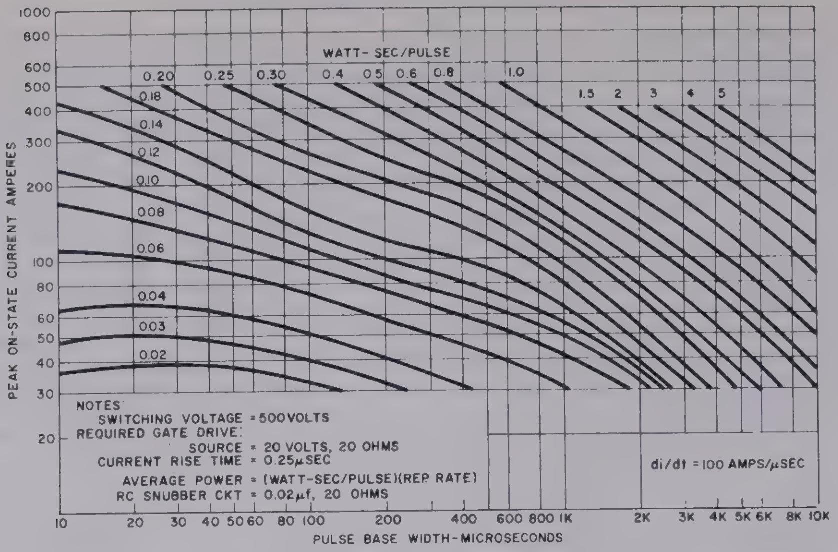


10. **Maximum allowable peak on-state current vs. di/dt (T_C = 65°C)**

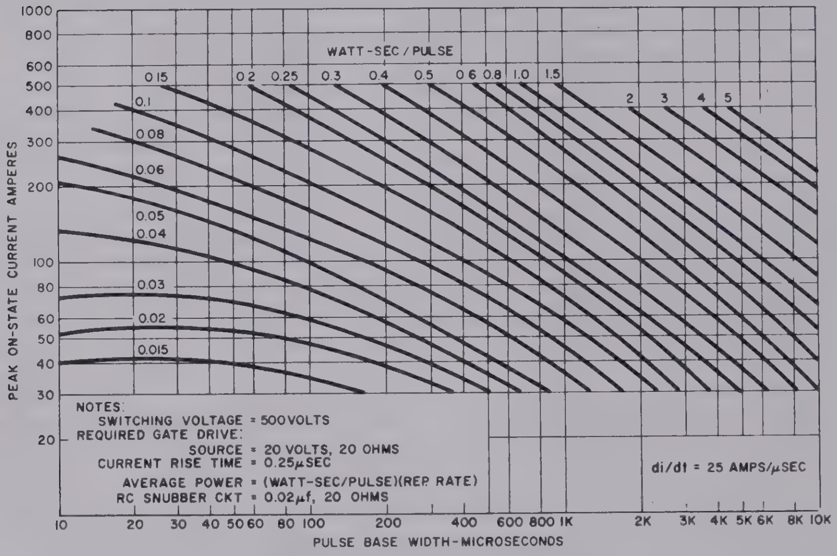


11. **Maximum allowable peak on-state current vs. di/dt (T_C = 90°C)**

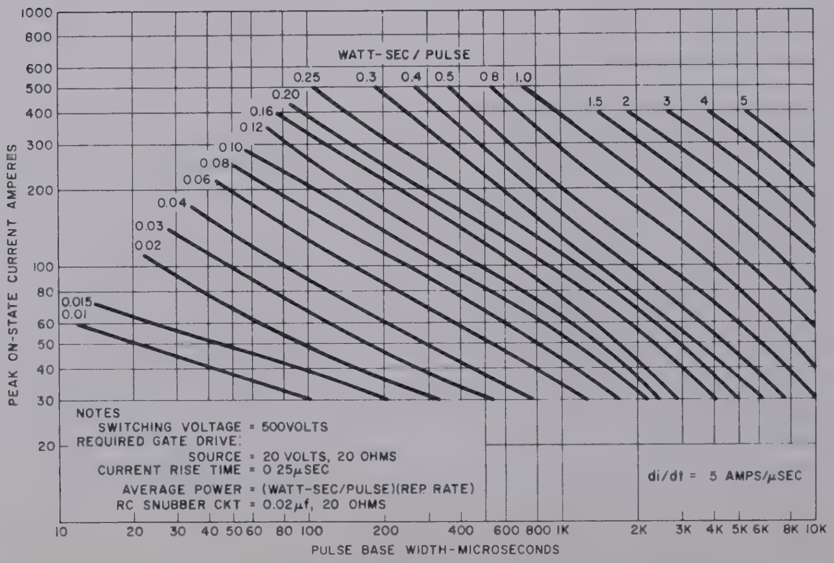
RECTANGULAR WAVE DATA SWITCHING VOLTAGE - 500 VOLTS
WATT-SECOND PER PULSE



12. Energy per pulse vs. peak current and pulse width (di/dt = 100 A/μsec.)

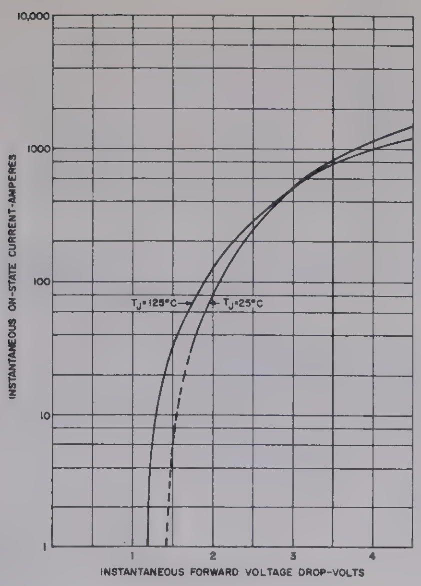


13. Energy per pulse vs. peak current and pulse width (di/dt = 25 A/μsec.)

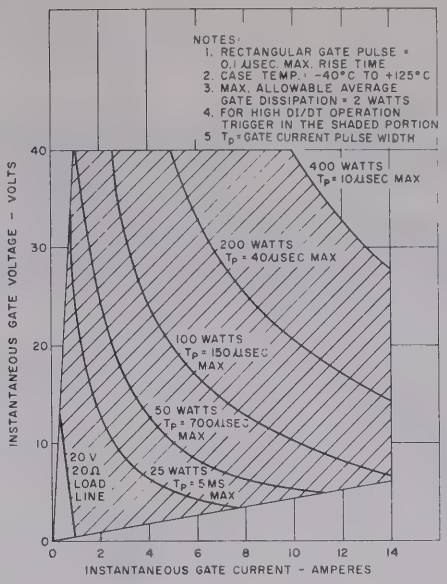


14. Energy per pulse vs. peak current and pulse width (di/dt = 5 A/μsec.)

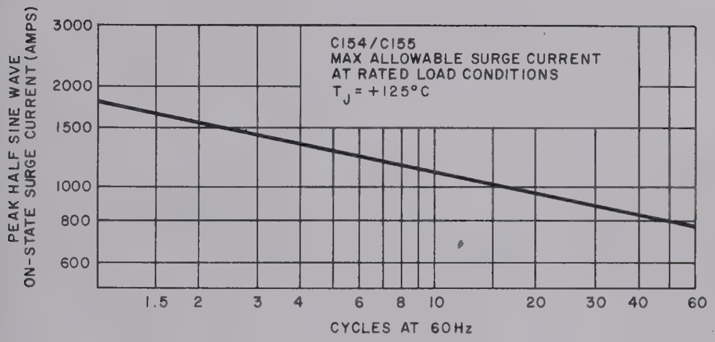
LOW FREQUENCY DATA



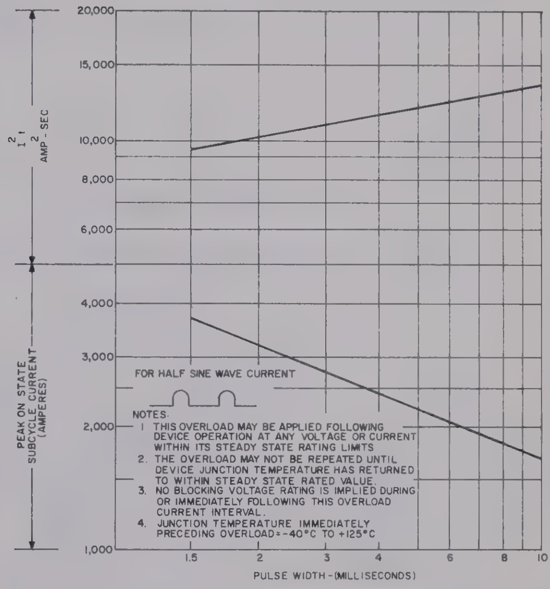
15. Forward conduction characteristic, on-state


NOTES:
1. RECTANGULAR GATE PULSE = 0.1 μSEC. MAX. RISE TIME
2. CASE TEMP.: −40°C TO +125°C
3. MAX. ALLOWABLE AVERAGE GATE DISSIPATION = 2 WATTS
4. FOR HIGH DI/DT OPERATION TRIGGER IN THE SHADED PORTION
5. T_p = GATE CURRENT PULSE WIDTH

16. Maximum allowable peak gate power vs. gate pulse width



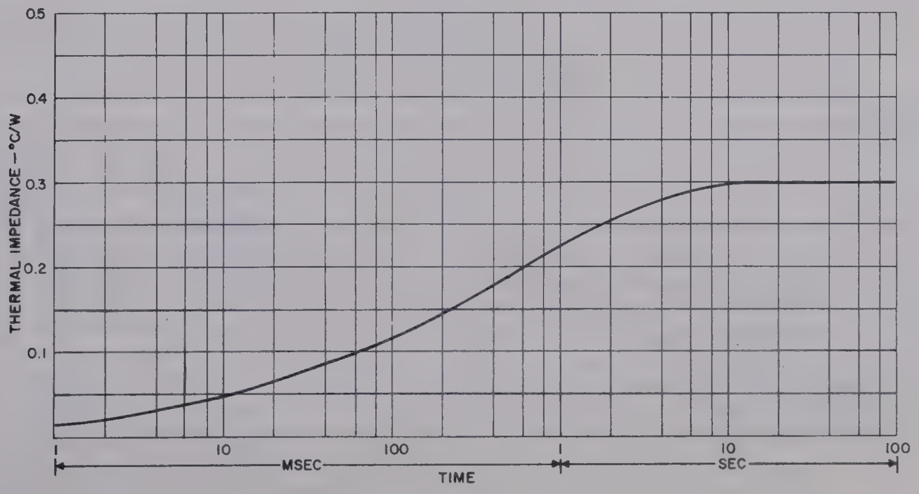
17. Maximum allowable surge current following rated load conditions


FOR HALF SINE WAVE CURRENT

NOTES:
1. THIS OVERLOAD MAY BE APPLIED FOLLOWING DEVICE OPERATION AT ANY VOLTAGE OR CURRENT WITHIN ITS STEADY STATE RATING LIMITS
2. THE OVERLOAD MAY NOT BE REPEATED UNTIL DEVICE JUNCTION TEMPERATURE HAS RETURNED TO WITHIN STEADY STATE RATED VALUE.
3. NO BLOCKING VOLTAGE RATING IS IMPLIED DURING OR IMMEDIATELY FOLLOWING THIS OVERLOAD CURRENT INTERVAL.
4. JUNCTION TEMPERATURE IMMEDIATELY PRECEDING OVERLOAD = −40°C TO +125°C

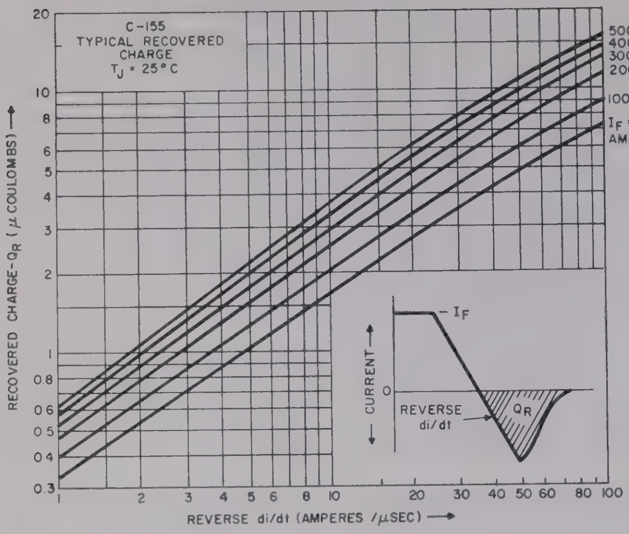
I^2t
AMP^2 - SEC
PEAK ON STATE
SUBCYCLE CURRENT
(AMPERES)
20,000
15,000
10,000
8,000
6,000
4,000
3,000
2,000
1,000
1.5
2
3
4
6
8
10
PULSE WIDTH - (MILLISECONDS)

18. Sub-cycle surge and I^2t rating following rated load conditions

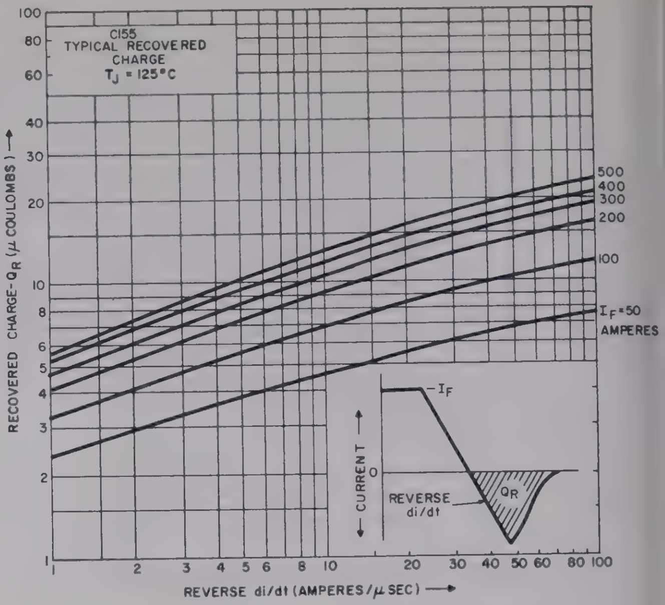


19. Transient thermal impedance, junction to case

C155 RECOVERED CHARGE DATA



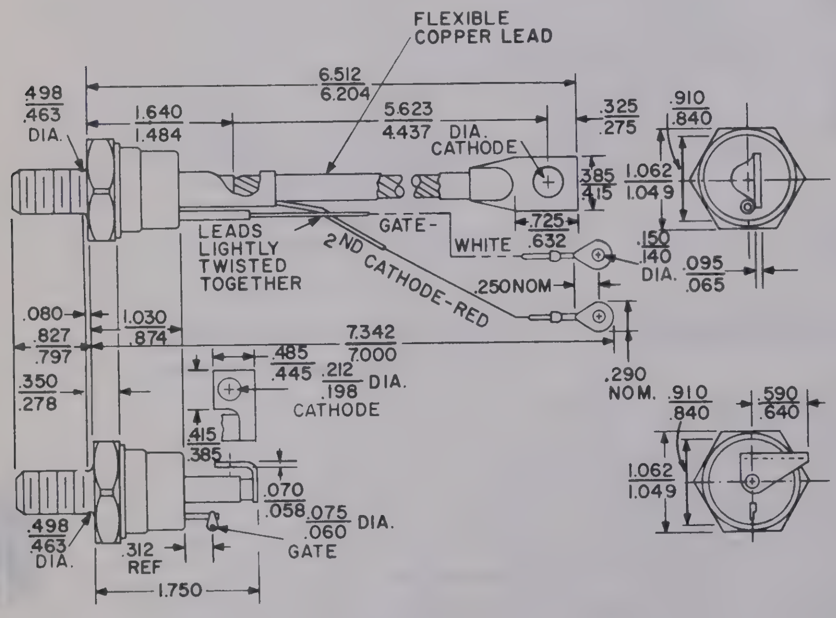
20. Typical recovered charge data (T_J = 25°C)



21. Typical recovered charge data (T_J = 125°C)

OUTLINE DRAWINGS

C154/C155 OUTLINE (Conforms to JEDEC TO-49 Outline)


FLEXIBLE COPPER LEAD
6.512
6.204
.498
.463
DIA.
1.640
1.484
5.623
4.437
DIA.
CATHODE
.325
.275
.910
.840
.385
.415
1.062
1.049
LEADS LIGHTLY TWISTED TOGETHER
GATE-
WHITE
.725
.632
2ND CATHODE-RED
.150
.140
DIA.
.095
.065
.250NOM
.080
.827
.797
1.030
.874
7.342
7.000
.350
.278
.485
.445
.212
.198
DIA.
CATHODE
.290 NOM.
.910
.840
.590
.640
.415
.385
.070
.058
.075
.060
DIA.
1.062
1.049
.498
.463
DIA.
.312 REF
GATE
1.750

NOTES:
(1) Complete stud threads (1/2-20 UNF 2A) to within 2-1/2 threads of head.
(2) Flexible lead covered with silicon rubber installation (Class H), 600 volt ASTM standard wall.
(3) Orientation of cathode and gate terminals not defined.
(4) One, 1/2-20 steel, cadmium-plated nut and one steel cadmium plated spring washer supplied with each unit. (Brass hardware available upon request.)
(5) Approximate weights: C154/C155–4.0 oz.
C156/C157–3.7 oz.

TABLE OF DIMENSIONS

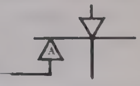
Conversion Table

DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	.797	.827	20.243	21.005
B	—	.080	—	2.032
C	.278	.350	7.060	8.890
D	.874	1.030	22.099	26.162
E	1.049	1.062	26.644	26.975
F	.840	.910	21.335	23.115
G	6.204	6.512	157.619	165.443
G_1	—	1.750	—	44.450
H	1.484	1.640	37.653	41.656
J	4.437	5.623	112.698	142.824
K	.275	.325	6.985	8.255
K_1	.445	.485	11.302	12.319
L	.251	.281	6.375	7.137
L_1	.198	.212	5.029	5.385
M	.500	.600	12.700	15.240
M_1	.385	.415	9.778	10.541
N	.632	.725	16.052	18.390
N_1	.590	.640	14.985	16.256
O	7.000	7.342	177.799	186.487
O_1	.312 Ref.		7.925 Ref.	
P	.140	.150	3.555	3.811
P_1	.060	.075	1.524	1.905
Q	.250 nom.		6.350 nom	
R	.290 nom.		7.366 nom	
S	.065	.095	1.651	2.413
S_1	.058	.070	1.473	1.778
T	.463	.498	11.760	12.649

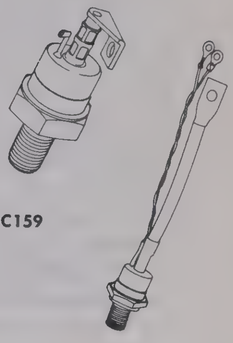
HIGH SPEED
Silicon Controlled Rectifier

C158
C159

1200 Volts **110 A RMS**

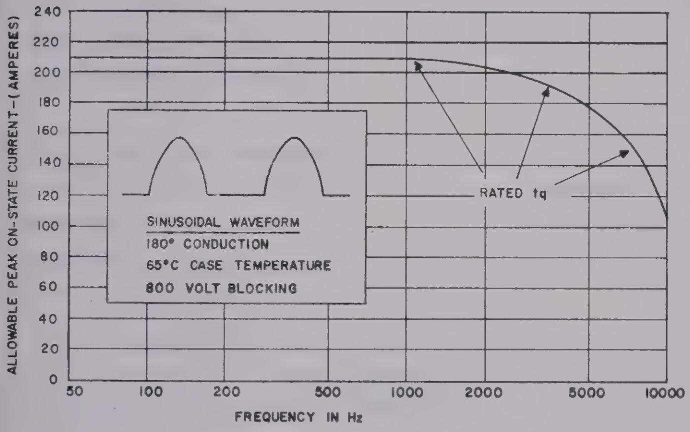


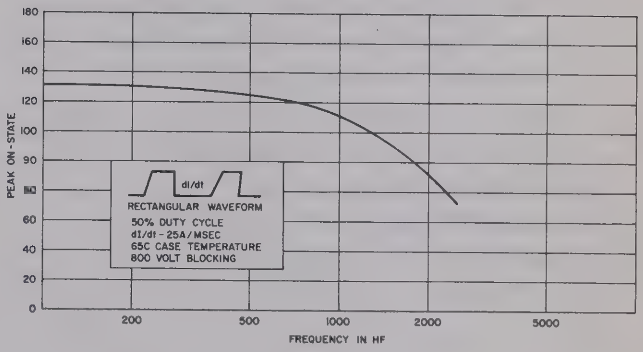
The General Electric Type C158/159 Series of silicon controlled rectifiers are reverse blocking triode thyristors designed primarily for power switching at frequencies considerably higher than the prevalent 50 to 400 Hz. The Type C158/159 SCR is explicitly rated for half sine wave current up to 10k Hz. and rectangular current waveshape up to 5k Hz.



For efficient operation in high speed applications, the C158/159 SCR provides a superior mix of capabilities:

- Forward and reverse blocking voltage to 1200 volts
- 40 μsec turn-off-time at severe operating conditions†
- 25 μsec turn-off-time at less severe operating conditions†
- High di/dt and dv/dt at high frequency
- Very low switching losses at high frequency
- Amplifying gate permits soft-fire characteristics





Equipment designers can use the C158/159 SCR in demanding applications, such as:

- **Choppers**
- **Inverters**
- **Regulated power supplies**
- **Sonar transmitters**
- **Induction heaters**
- **Radio transmitters**
- **Cycloconverters**
- **DC to DC converters**
- **High frequency lighting**

FOR SINE WAVE OPERATION

Like the Type C140/141 SCR (GE's first high-frequency SCR), the C158/159 SCR is rated for:

- **Peak current**

  vs.
- **Pulse width**
- **Frequency**
- **Case temperature**

FOR RECTANGULAR WAVE OPERATION

GE now introduces a new, high-frequency rating for the C158/159 SCR, which is:

- **Peak current**

  vs.
- **di/dt of leading edge**
- **Frequency**
- **Duty cycle**
- **Case temperature**

†Shorter turn-off-time available upon special request.

MAXIMUM ALLOWABLE RATINGS

Types	Repetitive Peak Off-State Voltage, V_{DRM}	Repetitive Peak Reverse Voltage, V_{RRM} (1)	Non-repetitive Peak Reverse Voltage, V_{RSM} (1)
	T_C = −40°C to +125°C (2)	T_C = −40°C to +125°C (2)	T_C = −40°C to +125°C (2)
C158E, C159E	500 Volts	500 Volts	600 Volts
C158M, C159M	600	600	720
C158S, C159S	700	700	840
C158N, C159N	800	800	960
C158T, C159T	900	900	1080
C158P, C159P	1000	1000	1200
	T_C = 0°C to +125°C (3)	T_C = 0°C to +125°C (3)	T_C = 0°C to +125°C (3)
C158PA, C159PA	1100	1100	1300
C158PB, C159PB	1200	1200	1400

(1) Half sine wave voltage pulse, 10 millisecond maximum duration.

(2) Ratings apply for zero or negative gate voltage. Maximum case to ambient thermal resistance for which maximum V_{DRM} and maximum V_{RRM} ratings apply equals 1.1°C/watt.

(3) Ratings apply for zero or negative gate voltage. Maximum case to ambient thermal resistance for which maximum V_{DRM} and maximum V_{RRM} ratings apply equals 0.5°C/watt.

Peak Positive Anode Voltage .... None†

RMS On-State Current, $I_{T(RMS)}$ .... 110 Amperes

Average On-State Current, $I_{T(AV)}$ .... (see Charts)

Peak One Cycle Surge (non-rep) On-State Current, I_{TSM} .... 1600 Amperes

I^2t (for fusing) for times $\geqq$ 1.5 milliseconds .... 5200 Ampere^2 seconds

I^2t (for fusing) for times $\geqq$ 8.3 milliseconds .... 10,500 Ampere^2 seconds

Critical Rate-of-Rise of On-State Current, di/dt,
During Turn-On Interval .... 800 Amperes per microsecond††

Peak Gate Power Dissipation, P_{GM} . . . (Pulse Width = 10μsec) .... 400 Watts

Average Gate Power Dissipation, $P_{G(AV)}$ .... 2 Watts

Peak Negative Gate Voltage, V_{GM} .... 20 Volts

Storage Temperature, T_{STG} .... −40°C to +125°C

Operating Temperature, T_J .... −40°C to +125°C

Stud Torque .... 150 Lb-in (Max), 125 Lb-in (Min)
175 Kg-cm (Max), 150 Kg-cm (Min)

†This SCR may be, non-repetitively, turned-on in the forward direction by exceeding the breakover voltage (V_{DRM}) with either a rapidly or slowly rising waveform. At breakover, di/dt must be limited to 20 amps/μsec and peak current to 1000 amperes.

††Required trigger source — 20 volts, 20 ohms; maximum switching voltage — 1200 volts; short-circuit gate supply current risetime — 5 μsec. (This short-circuit current may be measured with a TEKTRONICS current probe.); RC Snubber circuit used across SCR—(see Figure 3).

di/dt rating is established in accordance with JEDEC Suggested Standard No. 7, Section 5.1.2.4. Immediatey after each current pulse, off-state (blocking) voltage capability may be temporarily lost for durations less than the period of the applied pulse repetition rate. The pulse repetition rate for this test is 400 Hz: The duration of the JEDEC di/dt test condition is 5.0 seconds (minimum).

di/dt up to 100 amps/μsec, at specified gate drive and switching voltage is part of the rectangular current wave ratings (see rating curves of Figures 11 through 22). This is a repetitive, long-term rating confirmed by life test.

See notes for Figure 19 for higher repetitive di/dt ratings.

CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
Peak Reverse and Off-State Current	I_{DRM} and I_{RRM}				mA	T_C = +25°C
C158E, C159E		—	3	10		$V_{DRM} = V_{RRM} =$ 500 Volts peak
C158M, C159M		—	3	10		600 Volts peak
C158S, C159S		—	3	10		700 Volts peak
C158N, C159N		—	3	10		800 Volts peak
C158T, C159T		—	3	9		900 Volts peak
C158P, C159P		—	3	7		1000 Volts peak
C158PA, C159PA		—	3	7		1100 Volts peak
C158PB, C159PB		—	3	7		1200 Volts peak

CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
Peak Reverse and Off-State Current	I_{DRM} and I_{RRM}				mA	$T_C = 125°C$
C158E, C159E		—	12	15		$V_{DRM} = V_{RRM} =$ 500 Volts peak
C158M, C159M		—	12	15		600 Volts peak
C158S, C159S		—	12	15		700 Volts peak
C158N, C159N		—	12	15		800 Volts peak
C158T, C159T		—	12	15		900 Volts peak
C158P, C159P		—	12	15		1000 Volts peak
C158PA, C159PA		—	12	16		1100 Volts peak
C158PB, C159PB		—	12	17		1200 Volts peak
Effective Thermal Resistance	$\theta_{J\text{-}C}$	—	.2	.3	°C/ watt	Junction to case (DC)
Critical Exponential Rate of Rise of Forward Blocking Voltage (Higher values may cause device switching)	dv/dt	200 *	500	—	V/μsec	V_{DRM}, $T_C = +125°C$, Gate open.
Holding Current	I_H	—	20	500	mAdc	$T_C = +25°C$, Anode supply = 24Vdc. Initial forward current = 2 amps.
DC Gate Trigger Current	I_{GT}	—	50	150	mAdc	$T_C = +25°C$, $V_D = 6$Vdc, $R_L = 3$ ohms.
		—	75	300	mAdc	$T_C = -40°C$, $V_D = 6$Vdc, $R_L = 3$ ohms.
		—	15	125	mAdc	$T_C = +125°C$, $V_D = 6$ Vdc, $R_L = 3$ ohms.
DC Gate Trigger Voltage	V_{GT}	—	3	5	Vdc	$T_C = -40°C$ to 0°C, $V_D = 6$ Vdc, $R_L = 3$ ohms.
		—	1.25	3.0	Vdc	$T_C = 0°C$ to +125°C, $V_D = 6$ Vdc, $R_L = 3$ ohms.
		0.15	—	—	Vdc	$T_C = 125°C$, V_{DRM}, $R_L = 1000$ ohms.
Peak On-State Voltage	V_{TM}	—	2.8	3.5	Volts	$T_C = +25°C$, $I_{TM} = 500$A peak. Duty cycle $\leqq$ .01%.
Turn-On Time (Delay Time + Rise Time)	t_{GT}	—	2	—	μsec	$T_C = +25°C$, $I_T = 50$ Adc, V_{DRM}. Gate supply: 10 volt open circuit, 20 ohm, 0.1 μsec max. rise time. †††
Delay Time	t_d	—	0.5	2.0	μsec	$T_C = +25°C$, $I_T = 50$ Adc, V_{DRM}, Gate supply: 10 volt open circuit, 20 ohm, 1.0 μsec max. rise time. ††, †††
Conventional Circuit Commutated Turn-Off-Time (with Reverse Voltage)	t_q	—	20	30	μsec	(1) $T_C = +125°C$, (2) $I_T = 150$A. (3) $V_R = 50$ volts min., (4) V_{DRM} (reapplied), (5) Rate of rise of reapplied forward blocking voltage = 20 V/μsec (linear). (6) Commutation di/dt = 5 Amps/μsec. (7) Repetition rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts, 100 ohms.
		—	25	40	μsec	(1) $T_C = +125°C$, (2) $I_T = 150$A, (3) $V_R = 50$ volts min., (4) V_{DRM} (reapplied), (5) Rate of rise of reapplied forward blocking voltage = 200 V/μsec (linear). (6) Commutation di/dt = 5 Amps/μsec. (7) Repetition rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts, 100 ohms.
Conventional Circuit Commutated Turn-off-Time (with Feedback Diode)	$t_{q\,(diode)}$	—	40	—†	μsec	(1) $T_C = +125°C$, (2) $I_T = 150$A, (3) $V_R = 1$ volt (Forward drop of GE A96 rectifier diode at $I_T = 150$A), (4) V_{DRM}, (5) Rate of rise of reapplied forward blocking voltage = 200 V/μsec (linear). (6) Commutation di/dt = 5 Amps/μsec. (7) Repetition rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts, 100 ohms.
Pulse Circuit Commutated Turn-Off-Time (with Reverse Voltage)	$t_{q\,(pulse)}$	—	25	40	μsec	(1) $T_C = +125°C$, V_{DRM} (reapplied), (2) Rate of rise of reapplied forward blocking voltage = 200 V/μsec (linear), (3) Rep. rate = 400 Hz., (4) Gate supply = 20 volts, 80 ohms, 1.0 μsec max. rise time. (5) $I_T = 500$ A peak, $t_p = 3$ μsec (half sine wave), (6) $V_R = 50$ volts min.
Pulse Circuit Commutated Turn-Off-Time (with Feedback Diode)	$t_{q\,(pulse)\,(diode)}$	—	40	—†	μsec	(1) $T_C = +125°C$, V_{DRM} (reapplied), (2) Rate of rise of reapplied forward blocking voltage = 200 V/μsec (linear), (3) Rep. Rate = 400 Hz., (4) Gate supply = 20 volts, 80 ohms, 1.0 μsec max. rise time, (5) $I_T = 500$ A peak, $t_p = 3$ μsec (half sine wave), (6) $V_R = 1$ volt (Forward drop of GE A96 rectifier diode at $I_T = 150$A).

†Consult Factory for specified maximum Turn-Off Time.

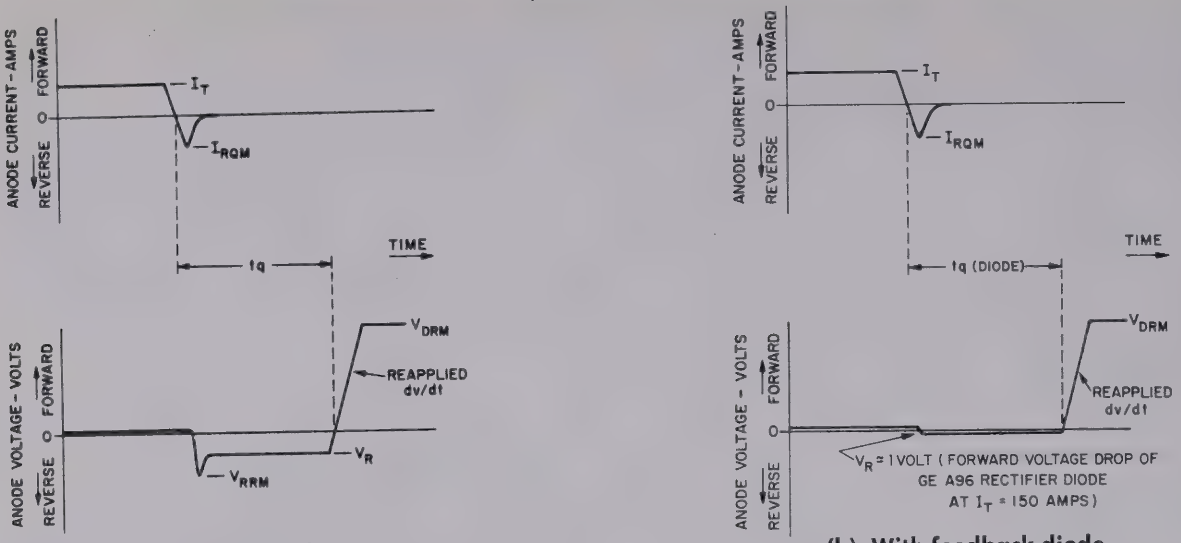
††Delay Time may increase significantly as the gate drive approaches the I_{GT} of the Device Under Test (D.U.T.).

†††Current risetime as measured with a current probe, or voltage risetime across a non-inductive resistor.

*Selections of static dv/dt to 300, 400, 500 volts/μsec available, consult factory.

WAVEFORM DEFINITION OF TURN-OFF-TIME

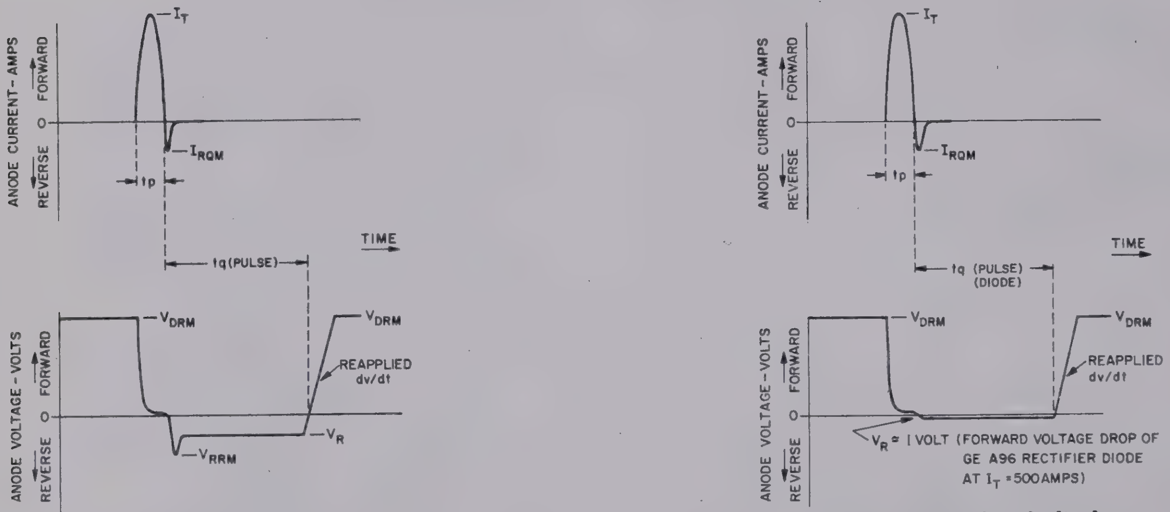
(not to scale)



(a) **With reverse voltage**

(b) **With feedback diode**

1. **Conventional circuit commutated turn-off-time**

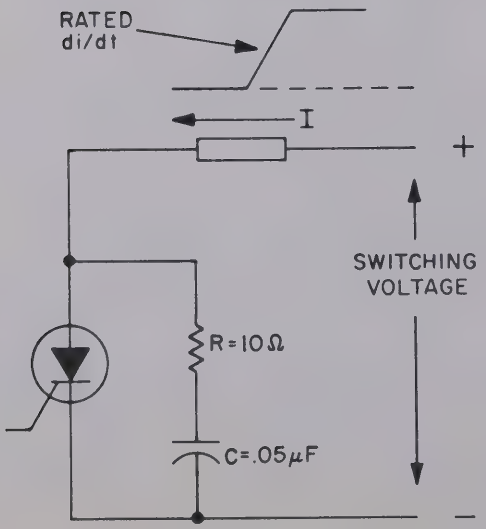


(a) **With reverse voltage**

(b) **With feedback diode**

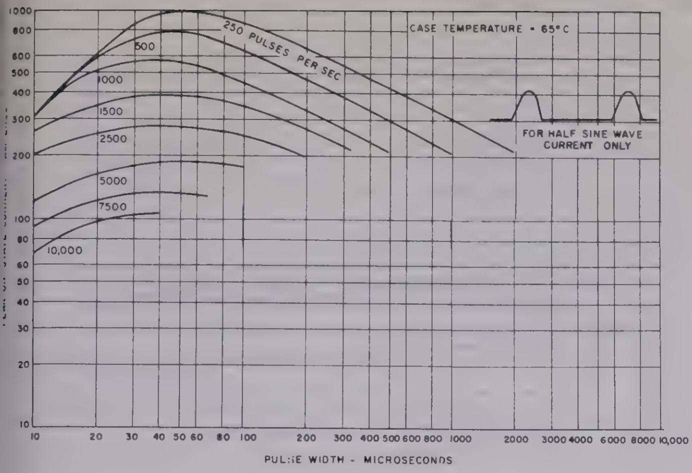
2. **Pulse circuit commutated turn-off-time**

RATED di/dt AND THE RC SNUBBER CIRCUIT

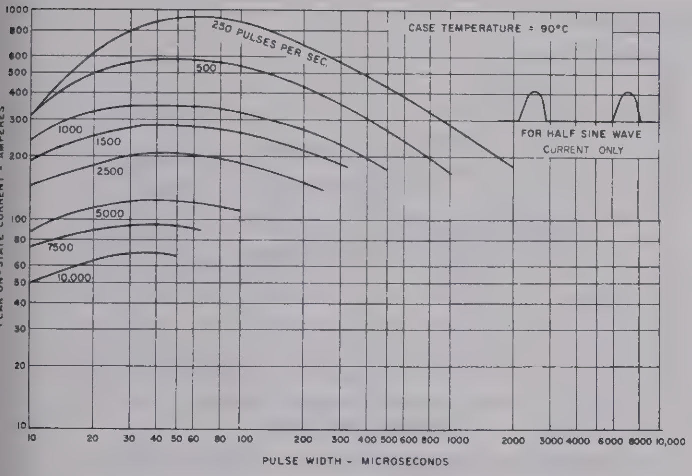


3. **RC Snubber circuit**

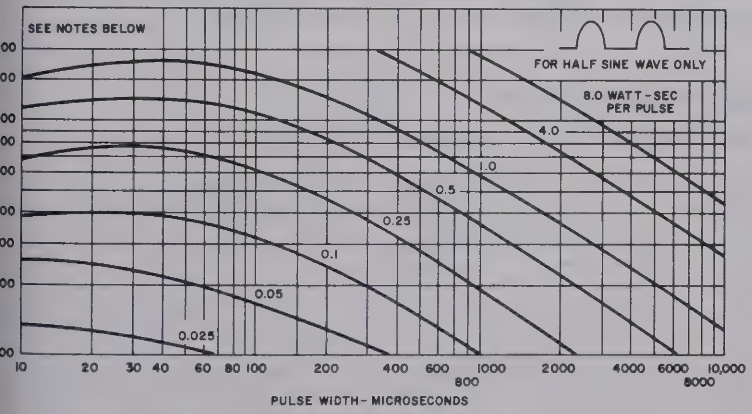
The rated di/dt for the Type C158 SCR is in addition to the discharge of the RC Snubber circuit shown connected in parallel with the SCR. For all high-frequency ratings, the SCR shunted by the snubber has been considered as the device under test.



4. Maximum allowable peak on-state current vs. pulse width ($T_C = 65^O$ C)



5. Maximum allowable peak on-state current vs. pulse width ($T_C = 90^O$ C)



6. Energy per pulse for sinusoidal pulses

4 and 5 give the maximum value of peak on-state current at which the specified turn-off-time and dv/dt still apply.

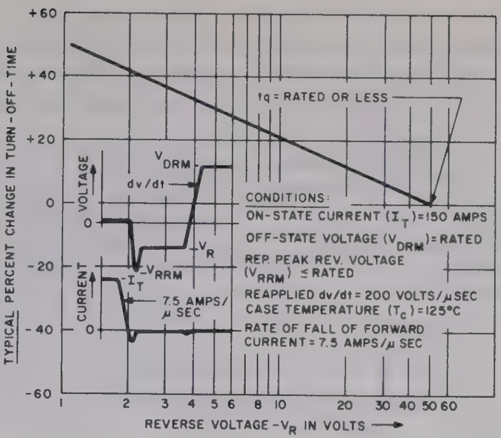
S: Charts 4, 5, 6
itching voltage = 800 volts
nimum ckt. turn-off-time = 40 μsec
ximum ckt. dv/dt = 200 volts/μsec
verse voltage applied = 50 V ≤ V_R ≤ 800 V

5. Required gate drive:
   20 volts, 65 ohms, 1 μsec risetime for less than 100 amps/μsec
   20 volts, 20 ohms, .5 μsec risetime for greater than 100 amps/μsec
6. Energy per pulse for sinusoidal pulses.
7. Double Side Cooled

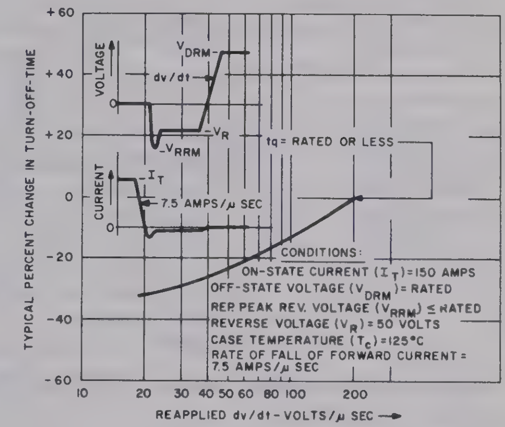
circuit dI/dt remains below 100 amps/μs, and normally constructed snubbers using the components specified are employed, then oft" gate drive shown under "conditions" for each current rating curve is sufficient.

circuit dI/dt exceeds 100 amps/μs shown by the boundary lines, (on the sine wave curves) then the stiff gate source (20 V – 20Ω), μs, specified in Chart #18 must be used. In addition the total device dI/dt must be checked to insure that it is not above the 500 μs which is the long term repetitive limit noted in Chart #18 for stiff gate source.

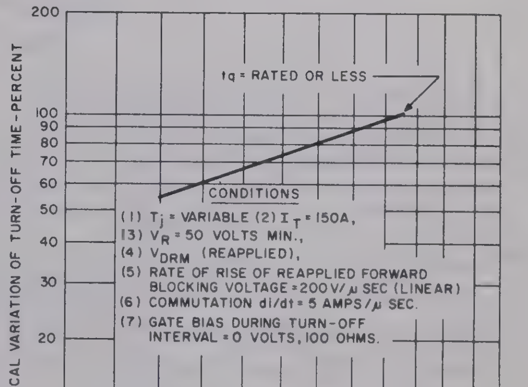
TURN-OFF-TIME DATA



7. This curve shows a typical variation of SCR turn-off-time with applied reverse voltage (V_R) during the turn-off interval. Testing at V_R = "1 volt" is done with a GE A396 fast recovery diode in inverse parallel with the C158. For SCR's with specified maximum turn-off-time with an inverse parallel diode — consult the factory.



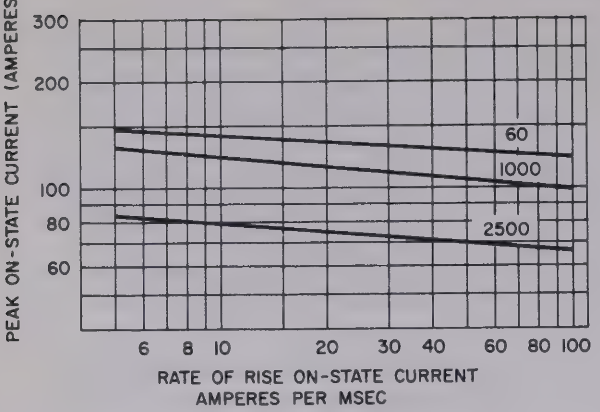
8. This curve shows a typical variation of SCR turn-off-time with reapplied dv/dt. Specified turn-off-time (40 μsec) is with reapplied dv/dt of 200 volts/μsec. Note turn-off-time enhancement at lower dv/dt. When requesting selected turn-off-time (less than 40 μsec) also specify maximum reapplied dv/dt.



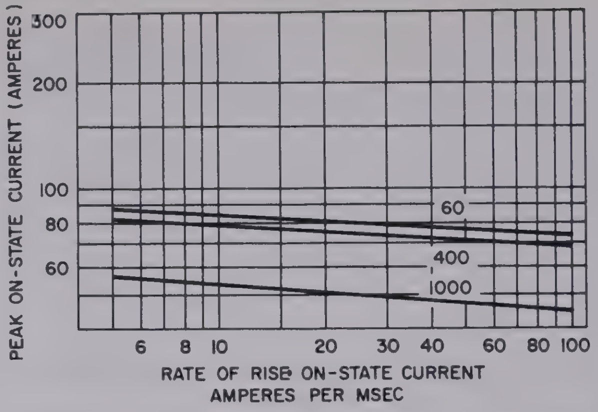
9. This curve shows typical variation of SCR turn-off-time with junction temperature (T_J). Specified turn-off-time is based on a 125°C junction temperature. Note turn-off-time enhancement at lower temperatures.

RECTANGULAR WAVE DATA

DUTY CYCLE — 50%

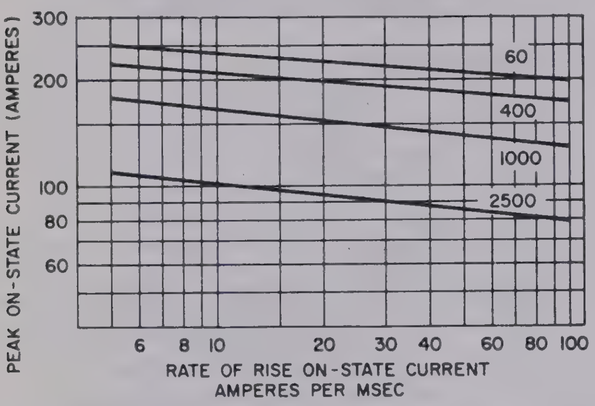


10. Maximum allowable peak on-state current vs. di/dt ($T_C = 65°C$)

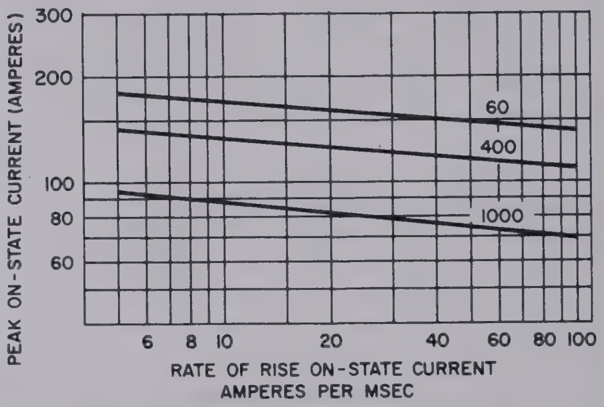


11. Maximum allowable peak on-state current vs. di/dt ($T_C = 90°C$)

DUTY CYCLE — 25%



12. Maximum allowable peak on-state current vs. di/dt ($T_C = 65°C$)

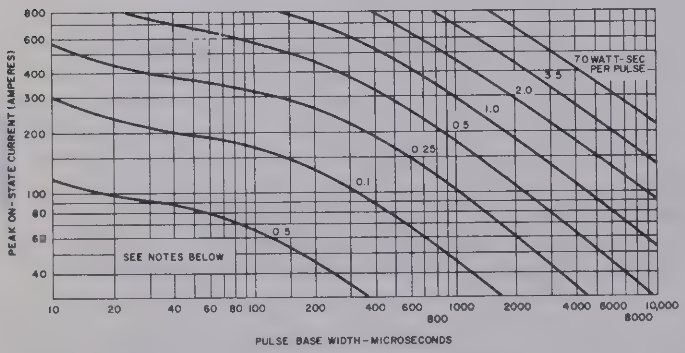


13. Maximum allowable peak on-state current vs. di/dt ($T_C = 90°C$)

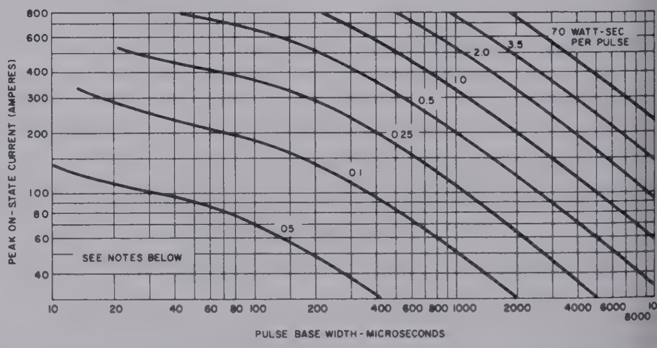
NOTES:
1. RC Snubber ckt. = .25μF, 5Ω 2. Off-state voltage = 800 volts 3. Reverse voltage = 50 V ≤ V_R ≤ 800 V 4. Turn-off-time = 40 μsec
5. dv/dt (maximum) = 200 volts/μsec 6. Required gate drive: 20 volts, 65 ohms, 1 μsec risetime 7. Double Side Cooled

RECTANGULAR WAVE DATA

WATT-SECOND PER PULSE

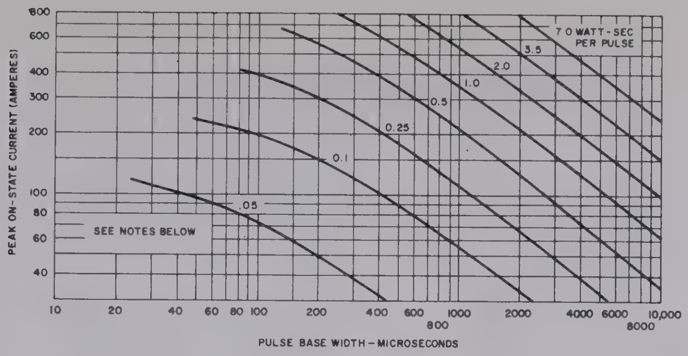


14. Energy per pulse vs. peak current and pulse width (di/dt = 100A/μsec)



15. Energy per pulse vs. peak current and pulse width (di/dt = 25A/μsec)

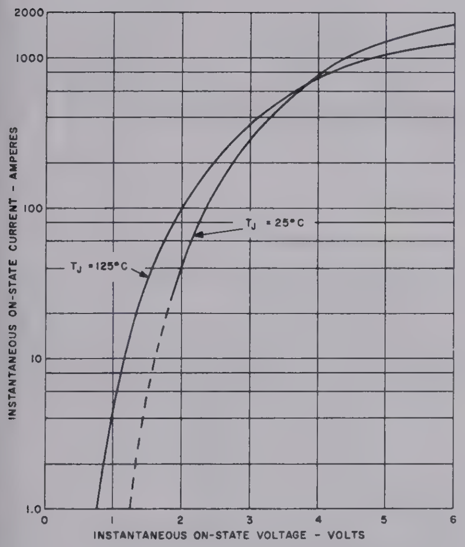
NOTES:
1. Switching voltage = 800 volts 2. Required gate drive: 20 volts, 65 ohms, 1 μsec risetime 3. Average power = (watt-sec/pulse)(rep. rate)
4. RC Snubber ckt. = .25 μF, 5Ω



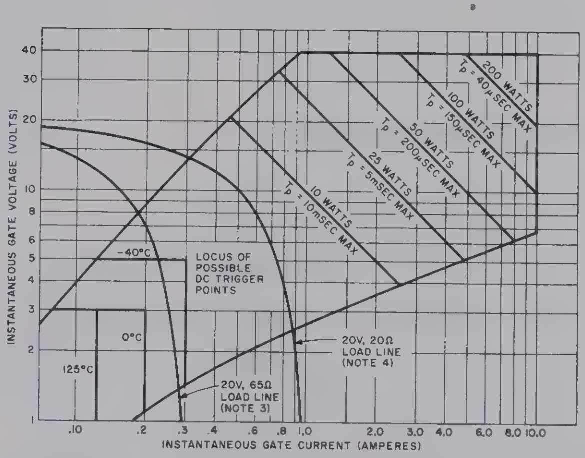
16. Energy per pulse vs. peak current and pulse width (di/dt = 5A/μsec)

NOTES:

1. Switching voltage = 800 volts 2. Required gate drive: 20 volts, 65 ohms, 1 μsec risetime 3. Average power = (watt-sec/pulse)(rep. rate)
4. RC Snubber ckt. = .25 μF, 5Ω



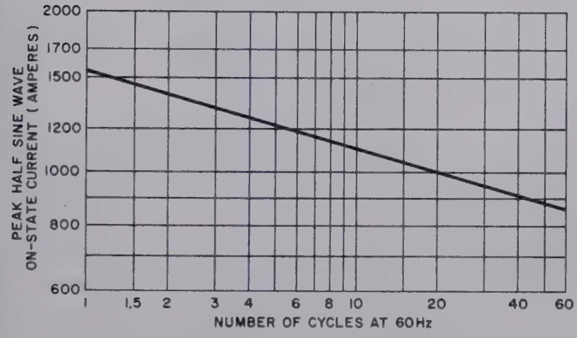
17. Forward conduction characteristic, on-state



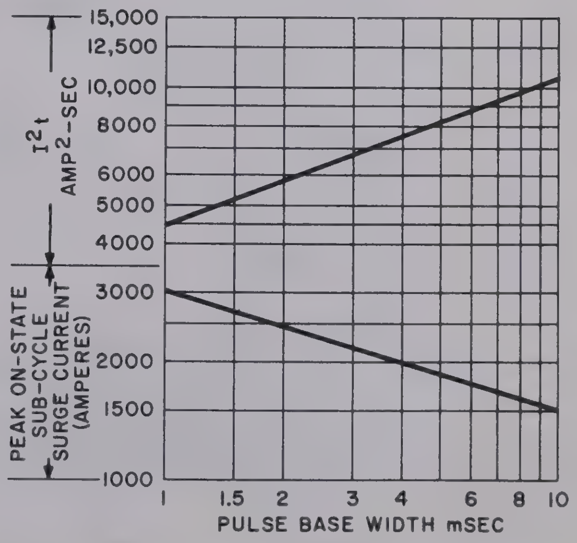
NOTES:

1. Maximum allowable average gate dissipation = 2 watts
2. The locus of possible dc trigger points lie outside the boundaries shown at various case temperatures
3. T_p = Rectangular gate current pulse width (5 μs min duration; 1.0 μs max rise time for 20 V, 65Ω source)
4. 20 V – 20Ω is the minimum gate source load line when rate of circuit current rise > 100 amp/μs or anode rate of current rise > 200 amps/μs (T_p = 5μs min, 0.5 μs max rise time)
Maximum long term repetitive anode dI/dt = 500 amps/μs with 20 V – 20Ω gate source.

18. Maximum allowable peak gate power vs. gate pulse width

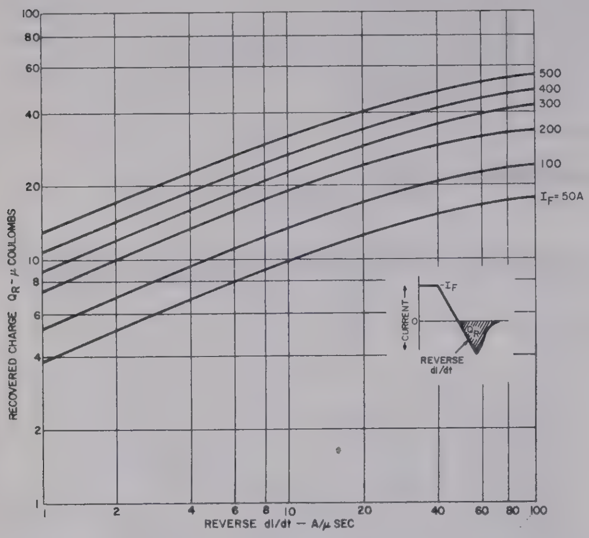


19. Maximum allowable surge current following rated load conditions

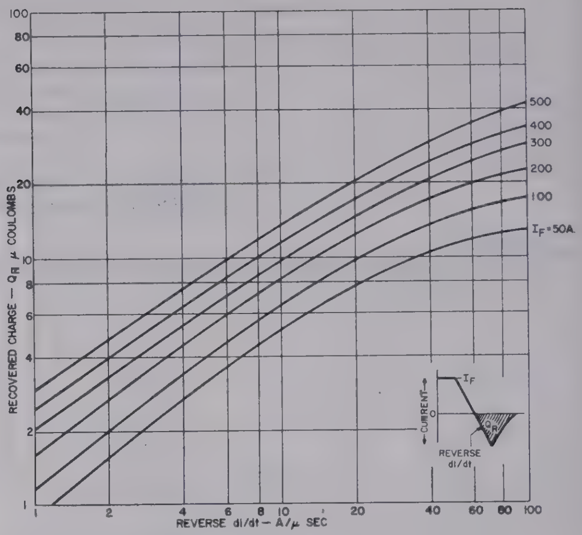


20. Sub-cycle surge and I^2t rating following rated load conditions

LOW FREQUENCY DATA



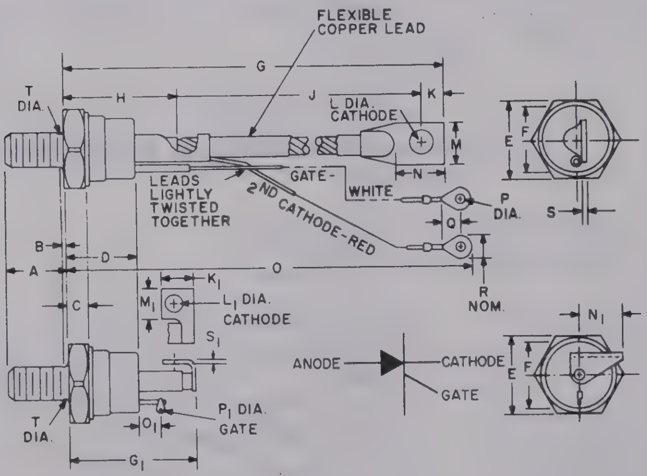
21. Typical Recovered Charge (125°C)



22. Typical Recovered Charge (25°C)

OUTLINE DRAWINGS

C158 OUTLINE (Conforms to JEDEC TO-94 Outline)



FLEXIBLE COPPER LEAD
G
T DIA.
H
J
K
L DIA. CATHODE
M
E
F
N
GATE-WHITE
LEADS LIGHTLY TWISTED TOGETHER
2ND CATHODE-RED
P DIA.
S
Q
B
D
A
O
R NOM.
C
K_1
M_1
L_1 DIA. CATHODE
S_1
N_1
ANODE
CATHODE
GATE
E
F
T DIA.
O_1
P_1 DIA. GATE
G_1

C159 OUTLINE

TABLE OF DIMENSIONS

Conversion Table

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.797	.827	20.243	21.005
B	—	.080	—	2.032
C	.278	.350	7.060	8.890
D	.874	1.030	22.099	26.162
E	1.049	1.062	26.644	26.975
F	.840	.910	21.335	23.115
G	6.204	6.512	157.619	165.443
G_1	—	1.750	—	44.450
H	1.484	1.640	37.653	41.656
J	4.437	5.623	112.698	142.824
K	.275	.325	6.985	8.255
K_1	.445	.485	11.302	12.319
L	.251	.281	6.375	7.137
L_1	.198	.212	5.029	5.385
M	.500	.600	12.700	15.240
M_1	.385	.415	9.778	10.541
N	.632	.725	16.052	18.390
N_1	.590	.640	14.985	16.256
O	7.000	7.342	177.799	186.487
O_1	.312 Ref.		7.925 Ref.	
P	.140	.150	3.555	3.811
P_1	.060	.075	1.524	1.905
Q	.250 Nom.		6.350 Nom.	
R	.290 Nom.		7.366 Nom.	
S	.065	.095	1.651	2.413
S_1	.058	.070	1.473	1.778
T	.463	.498	11.760	12.649

NOTES:

1. Complete stud threads (1/2-20 UNF 2A) to within 2-1/2 threads of head.
2. Flexible lead covered with silicon rubber insulation (Class H), 600 volt ASTM standard wall.
3. Orientation of cathode and gate terminals not defined.
4. One, 1/2-20 steel, nickel-plated nut and one silicon-bronze spring washer supplied with each unit.
5. Approximate weights: C158 — 4.0 oz.; C159 — 3.7 oz.

HOW TO USE THIS SPECIFICATION SHEET

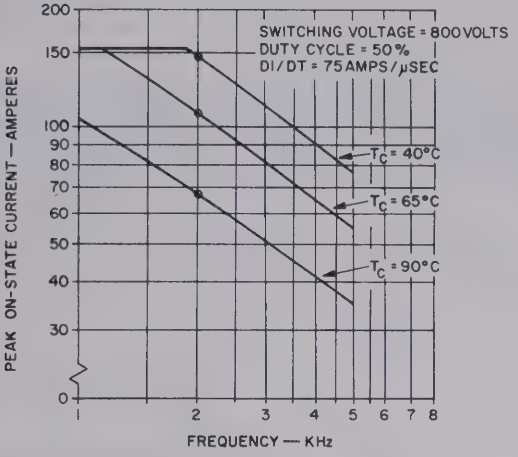
EXAMPLE 1. (High Frequency Rectangular Current Pulse)

Problem:

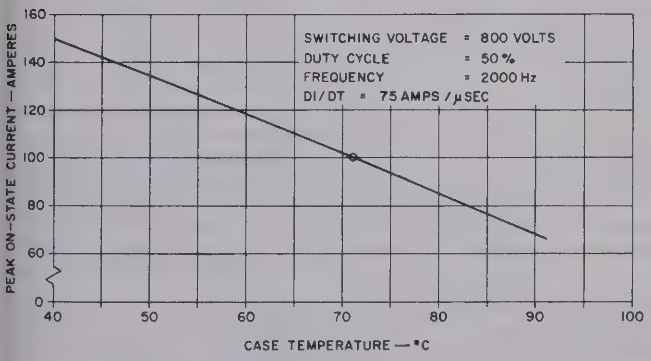
A C158 silicon controlled rectifier is to be applied in a 2000 Hz, "square" wave inverter. It is calculated that the current through the SCR will be of rectangular wave shape, with the leading edge of the current wave rising at 75 amps/μsec. The peak value of the rectangular current wave is 100 amperes and operation is at 50% duty cycle. Find the maximum allowable SCR case temperature, and the total power dissipated in the SCR.

Solution:

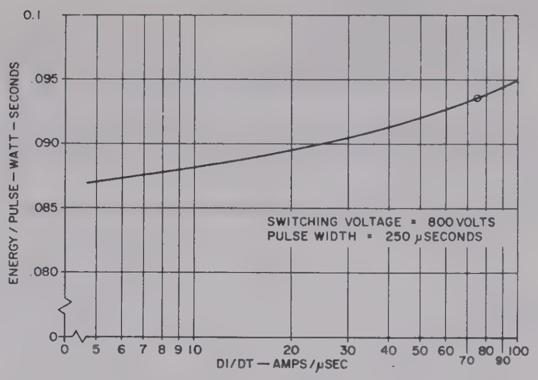
The first step in finding the maximum allowable SCR case temperature is to consult the rating curves of Figures 10, 11 and 12 which are applicable for 50% duty cycle. Since there is no curve for 2000 Hz, an interpolation is required. Peak allowable rectangular wave current at a di/dt of 75 amps/μsec versus frequency is plotted in the following chart for three given case temperatures (T_C = 40°C, 65°C and 90°C).



The interpolated peak allowable rectangular wave current at 2000 Hz is then plotted against the SCR case temperature. As shown in the chart below, this gives a maximum allowable SCR case temperature of 71°C for 100 amperes peak current at a frequency af 2000 Hz.



At 2000 Hz, the half period (50% duty cycle) and, thus, the pulse width is 250 μseconds. To find the power dissipated, the energy per pulse at 100 amperes peak current and 75 amps/μsec for a 250 μsec pulse must be found. The rating curves of Figures 20, 21 and 22 must be consulted; these curves give energy per pulse as a function of peak current and pulse width. Each curve is for a fixed di/dt of the leading edge of the rectangular current wave. Again an interpolation is required since there is no specific curve for a di/dt of 75 amps/μsec. The following curve shows such an interpolation; the energy per pulse at a di/dt of 75 amps/μsec is 0.0935 watt-seconds.



Knowing the energy per pulse, multiplying by the operating frequency gives the power dissipation.

Energy/pulse = 0.0935 watt-seconds
Frequency = 2000 Hz
Power dissipation = (0.0935 watt-seconds) x (2000 Hz)
= 187 watts

Using the unique rating curves provided by this specification, all losses (switching, blocking, conduction and gating) are readily determined by the above procedure.

Additionally, specified turn-off-time (40 μsec, max) and dv/dt (200 volts/μsec, min) is inherent in these device ratings.

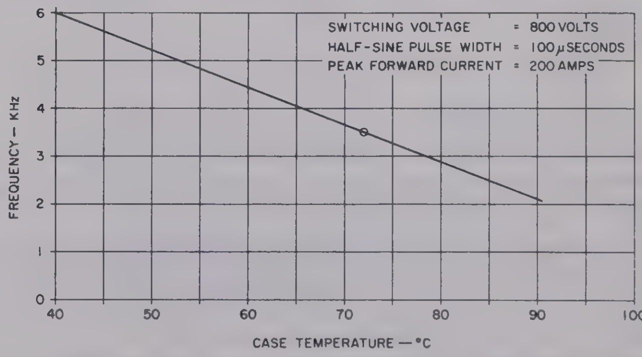
EXAMPLE II. (High Frequency, Half Sinusoidal Current Pulse)

Problem:

A C158 silicon controlled rectifier is to be applied in a 3500 Hz "sine" wave inverter. It is calculated that the current through the SCR will be half sinusoidal, the base of which is 100 μseconds wide. The peak half-sinusoidal current is 200 amperes. Find the maximum allowable SCR case temperature, and the total power dissipated in the SCR.

Solution:

For half-sinusoidal current operation, refer to the rating curves of Figures 4, 5 and 6. It is seen that the conditions of (a) 200 peak amperes, (b) 3500 Hz, and (c) 100 μsecond pulse width do not fit any of the three fixed SCR case temperatures (T_C = 40°C, 65°C and 90°C). An interpolation is required. This is accomplished by plotting the allowable *frequency* of a 100 peak ampere, 100 μsecond wide pulse as a function of case temperature; such a plot is shown in the curve below.



It is seen that the maximum allowable SCR case temperature is 72°C.

The energy dissipated by the SCR during one switching cycle is found from the rating curve of Figure 7. At 200 peak amperes for half-sinusoidal pulse, which is 100 μseconds wide (at its base), the energy per pulse is 0.05 watt-seconds. A multiplication by the switching frequency gives a total average power dissipation. As in EXAMPLE I, this multiplication includes all losses.

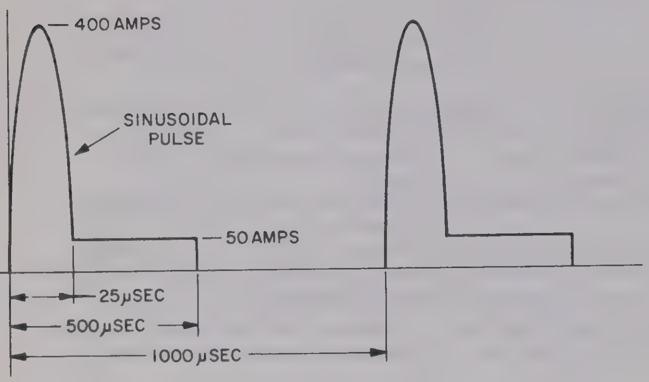
Power dissipation = (0.05 watt-seconds) x (3500 Hz)
= 175 watts

HOW TO USE THIS SPECIFICATION SHEET (Cont'd)

EXAMPLE III. (High Frequency Rectangular Current Pulse With High Initial Sinusoidal Current Pulse)

Problem:

An application demands an SCR which can switch at 1000 Hz, and can handle an On-State current waveform as shown in the following chart.

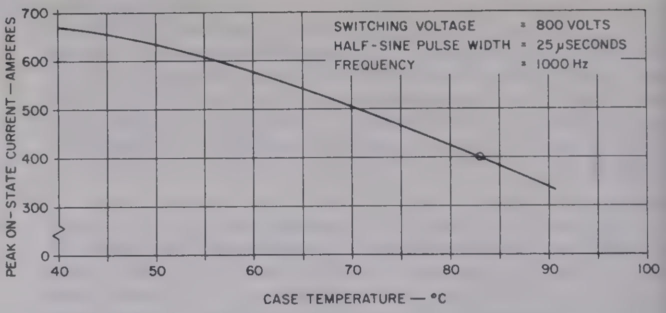


Solution:

It is desirable to divide this problem into two parts:

1. Find the maximum allowable SCR case temperature, and the power dissipation if the C158 was conducting *only the high initial half-sinusoidal pulse of current.*
2. Find the additional reduction in maximum allowable SCR case temperature due to a 50 peak ampere, 475 μsecond wide rectangular pulse at 1000 Hz. Also find the additional average power dissipation contributed by this portion of the total pulse.

Part 1 of the solution is approached by referring to the rating curves of Figure 4, 5 and 6. An interpolation between the three SCR case temperatures (T_C = 40°C, 65°C and 90°C) for a 400 peak ampere, 25 μsecond wide half-sinusoidal pulse gives a maximum allowable SCR case temperature of 83°C. The following curve demonstrates this interpolation.



From the rating curve of Figure 7 it is seen that the energy per pulse for a 400 peak ampere, 25 μsecond wide half-sinusoidal current pulse is 0.13 watt-seconds. Multiplying this figure by the switching frequency gives the average power dissipation for the *half-sinusoidal portion of the total pulse.*

Power dissipation (half-sinusoidal portion) = P_1
P_1 = (0.13 watt-seconds) x (1000 Hz)
= 130 watts

Now assume that the C158 is conducting a rectangular current pulse (500 μseconds wide) rising to a peak value of 50 amperes at a rate-of-rise of 5 amps/μsec. Switching frequency is still 1000 Hz. By referring to the rating curve of Figure 21, the energy per pulse for a 50 ampere peak, 500 μseconds wide rectangular pulse is found to be at 0.06 watt-seconds. At 1000 Hz this represents an additional 60 watts of power loss. The maximum allowable SCR case temperature must be lower than the previously calculated 83°C, in order to allow for the additional loss.

Using the relationship:

$\Delta T = P_2 \times \theta$,
where P_2 = Power dissipation due to rectangular portion of pulse
= 60 watts,
and θ = SCR steady-state thermal resistance
= 0.3°C/watt (for C158).
Then ΔT = (60 watts) x (0.3°C/watt)
= 18°C,
and the maximum allowable SCR case temperature ≐ 83°C − 18°C
= 65°C.
The total power dissipation is: $P_1 + P_2 = 130 + 60$
190 watts.

OTHER INVERTER DEVICE AND APPLICATION INFORMATION AVAILABLE FROM GENERAL ELECTRIC*

Publication Number	Title
	Specification Sheets
140.12	1N3879 Series (6 amp) Fast Recovery Diode
140.22	1N3889 Series (12 amp) Fast Recovery Diode
140.23	A28 Series (12 amp) Very Fast Recovery Diode
140.47	1N3899 Series (20 amp) Fast Recovery Diode
140.48	1N3909 Series (30 amp) Fast Recovery Diode
145.55	A96 Series (250 amp) Fast Recovery Diode
160.35	C140 Series (35A) 50-400V High Speed SCR
160.39	C144 Series (35A) 500-800V High Speed SCR
170.35	C154-7 Series (110 amp) High Speed SCR
170.36	C158, 9 Series (110 amp) High Speed SCR
170.37	C385 Series (250 amp) High Speed SCR
170.38	C358 Series (225A) High Speed SCR
170.42	C395 Series (550A) up to 600V, High Speed SCR
170.44	C388, C387 Series (550A) High Speed SCR
170.45	C398, C397 Series (700A) High Speed SCR
170.53	C185 Series (235 amp) High Speed SCR
170.57	C354, 5 Series (115 amp) High Speed SCR
170.76	C506 Series (625 amp) High Speed SCR
170.80	C510 Series (625 amp) High Speed SCR

Publication Number	Title
	Application Notes
200.38	"Application of Fast Recovery Rectifiers"
200.41	"Simple Circuits For Triggering SCR's Into Fast-Rising Load Currents"
200.42	"Commutation Behavior of Diffused High Current Rectifier Diodes"
200.49	"A Low Cost Ultrasonic Frequency Inverter Using A Single SCR"
	Technical Paper Reprints
660.13	"The Rating and Application of SCR's Designed for Switching at High Frequencies"
660.14	"Basic Magnetic Functions in Converters and Inverters Including New Soft Commutations"
660.15	"SCR Inverter Commutated By An Auxiliary Impulse"
660.16	"An SCR Inverter With Good Regulation and Sine Wave Output"
	Seminar Notes
671.4	"The Widening World of The Fast Recovery Rectifier Diode"
671.15	"The Amplifying Gate SCR"

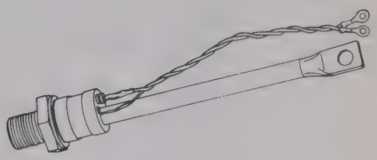
***For copies of any published information, please order by decimal publica tion number from: General Electric Company, Distribution Services, River Road, Schenectady, N. Y. 12305.**

SCR

SERIES C180

- General Electric offers basic Silicon Controlled Rectifiers for your High Power needs. Devices are available for your selection on the basis of voltage. The C180 series feature guaranteed dv/dt of 200 volts per microsecond at rated voltages.
- These Units Feature Immunity to Forward Voltage Destruction†

†For special selections of Turn-Off time, please contact your G-E Electronic Components Sales Operation Office.



MAXIMUM ALLOWABLE RATINGS

Type	Peak Forward Blocking Voltage, V_{FOM}* $T_C = -40°C$ to $+120°C$	Repetitive Peak Reverse Voltage V_{ROM} (rep)* $T_C = -40°C$ to $+120°C$	Non-repetitive Peak Reverse Voltage (<5.0 Millisec. V_{ROM} (Non rep) $T_C = -40°C$ to $+120°C$
C180 A	100 volts	100 volts	200 volts
C180 B	200	200	300
C180 C	300	300	400
C180 D	400	400	500
C180 E	500	500	600
C180 M	600	600	720
C180 S	700	700	840
C180 N	800	800	950
C180 T	900	900	1075
C180 P	1000	1000	1200
C180 PA	1100	1100	1325
C180 PB	1200	1200	1450
C180 PC	1300	1300	1550

RMS Forward Current, On-State . . . 235 amperes (all conduction angles)
Average Forward Current, On-State . . . Depends on conduction angle. (See charts.)
Peak One-cycle Surge Forward Current, I_{FM} (surge) . . . C180 . . . 3500 amperes

Maximum Rate of Rise of Anode Current During Turn-on Interval
(High Gate Drive Required, Chart 35) : . . .
C180, A—E . . . 100A/μsec
C180, M—P . . . 75A/μsec
C180, PA—PB . . . 50A/μsec
C180PC . . . 50A/μsec

I^2t (for fusing) (for times ≤ 1.5 milliseconds) . . . C180 = 32,000 ampere² seconds
Peak Gate Power Dissipation, P_{GM} . . . 10 watts
Average Gate Power Dissipation, $P_{G(AV)}$ . . . 2 watts
Peak Reverse Gate Voltage, V_{GRM} . . . 5 volts
Storage Temperature, T_{stg} . . . −40°C to +150°C
Operating Temperature . . . −40°C to +125°C
Stud Torque . . . 250 lb-in (290 kg-cm) min., 300 lb-in (345 kg-cm) max.

*Ratings apply for zero or negative gate voltage. Maximum heatsink thermal resistance for which maximum PRV ratings apply equal 1.5°C/watt.

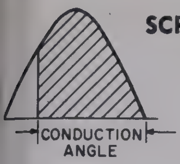
†These devices may be turned on in the forward direction by exceeding the forward breakover voltage (V_{BO}) with either a rapidly, or slowly, rising waveform. This has been confirmed in the laboratory by using a 3 kv. open circuit voltage, a 4 ampere short circuit current, a 0.1 μsec. risetime supply, and a 60 cycle half sine wave of voltage.

CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Peak Reverse and Forward Blocking Current	I_{ROM} and I_{FOM}				ma	$T_C = +25°C$
C180, A		—	3	10		$V_{FOM} = V_{ROM} =$ 100V peak
C180, B		—	3	10		200V peak
C180, C		—	3	10		300V peak
C180, D		—	3	10		400V peak
C180, E		—	3	10		500V peak
C180, M		—	3	10		600V peak
C180, S		—	3	10		700V peak
C180, N		—	3	10		800V peak
C180, T		—	3	9		900V peak
C180 P		—	3	7		1000V peak
C180 PA		—	3	7		1100V peak
C180 PB		—	3	6		1200V peak
C180 PC		—	3	5		1300V peak
Peak Reverse and Forward Blocking Current	I_{ROM} and I_{FOM}				ma	$T_C = +120°C$
C180, A			15	20		$V_{FOM} = V_{ROM} =$ 100V peak
C180, B			15	20		200V peak
C180, C			15	20		300V peak
C180, D			15	20		400V peak
C180, E			15	20		500V peak
C180, M			15	20		600V peak
C180, S			15	20		700V peak
C180, N			15	20		800V peak
C180, T			15	18		900V peak
C180, P			12	15		1000V peak
C180, PA			11	14		1100V peak
C180, PB			10	13		1200V peak
C180 PC			8	11		1300V peak
Effective Thermal Resistance	θ_{J-C}	—	.12	.14	°C/watt	Junction to case (DC)
Exponential Rate of Rise of Forward Blocking Voltage that will not turn-on SCR	dv/dt	200	500	—	V/μsec	$T_C = +120°C$, Gate open circuited, $V_{FOM} =$ Rated, $dv/dt = \left(\frac{V_{FOM}}{\tau}\right)(.632)$
Holding Current	I_{HO}	—	75	500	mAdc	$T_C = +25°C$, Anode supply = 24Vdc, Initial Forward Current = 2.5A
Turn-On Time (Delay Time + Rise Time)	$t_d + t_r$	—	8	—	μsec	$T_C = +25°C$, $I_F = 100$Adc, $V_{FXM} =$ rated, Gate supply: 10 volt open circuit, 25 ohm, 0.1 μsec max. rise time.
Gate Pulse Width Necessary to Trigger		—	8	10	μsec	Gate supply: 5 volt open circuit, 5 ohm, .1 μsec rise time. $I_F = 1$ amp. For high di/dt capability see Chart 35.
Gate Trigger Current C180	I_{GT}	—	100	150	mAdc	$T_C = +25°C$, $V_{FX} = 6$Vdc, $R_L = 12$ ohms
		—	—	200		$T_C = -40°C$, $V_{FX} = 6$Vdc, $R_L = 12$ ohms
		—	—	125		$T_C = +120°C$, $V_{FX} = 6$Vdc, $R_L = 12$ ohms
Gate Trigger Voltage C180	V_{GT}	—	1.25	3.0	Vdc	$T_C = -40°C$ to $+120°C$, $V_{FX} = 6$Vdc, $R_L = 12$ ohms
		0.15	—	—		$T_C = +120°C$, $V_{FX} = 6$Vdc, $R_L = 12$ ohms
Peak On-Voltage C180	V_{FM}	—	2.3	2.85	V	$T_C = +25°C$, $I_{FM} = 1500$A Peak Duty Cycle $\leqq$ .01%

*Maximum heat sink thermal resistance ≤ 1.5°C/W
†Consult factory if guaranteed time is required

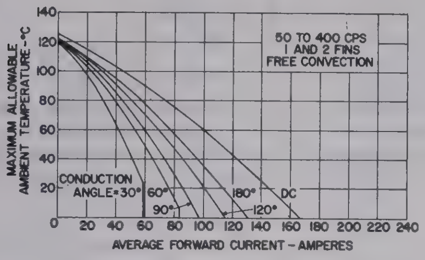
SERIES C180



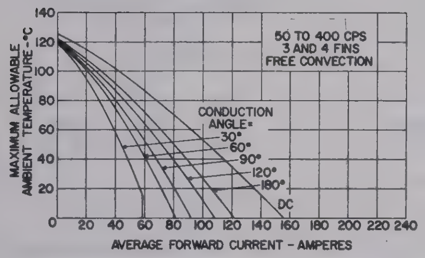
SCR MOUNTED ON HEATSINK SINUSOIDAL WAVEFORM

FREE CONVECTION

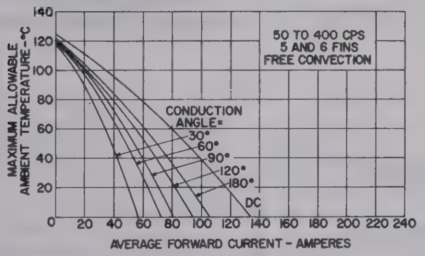
1 & 2 FINS



3 & 4 FINS

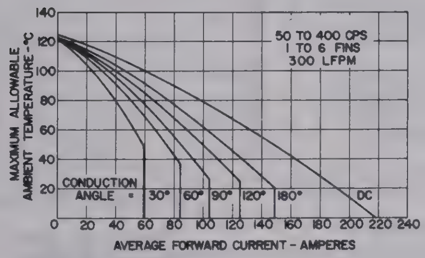


5 & 6 FINS



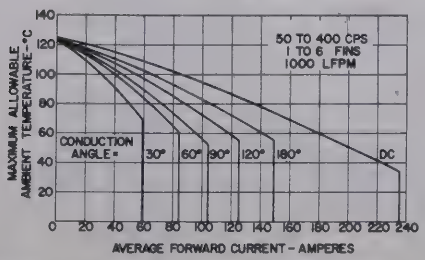
300 LFPM

1-6 FINS

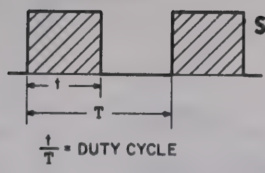


1000 LFPM

1-6 FINS



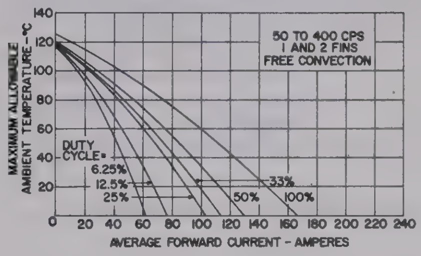
MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



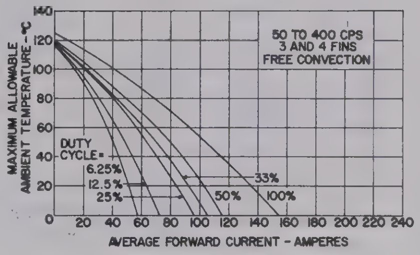
SCR MOUNTED ON HEATSINK RECTANGULAR WAVEFORM

FREE CONVECTION

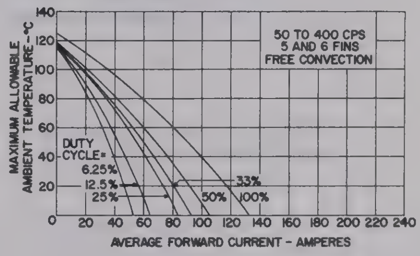
1 & 2 FINS



3 & 4 FINS

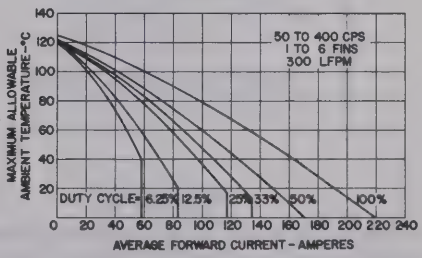


5 & 6 FINS



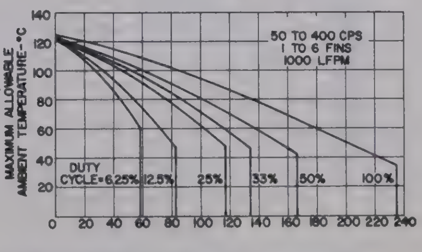
300 LFPM

1-6 FINS



1000 LFPM

1-6 FINS



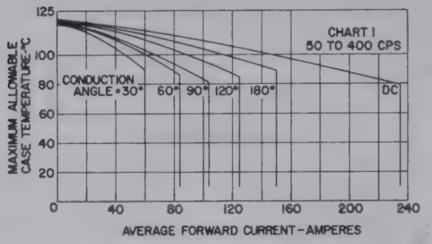
MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM

SERIES C180

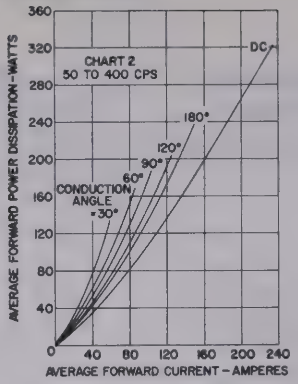
SCR SPECIFICATIONS

SINUSOIDAL WAVEFORM

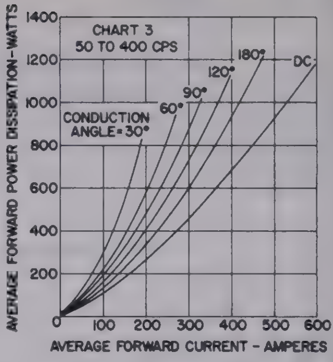
C180



MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



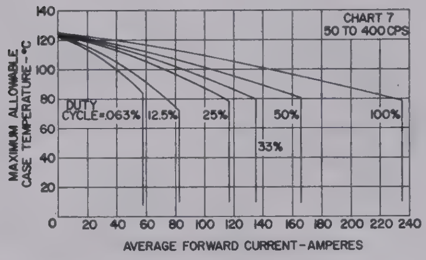
AVERAGE FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



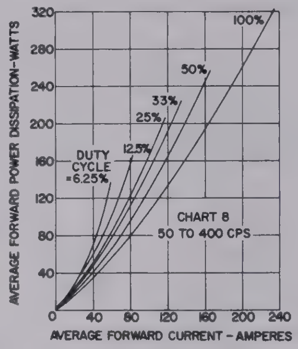
EXTENDED FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM

RECTANGULAR WAVEFORM

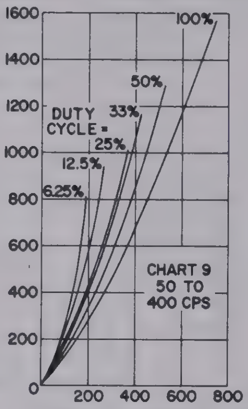
C180



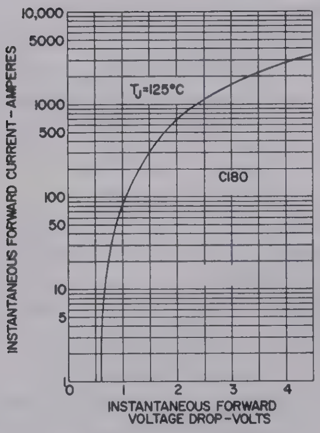
MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



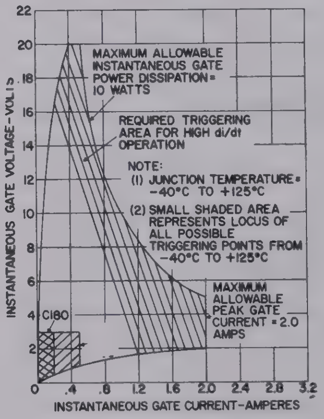
AVERAGE FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



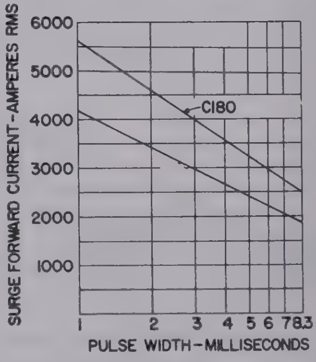
EXTENDED FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



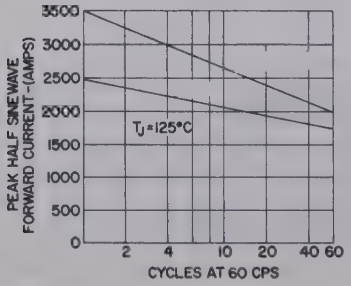
MAXIMUM FORWARD CHARACTERISTICS, ON-STATE



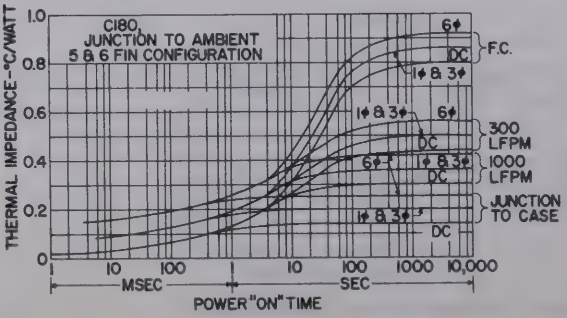
GATE TRIGGERING CHARACTERISTIC



SUB-CYCLE SURGE FORWARD CURRENT, NON-REPETITIVE



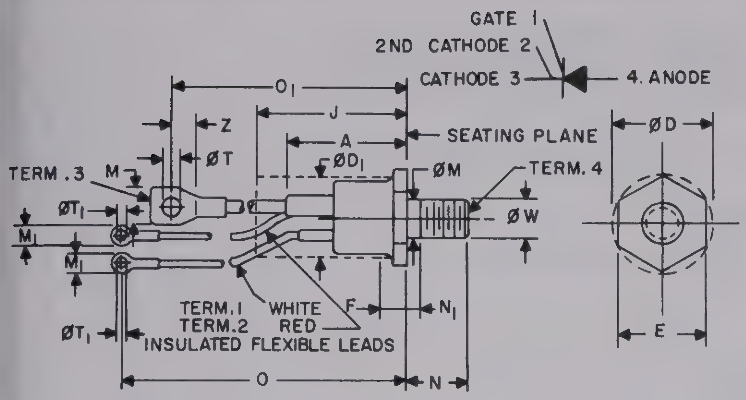
MAXIMUM ALLOWABLE SURGE CURRENT AT RATED LOAD CONDITIONS



TRANSIENT THERMAL IMPEDANCE

SERIES C180

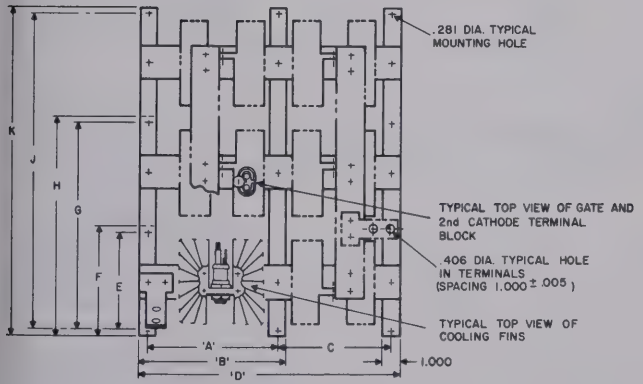
OUTLINE DRAWINGS

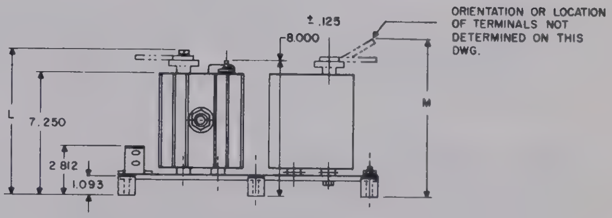

GATE 1
2ND CATHODE 2
CATHODE 3
4. ANODE
O1
Z
J
ØT
A
SEATING PLANE
ØD
TERM. 3
M
ØD1
ØM
TERM. 4
ØT1
M1
ØW
M1
TERM.1
TERM.2
WHITE
RED
F
N1
E
ØT1
INSULATED FLEXIBLE LEADS
O
N

SYMBOL	MILLIMETERS		INCHES		NOTES
	Min.	Max.	Min.	Max.	
A	39.75	57.15	1.565	2.250	
ØD		36.65		1.443	7
ØD₁		30.94		1.218	1
E	30.94	31.75	1.218	1.250	
F	5.84	10.16	.230	.400	5
J		82.55		3.250	1,8
M	13.46	19.18	.530	.755	2
ØM	17.78	19.02	.700	.749	
M₁	5.46	7.62	.215	.300	2
N	26.59	27.36	1.047	1.077	1,4
N₁		3.96		.156	3
O	186.69	205.74	7.350	8.100	
O₁	186.69	205.74	7.350	8.100	
ØT	7.87	8.74	.310	.344	
ØT₁	3.56	3.94	.140	.155	
ØW	17.853	18.018	.7029	.7094	4
Z	8.64		.340		6

NOTES:

1. The device with exception of the hexagon thread and flexible leads lies within the cylinder diameter ØD₁ and length J.
2. Angular orientation of these terminals with respect to hex portion is undefined. Square or radius on end of terminals is optional.
3. Length of incomplete or undercut threads.
4. Pitch diameter of ¾ -16 UNF-2A (coated) threads.(ASA B1.1).
5. A chamfer (or undercut) on one or both ends of hex portion is optional.
6. Minimum flat.
7. Diameter of seating surface.
8. Seated height with lead bent 90°
9. Dimensions should be used for estimating only.


.281 DIA. TYPICAL MOUNTING HOLE
K
J
H
G
F
E
TYPICAL TOP VIEW OF GATE AND 2nd CATHODE TERMINAL BLOCK
.406 DIA. TYPICAL HOLE IN TERMINALS (SPACING 1.000 ± .005)
TYPICAL TOP VIEW OF COOLING FINS
'A'
'B'
C
'D'
1.000


± .125
8.000
ORIENTATION OR LOCATION OF TERMINALS NOT DETERMINED ON THIS DWG.
L
7.250
M
2.812
1.093

No. of FINS	A±.032	B±.062	C±.032	D±.062	E±.032	F±.062	G±.045	H±.062	J±.045	K±.062	L±.156	M±.156	Weight lbs.
1	7.625	8.625	—	—	5.500	6.250	—	—	—	—	—	8.937	3.33
2	7.625	8.625	—	—	5.500	—	11.812	12.562	—	—	8.827	—	6.66
2	7.625	8.625	—	—	5.500	—	11.812	12.562	—	—	—	—	6.66
4	7.625	—	6.500	15.125	5.500	—	11.812	12.562	—	—	8.827	—	13.32
4	7.625	—	6.500	15.125	5.500	—	11.812	12.562	—	—	8.827	—	13.32
6	7.625	—	6.500	15.125	5.500	—	11.812	—	18.125	18.875	8.827	—	20.00

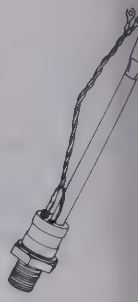
— means not present

HIGH SPEED
Silicon Controlled Rectifier

C185

600 Volts **300A RMS**

The General Electric Type C185 Silicon Controlled Rectifier is a reverse blocking triode thyristor designed primarily for power switching from 60–1000 Hz. This rugged SCR has been field proven for more than 6 years in applications like choppers, PWM motor controls, uninterruptible power supplies, and inverters.



For efficient operation in high speed applications, the C185 SCR provides a superior mix of capabilities:

- Forward and reverse blocking voltage to 600 volts
- 20 µsec turn-off-time maximum with shorter turn-off-times available from factory upon special request
- High di/dt and dv/dt at rated frequencies
- Low switching losses

MAXIMUM ALLOWABLE RATINGS

Types	Repetitive Peak Off-State Voltage, V_{DRM}(1)(2) $T_C = -40°C$ to $+125°C$	Repetitive Peak Reverse Voltage, V_{RRM}(1)(2) $T_C = -40°C$ to $+125°C$	Non-repetitive Peak Reverse Voltage, V_{RSM}(1)(3) $T_C = -40°C$ to $+125°C$
C185A	100 Volts	100 Volts	200 Volts
C185B	200	200	300
C185C	300	300	400
C185D	400	400	500
C185E	500	500	600
C185M	600	600	720

(1) Values apply for gate terminal open-circuited (negative gate bias is permissible).

(2) Ratings apply for zero or negative gate voltage. Maximum case to ambient thermal resistance for which maximum V_{DRM} and maximum V_{RRM} ratings apply equals 1.1°C/watt.

(3) Half sine wave voltage pulse, 10 millisecond maximum duration.

Peak Positive Anode Voltage	None*
RMS On-State Current, $I_{T(RMS)}$	235 Amperes
Average On-State Current, $I_{T(AV)}$	(see Charts)
Peak One Cycle Surge (non-rep) On-State Current, I_{TSM}	3500 Amperes
I^2t (for fusing) for times $\geqq$ 1.5 milliseconds	35,000 Ampere^2 seconds
I^2t (for fusing) for times $\geqq$ 8.3 milliseconds	50,000 Ampere^2 seconds
Critical Rate-of-Rise of On-State Current, di/dt, During Turn-On Interval	100 Amperes per microsecond**
Peak Gate Power Dissipation, P_{GM} .... (Pulse Width = 10 µsec)	400 Watts
Average Gate Power Dissipation, $P_{G(AV)}$	2 Watts
Peak Negative Gate Voltage, V_{GM}	20 Volts
Storage Temperature, T_{STG}	−40°C to +150°C
Operating Temperature, T_J	−40°C to +125°C
Stud Torque	300 Lb-in (Max), 250 Lb-in (Min) 345 Kg-cm (Max), 290 Kg-cm (Min)

***This SCR may be, non-repetitively, turned-on in the forward direction by exceeding the breakover voltage (V_{DRM}) with either a rapidly or slowly rising waveform. At breakover, di/dt must be limited to 20 amps/µsec and peak current to 1000 amperes.**

****Required trigger source—20 volts, 20 ohms; maximum switching voltage—V_{DRM}-volts; short-circuit gate supply current risetime—0.25 µsec. (This short-circuit current may be measured with a TEKTRONICS current probe.) RC Snubber circuit used across SCR—(see Figure 6).**

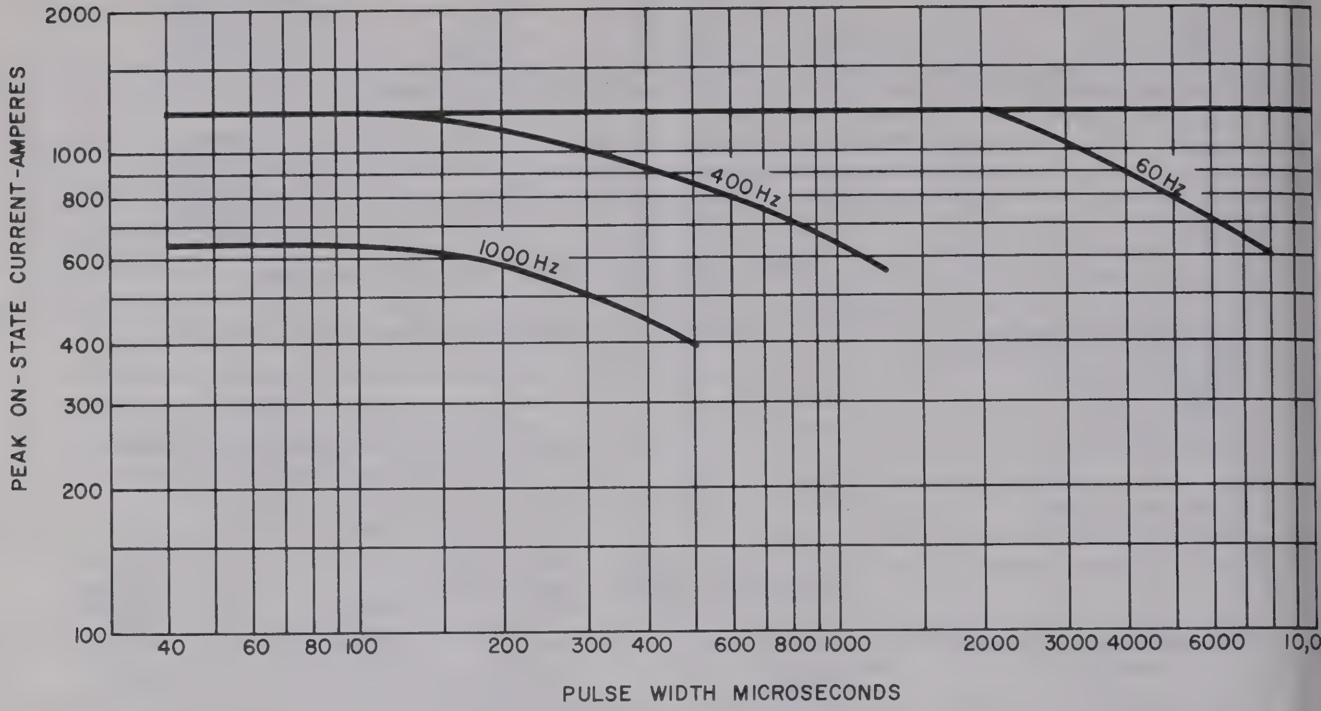
di/dt rating is established in accordance with JEDEC Suggested Standard No. 7, Section 5.1.2.4. Immediately after each current pulse, off-state (blocking) voltage capability may be temporarily lost for durations less than the period of the applied pulse repetition rate. The pulse repetition rate for this test is 400 Hz. The duration of the JEDEC di/dt test condition is 5.0 seconds (minimum).

di/dt up to 100 amps/µsec, at specified gate drive and switching voltage is part of the rectangular current wave ratings (see rating curves of Figures 12 through 35. This is a repetitive, long-term rating confirmed by life test.

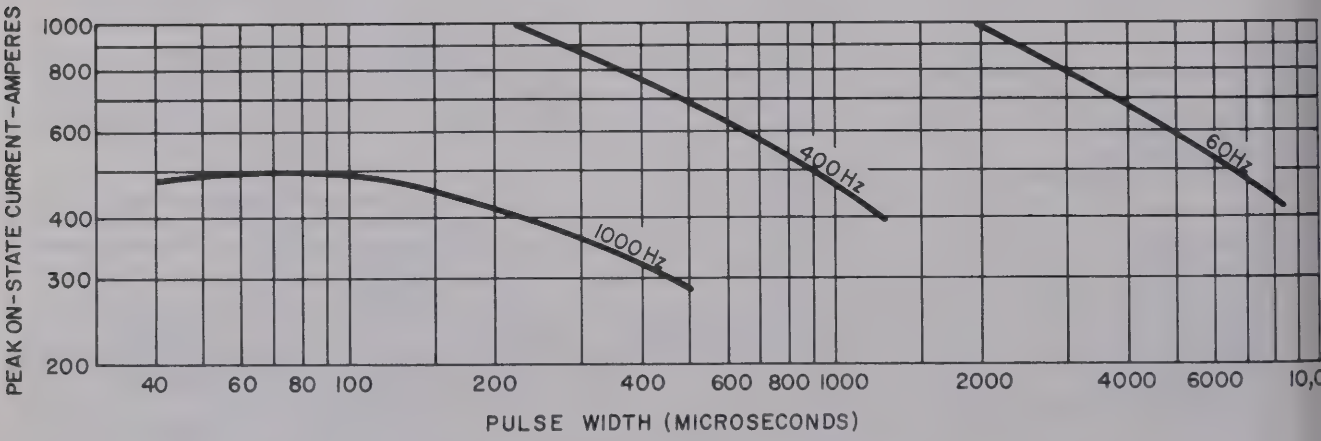
CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Peak Reverse and Off-State Current	I_{DRM} and I_{RRM}				mA	T_C = +25°C
C185A		—	3	10		$V_{DRM} = V_{RRM}$ = 100 Volts peak
C185B		—	3	10		200 Volts peak
C185C		—	3	10		300 Volts peak
C185D		—	3	10		400 Volts peak
C185E		—	3	10		500 Volts peak
C185M		—	3	10		600 Volts peak
Peak Reverse and Off-State Current	I_{DRM} and I_{RRM}				mA	T_C = 125°C
C185A		—	15	20		$V_{DRM} = V_{RRM}$ = 100 Volts peak
C185B		—	15	20		200 Volts peak
C185C		—	15	20		300 Volts peak
C185D		—	15	20		400 Volts peak
C185E		—	15	20		500 Volts peak
C185M		—	15	20		600 Volts peak
Effective Thermal Resistance	θ_{J-C}	—	.12	.15	°C/watt	Junction to case (DC)
Critical Exponential Rate of Rise of Forward Blocking Voltage (Higher values may cause device switching)	dv/dt	200	500	—	V/μsec	V_{DRM}, T_C = +125°C, Gate open.
Holding Current	I_H	—	75	500	mAdc	T_C = +25°C, Anode supply = 24Vdc. Initial forward current = 2.5 amps.
Pulse Gate Trigger Current and Voltage	$i_{GT(pulse)}$	—	1	2	Amps.	T_C = +25°C, t_p = 10 μsec.
	$V_{GT(pulse)}$	—	8	10	Volts	0.25 μsec rise time.
DC Gate Trigger Current	I_{GT}	—	125	300	mAdc	T_C = +25°C, V_D = 6Vdc, R_L = 12 ohms.
		—	175	500	mAdc	T_C = −40°C, V_D = 6Vdc, R_L = 12 ohms.
		—	100	250	mAdc	T_C = +125°C, V_D = 6Vdc, R_L = 12 ohms.
DC Gate Trigger Voltage	V_{GT}	—	1.5	3.0	Vdc	T_C = −40°C to +125°C, V_D = 6Vdc, R_L = 12 ohms.
		0.15	—	—	Vdc	T_C = +125°C, V_{DRM}, R_L = 1000 ohms.
Peak On-State Voltage	V_{TM}	—	2.3	2.85	Volts	T_C = +25°C, I_{TM} = 1500A peak. Duty cycle ≦ .01%.
Delay Time	t_d	—	1	2	μsec	T_C = +25°C, I_T = 50Adc, V_{DRM}, Gate supply: 10 volt open circuit, 20 ohm, 0.1 μsec max. rise time.
Conventional Circuit Commutated Turn-Off-Time (with Reverse Voltage)	t_q	—	15	20	μsec	(1) T_C = +125°C, (2) I_T = 250A, (3) V_R = 50 volts min., (4) V_{DRM} (reapplied), (5) Rate of rise of reapplied forward blocking voltage = 20V/μsec (linear). (6) Commutation di/dt = 12.5 Amps/μsec. (7) Duty/cycle ≦ .01%. (8) Gate bias during turn-off interval = 0 volts, 100 ohms.
Conventional Circuit Commutated Turn-Off-Time (with Feedback Diode)	$t_{q(diode)}$	—	20	30	μsec	(1) T_C = +125°C, (2) I_T = 250A. (3) V_R = 1 volt (Forward drop of GE A96 rectifier diode at I_T = 250A), (4) V_{DRM}, (5) Rate of rise of reapplied forward blocking voltage = 20V/μsec (linear). (6) Commutation di/dt = 12.5 Amps/μsec. (7) Duty cycle ≦ .01%. (8) Gate bias during turn-off interval = 0 volts, 100 ohms.
Pulse Circuit Commutated Turn-Off-Time (with Reverse Voltage)	$t_{q(pulse)}$	—	15	20	μsec	(1) T_C = +125°C, V_{DRM} (reapplied), (2) Rate of rise of reapplied forward blocking voltage = 20V/μsec (linear) (3) Rep. rate = 400 Hz., (4) Gate supply = 2 volts, 20 ohms, 0.25 μsec max. rise time, (5) I_T = 500A peak, t_p = 3 μsec (half sine wave), (6) V_R = 50 volts min.
Pulse Circuit Commutated Turn-Off-Time (with Feedback Diode)	$t_{q(pulse)(diode)}$	—	20	30	μsec	(1) T_C = +125°C, V_{DRM} (reapplied), (2) Rate of rise of reapplied forward blocking voltage = 20 V/μsec (linear), (3) Rep. rate = 400 Hz., (4) Gate supply = 20 volts, 20 ohms, 0.25 μsec max. rise time, (5) I_T = 500A peak, t_p = 3 μsec (half sine wave), (6) V_R = 1.5 volt (Forward drop of GE A96 rectifier diode at I_T = 500A).

SINE WAVE DATA



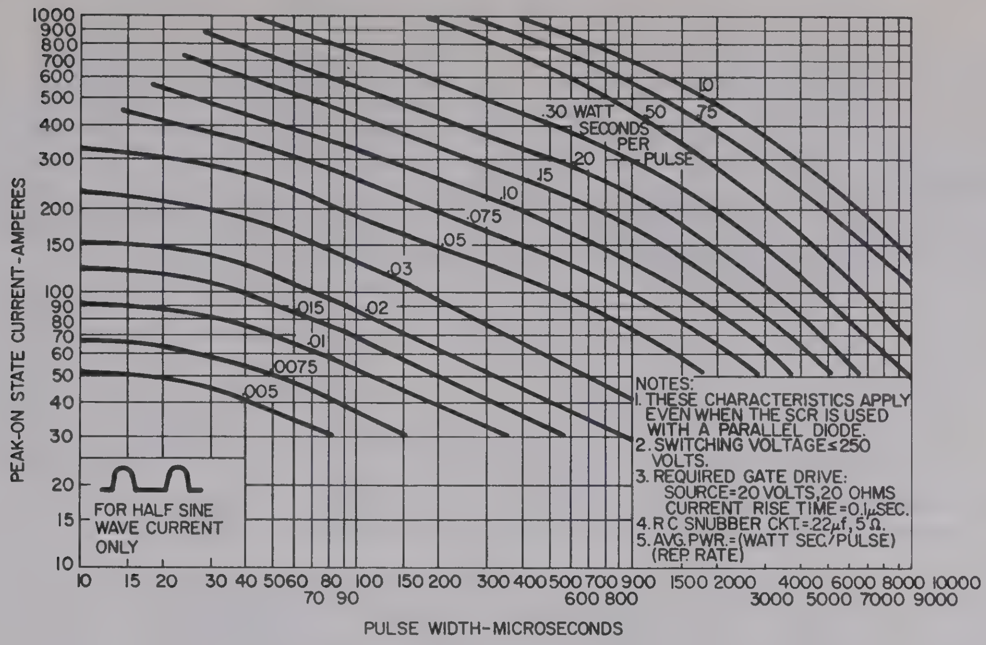
1. Maximum allowable peak on-state current vs. pulse width (T_C = 65°C)



2. Maximum allowable peak on-state current vs. pulse width (T_C = 90°C)

NOTES:
(1) Switching voltage—250 volts (2) Min. circuit turn-off-time ≥ 20 μsec. (3) Max. circuit dv/dt ≤ 200 V/μsec. (4) Required gate drive source = 20 volts, 20 ohms current rise time .1 μsec. (5) RC Snubber—.22 μf, 5 ohm.

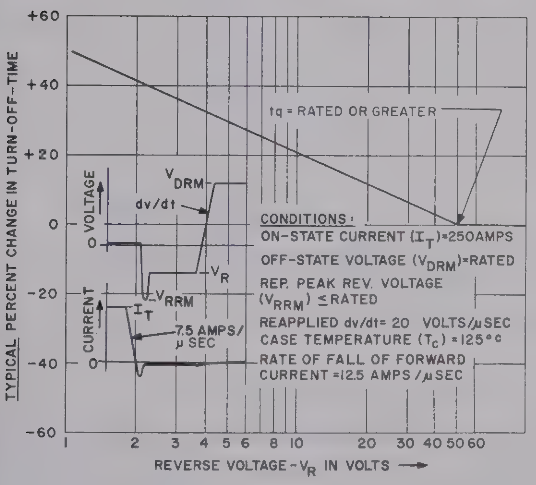
SINE WAVE DATA



NOTES:
1. THESE CHARACTERISTICS APPLY EVEN WHEN THE SCR IS USED WITH A PARALLEL DIODE.
2. SWITCHING VOLTAGE≤250 VOLTS.
3. REQUIRED GATE DRIVE: SOURCE=20 VOLTS, 20 OHMS CURRENT RISE TIME=0.1μSEC.
4. R C SNUBBER CKT.=.22μf, 5 Ω.
5. AVG. PWR.=(WATT SEC./PULSE)(REP. RATE)

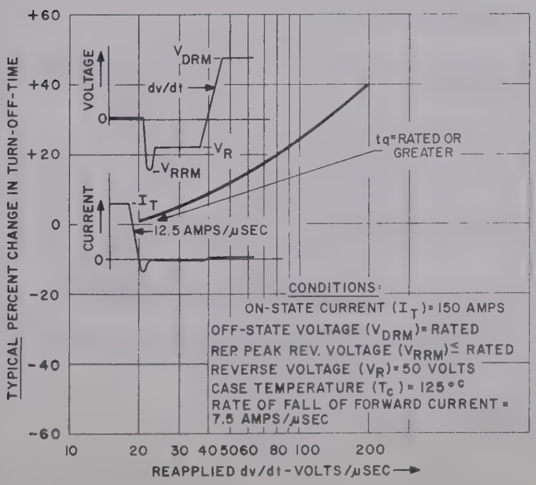
3. Energy per pulse for sinusoidal pulses

TURN-OFF-TIME DATA



CONDITIONS:
ON-STATE CURRENT (I_T)=250AMPS
OFF-STATE VOLTAGE (V_{DRM})=RATED
REP. PEAK REV. VOLTAGE (V_{RRM}) ≤RATED
REAPPLIED dv/dt= 20 VOLTS/μSEC
CASE TEMPERATURE (T_c) = 125°C
RATE OF FALL OF FORWARD CURRENT =12.5 AMPS /μSEC

4. This curve shows a typical variation of SCR conventional circuit commutated turn-off-time with applied reverse voltage (V_R) during the turn-off interval. Testing at V_R = "1 volt" is done with a GE A96 fast recovery diode in inverse parallel with the C185. For SCR's with specified maximum turn-off-time with an inverse parallel diode—consult the factory.

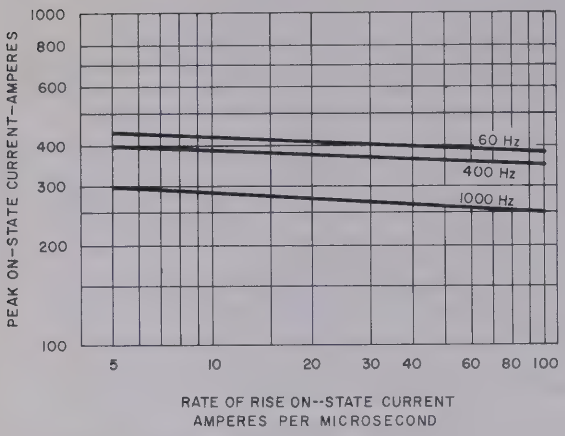


CONDITIONS:
ON-STATE CURRENT (I_T)= 150 AMPS
OFF-STATE VOLTAGE (V_{DRM})= RATED
REP. PEAK REV. VOLTAGE (V_{RRM})≤ RATED
REVERSE VOLTAGE (V_R)= 50 VOLTS
CASE TEMPERATURE (T_c) = 125°C
RATE OF FALL OF FORWARD CURRENT = 7.5 AMPS/μSEC

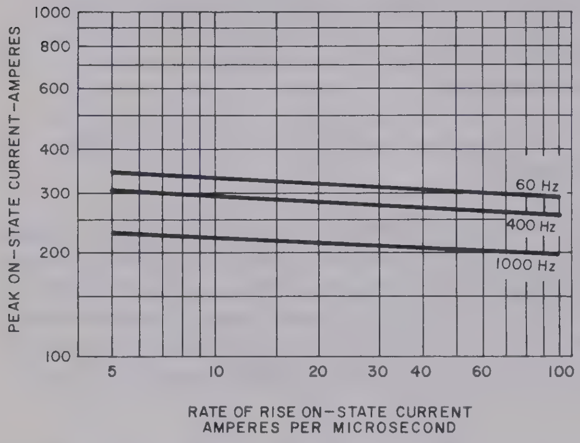
5. This curve shows a typical variation of SCR conventional circuit commutated turn-off-time with reapplied dv/dt. Specified turn-off-time is with reapplied dv/dt of 20 volts/μsec. Note turn-off-time increase at higher dv/dt. When requesting selected turn-off-time also specify maximum reapplied dv/dt.

RECTANGULAR WAVE DATA SWITCHING VOLTAGE - 500 VOLTS DOUBLE-SIDE COOLING

DUTY CYCLE—50%

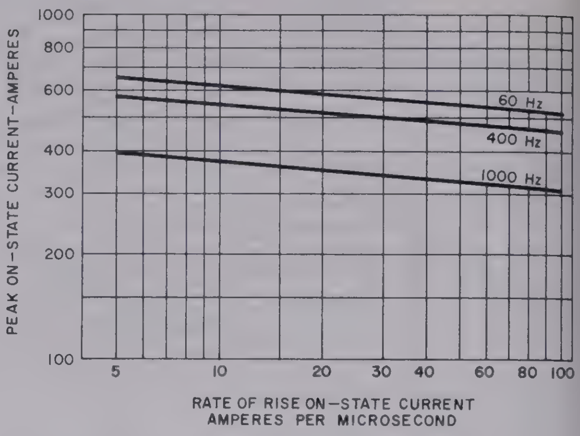


6. **Maximum allowable peak on-state current vs. di/dt (T_C = 65°C)**

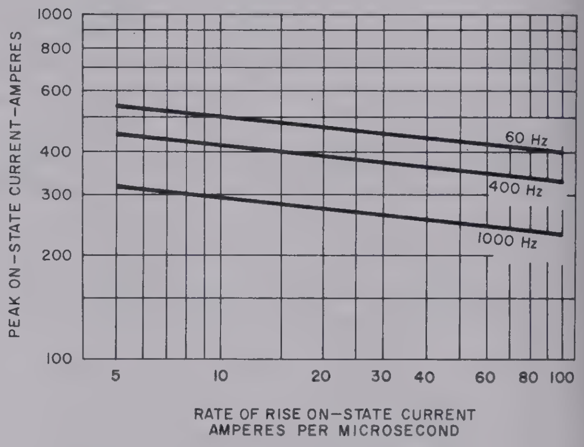


7. **Maximum allowable peak on-state current vs. di/dt (T_C = 90°C)**

DUTY CYCLE—25%

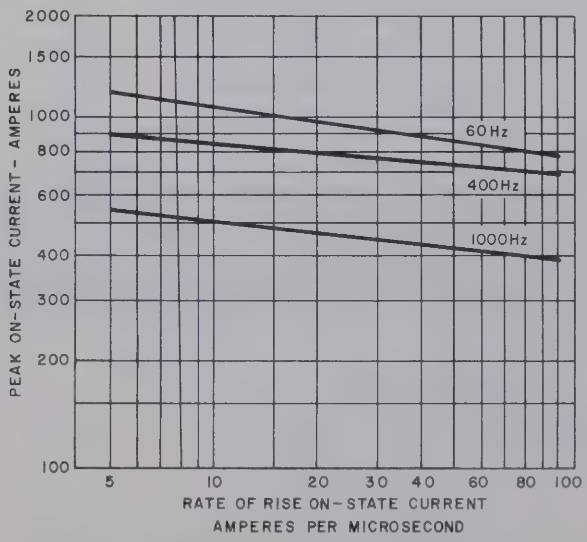


8. **Maximum allowable peak on-state current vs. di/dt (T_C = 65°C)**

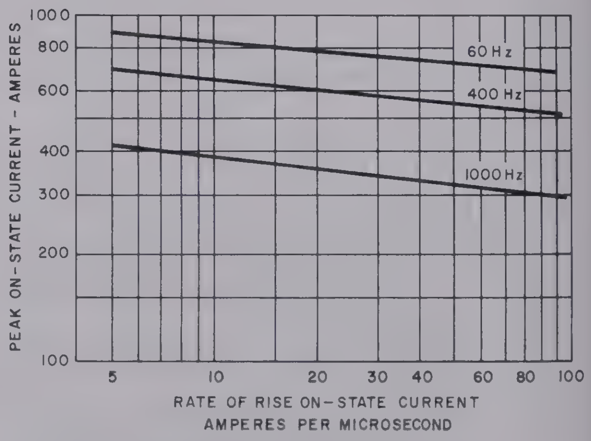


9. **Maximum allowable peak on-state current vs. di/dt (T_C = 90°C)**

DUTY CYCLE—10%



10. **Maximum allowable peak on-state current vs. di/dt (T_C = 65°C)**

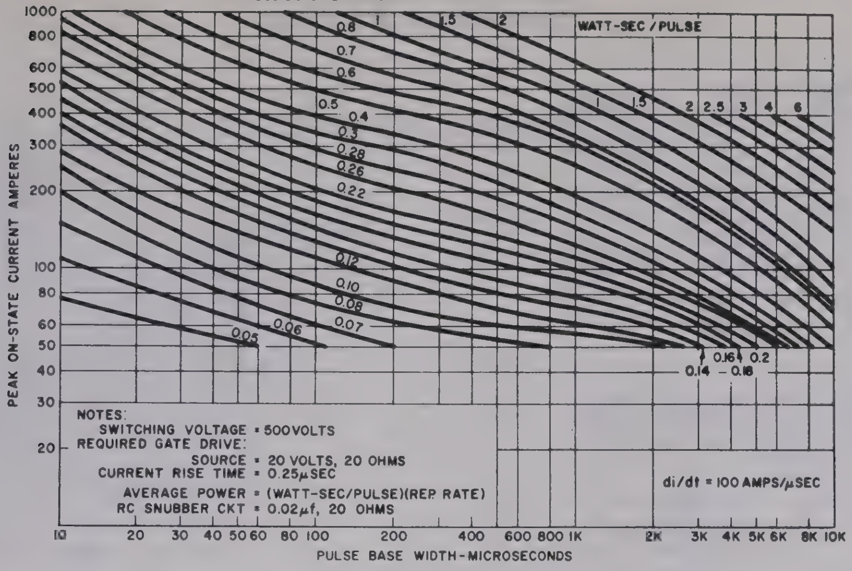


11. **Maximum allowable peak on-state current vs. di/dt (T_C = 90°C)**

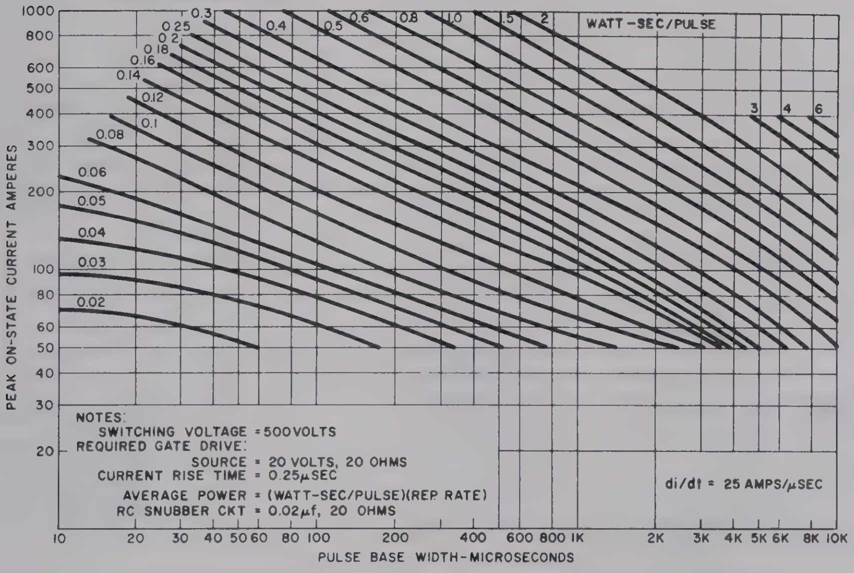
NOTES:
(1) Off-state voltage—500 volts (2) RC Snubber—.02 μf, 20 ohms (3) Turn-off-time ≥ 20 μsec. (4) Max. dv/dt ≤ 200 V/μsec
(5) Required gate drive—20 volts, 20 ohms, .1 μsec. rise time.

RECTANGULAR WAVE DATA SWITCHING VOLTAGE - 500 VOLTS

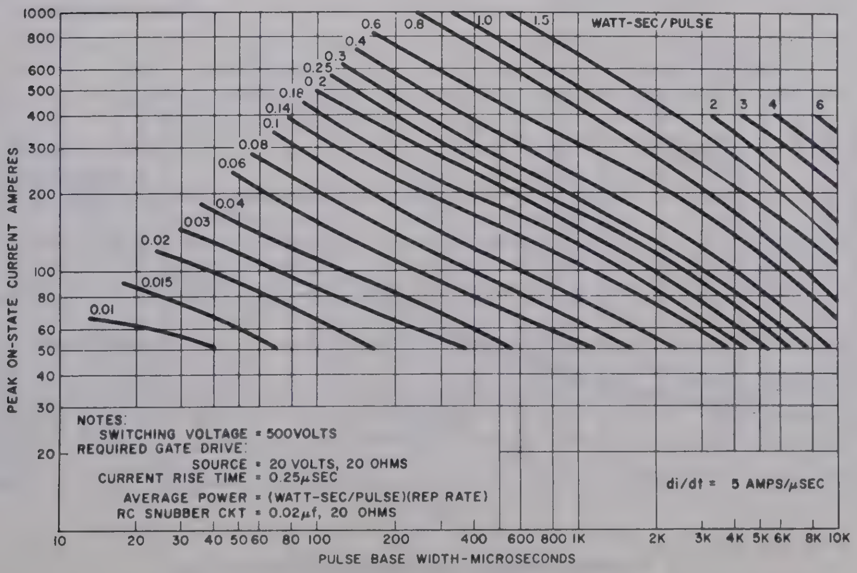
WATT-SECOND PER PULSE



12. Energy per pulse vs. peak current and pulse width (di/dt = 100 A/μsec.)

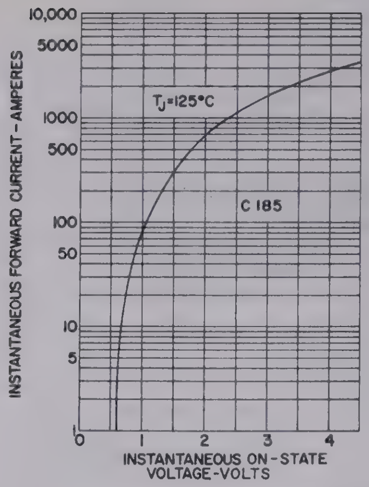


13. Energy per pulse vs. peak current and pulse width (di/dt = 25 A/μsec.)

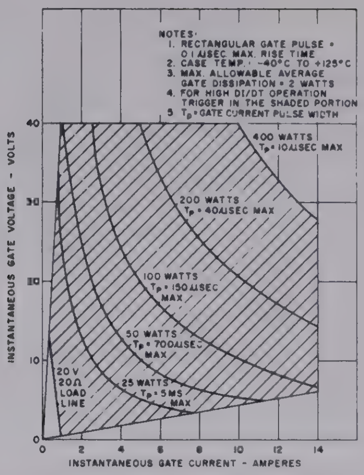


14. Energy per pulse vs. peak current and pulse width (di/dt = 5 A/μsec.)

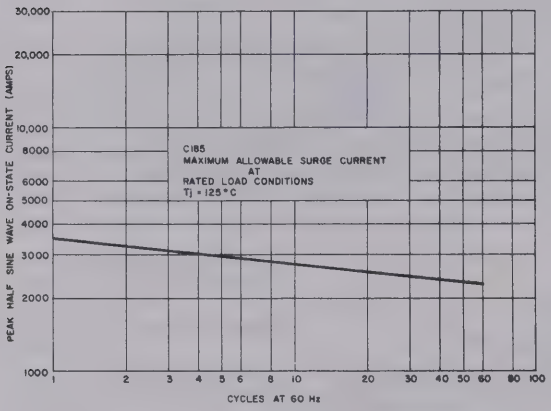
LOW FREQUENCY DATA



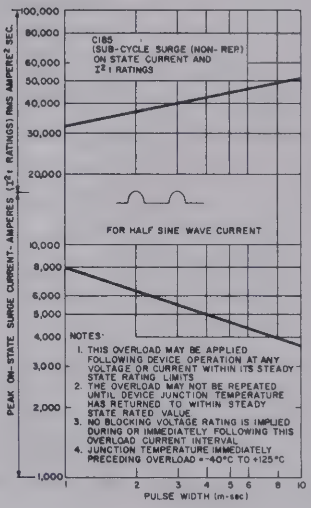
15. Forward conduction characteristic, on-state



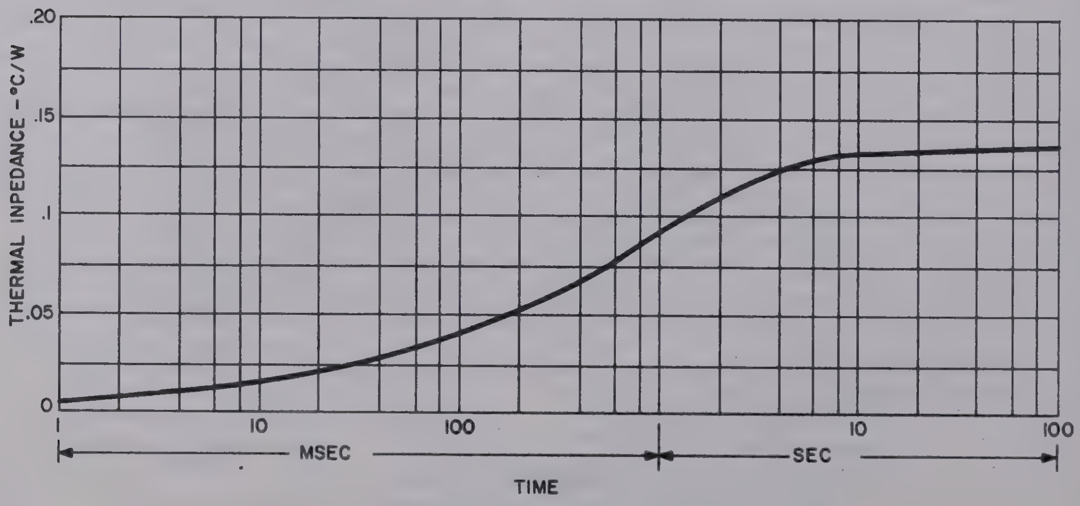
16. Maximum allowable peak gate power vs. gate pulse width



17. Maximum allowable surge current following rated load conditions

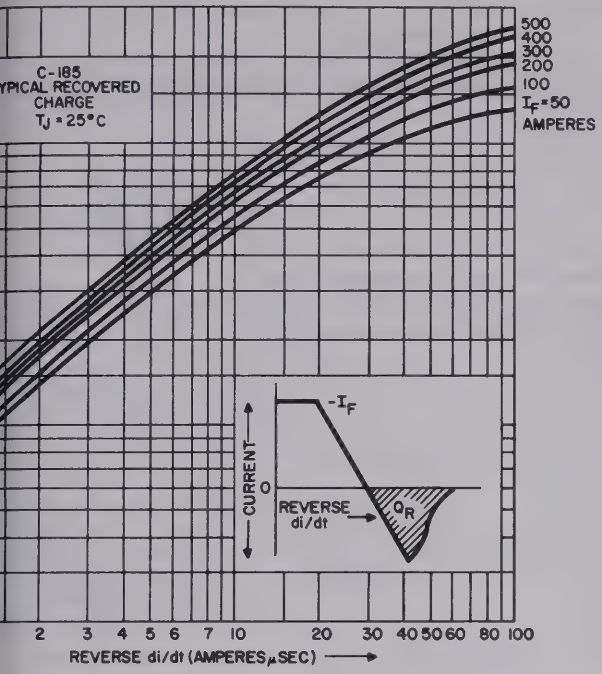


18. Sub-cycle surge and I^{2}t ratings following rated load conditions

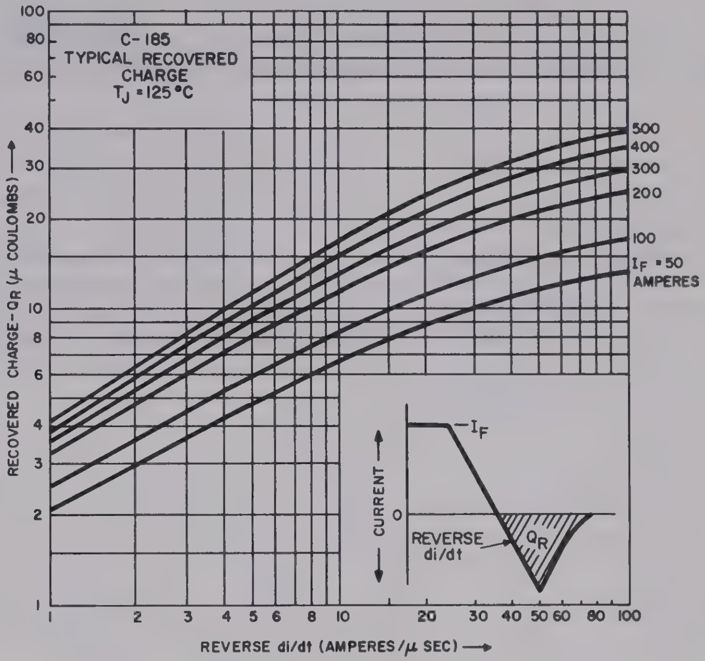


19. Transient thermal impedance, junction to case

C185 RECOVERED CHARGE DATA



20. Typical recovered charge data at 25°C



21. Typical charge data at 125°C

OUTLINE DRAWING

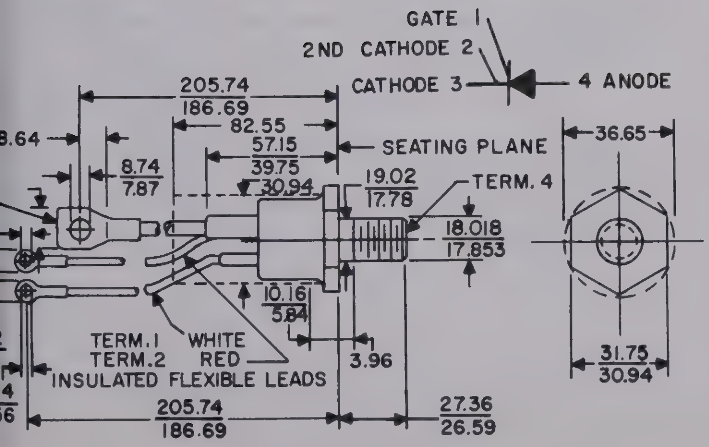

GATE 1
2ND CATHODE 2
CATHODE 3
4 ANODE
205.74
186.69
82.55
57.15
39.75
30.94
8.64
8.74
7.87
SEATING PLANE
19.02
17.78
TERM. 4
18.018
17.853
36.65
10.16
5.84
3.96
TERM.1 WHITE
TERM.2 RED
INSULATED FLEXIBLE LEADS
31.75
30.94
205.74
186.69
27.36
26.59

TABLE OF DIMENSIONS

CONVERSION TABLE

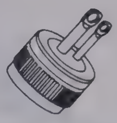
SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	39.75	57.15	1.565	2.250	
φD		36.65		1.443	7
φD_1		30.94		1.218	1
E	30.94	31.75	1.218	1.250	
F	5.84	10.16	.230	.400	5
J		82.55		3.250	1,8
M	13.46	19.18	.530	.755	2
φM	17.78	19.02	.700	.749	
M_1	5.46	7.62	.215	.300	2
N	26.59	27.36	1.047	1.077	1,4
N_1		3.96		.156	3
O	186.69	205.74	7.350	8.100	
O_1	186.69	205.74	7.350	8.100	
φT	7.87	8.74	.310	.344	
φT_1	3.56	3.94	.240	.155	
φW	17.853	18.018	.7029	.7094	4
Z	8.64		.340		6

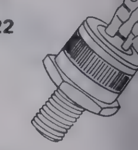
Silicon Controlled Rectifier

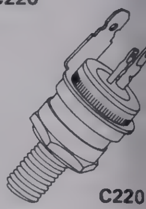
C220
C222

10 A RMS 25-500 Volts

The General Electric C220 Series C Silicon Controlled Rectifiers are reverse blocking triode thyristors. These SCR's feature a glass passivated pellet utilizing the proprietary GE Power-Glas Process that provides for lower leakage currents, super-clean surfaces and contamination-free pellet, which improves the reliability and performance of the SCR.


C222


C220


C220

TYPICAL SCR APPLICATIONS

TYPES OF EQUIPMENT	FUNCTIONS				
Application	Motor Control	Temperature Control	Relay & Solenoid Driver	Power Regulator	Capacitor Discha Circuit
Process Control Equipment	X	X	X	X	
Reproduction Equipment		X	X	X	
Blender, Mixers	X				
Hand Tools	X				
Machine Tools/Misc. Mfg.	X		X		
Sewing Machines	X				
Laundry			X		X
Farm Equipment	X		X		X
Photographic Equipment	X	X			
Clutches/Brakes			X		
Industrial Timers			X		
Vending Machines	X	X	X		
Battery Chargers				X	
Business Machines	X		X	X	
Gas & Oil Ignitors			X		X
Internal Combustion Engine Ignitions					X
Aircraft	X		X	X	
Biomedical	X	X	X	X	X
Computer	X		X	X	

MAXIMUM ALLOWABLE RATINGS

Package	VOLTAGE RATING							
	25	50	100	200	300	400	500	VDRM - Repetitive Peak Off-State Voltage (1,3) VRRM - Repetitive Peak Reverse Voltage T_C = -40°C to 100°C
	35	75	150	300	400	500	600	VRSM - Repetitive Reverse Voltage (1,2) T_C = -40°C to 100°C
Press Fit	C222U	C222F	C222A	C222B	C222C	C222D	C222E	
Stud	C220U	C220F	C220A	C220B	C220C	C220D	C220E	
Isolated Stud	C220U2	C220F2	C220 A2	C220B2	C220C2	C220D2	C220E2	

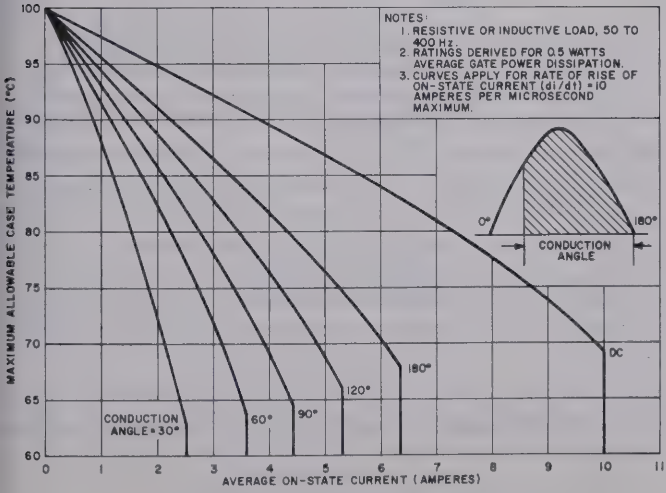
Peak Positive Anode Voltage (T_c = -40°C to +100°C) . . . . 560 Volts
RMS On-State Current, $I_{T(RMS)}$ . . . . 10 Amperes (all conduction angles)
Average On-State Current, $I_{T(AV)}$ . . . . Depends on conduction angle (see Charts 1 and 2)
Critical Rate-Of-Rise of On-State Current, di/dt:$^{(4)}$ . . . . (see Chart 3)
Gate triggered operation
Switching from 200 volts . . . . 100 Amperes per microsecond
Switching from 500 volts . . . . 50 Amperes per microsecond
Peak One cycle Surge (non-rep) On-State Current, I_{TSM} 50 Hz . . . . 82 Amperes
60 Hz . . . . 90 Amperes
I^2t (for fusing), for times at 8.3 milliseconds . . . . see Chart 1 . . . . 34 Ampere^2 seconds
1.5 milliseconds . . . . 27 Ampere^2 seconds
Peak Gate Power Dissipation, P_{GM} . . . . 5 Watts for 10 microseconds
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 0.5 Watts
Peak Positive Gate Current, I_{GM} . . . . (see Chart 8)
Peak Positive Gate Voltage, V_{GM} . . . . (see Chart 7)
Peak Negative Gate Voltage, V_{GM} . . . . 5 Volts
Storage Temperature, T_{stg} . . . . -40°C to +125°C
Operating Temperature, T_j . . . . -40°C to +100°C
Stud Torque (Stud and Isolated Stud Types). . . . . 25 Lb-in (29 Kg-cm)
Insertion Pressure (Press-Fit Type) . . . . 800 Lbs (364 Kg)
Isolation Breakdown Voltage Between Any Terminal and Stud (Isolated Stud Type)$^{(5)}$. . . . . 1800 Volts RMS

Notes:

1. Values apply for zero or negative gate voltage only.
2. Half sine wave voltage pulse, 10 millisecond maximum duration.
3. During performance of the Off-State and Reverse Blocking tests, the SCR should not be tested with a constant current source which would permit applied voltage to exceed the device rating.
4. di/dt rating is established in accordance with JEDEC Suggested Standard No. 7, Section 5.1.2.4. Off-State (blocking) voltage capability may be temporarily lost immediately after each current pulse for duration less than the period of the applied pulse repetition rate. The pulse repetition rate for this test is 400 Hz. The duration of the JEDEC di/dt test condition is 5.0 seconds (Minimum).
5. Rating applies for 50, 60 and 400 Hz sinusoidal wave form.

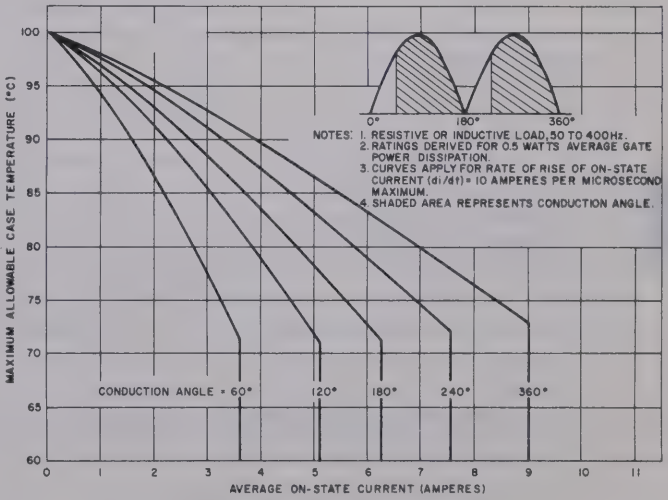
WARNING

Isolated stud products offered in this specification sheet should be handled with care. The ceramic portion of these thyristors contains BERYLLIUM OXIDE as a major ingredient. Do not crush or grind these portions of the thyristors because the dust resulting from such action may be hazardous if inhaled.



NOTES:
1. RESISTIVE OR INDUCTIVE LOAD, 50 TO 400 Hz.
2. RATINGS DERIVED FOR 0.5 WATTS AVERAGE GATE POWER DISSIPATION.
3. CURVES APPLY FOR RATE OF RISE OF ON-STATE CURRENT (di/dt) = 10 AMPERES PER MICROSECOND MAXIMUM.

1. Max. Allowable Case Temperature For Half-Wave Rectified Sine Wave of Current



NOTES:
1. RESISTIVE OR INDUCTIVE LOAD, 50 TO 400Hz.
2. RATINGS DERIVED FOR 0.5 WATTS AVERAGE GATE POWER DISSIPATION.
3. CURVES APPLY FOR RATE OF RISE OF ON-STATE CURRENT (di/dt) = 10 AMPERES PER MICROSECOND MAXIMUM.
4. SHADED AREA REPRESENTS CONDUCTION ANGLE.

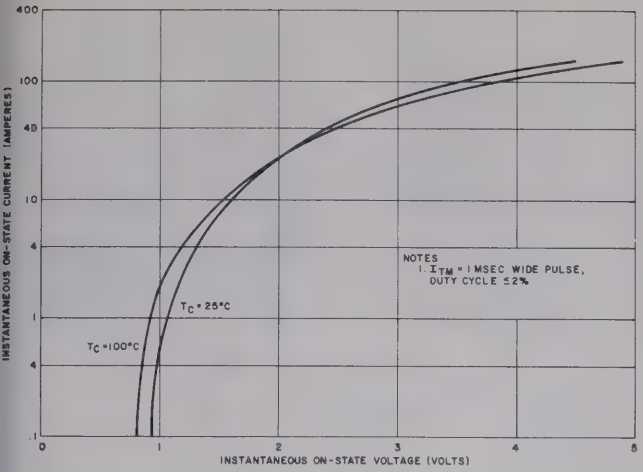
2. Max. Allowable Case Temperature For Full-Wave Rectified Sine Wave of Current

CHARACTERISTICS

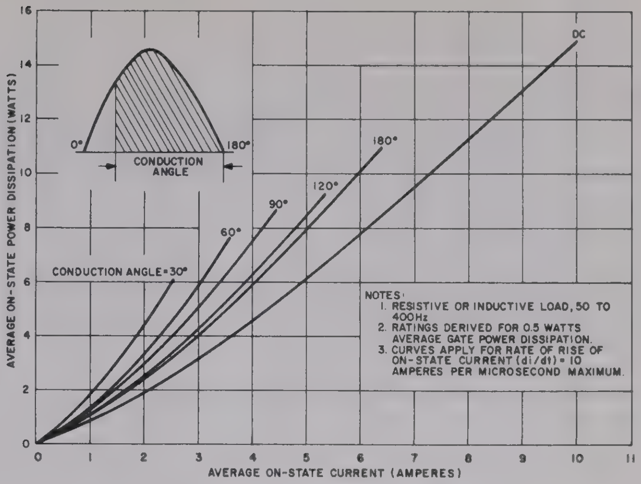
Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Peak Off-state or Reverse Current (1)	I_{DRM} or I_{RRM}				mA	$V_{DRM} = V_{RRM}$ = Max. allowable volts peak
		–	–	0.1		T_c = + 25°C
		–	–	0.5		T_c = +100°C
Peak-On-State Voltage	V_{TM}	–	–	1.95	Volts	T_c = +25°C, I_{TM} = 20 A peak, 1 millisecond wide pulse, Duty cycle ≦ 2%
Critical Rate of Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt		50	–	Volts/µsec	T_c = +100°C, Rated V_{DRM} Gate Open Circuited, Linear Waveform
Circuit Commutated Turn-Off Time	t_q	–	50	–	µsec	T_c = +100°C, I_{TM} = 10A peak. Rectangular current pulse, 40 µsec duration. Commutation rate = 5 A/µsec. Peak reverse voltage @ Rated volts max. Reverse voltage at end of turn-off time interval 12 volts min. Repetition rate = 60 pps. Rate of rise of re-applied off-state voltage (dv/dt) = 10 V/µsec. Off-state voltage = Rated V. Gate bias during turn-off time interval = 0 volts, 100 ohms.
D.C. Gate Trigger Current	I_{GT}	–	–	25	mAdc	T_c = +25°C V_D = 6 Vdc R_L = 91 ohms
		–	–	40		T_c = -40°C V_D = 6 Vdc R_L = 45 ohms
D.C. Gate Trigger Voltage	V_{GT}	–	–	1.5	V_{dc}	T_c = +25°C V_D = 6 Vdc R_L = 91 ohms
		–	–	2.0		T_c = -40°C V_D = 6 V_{dc} R_L = 45 ohms
		0.2	–	–		T_c = +100°C Rated V_{DRM} R_L = 1000 ohms
Holding Current	I_H				mAdc	Anode Source Voltage = 24 Vdc, Peak Initiating On-State Current = 0.5A, 0.1 msec to 10 msec Wide Pulse. Gate Trigger Source = 7V, 20 ohms.
		–	–	30		T_c = +25°C.
		–	–	60		T_c = -40°C
Latching Current	I_L				mAdc	Main Terminal Source Voltage = 24 Vdc, Gate trigger source = 15 V, 100 ohms, 50 µsec pulse width, 5 µsec rise and fall times max.
		–	–	60		T_c = +25°C
		–	–	120		T_c = -40°C
Steady-State (2) Thermal Resistance					°C/Watt	
	$R\theta JC$	–	–	2.0		Junction to Case
	$R\theta JA$	–	–	45		Junction to Ambient

NOTES:

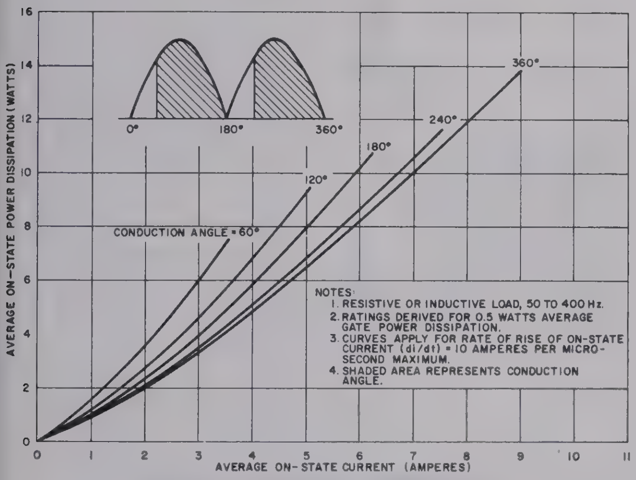
1. Values apply for zero or negative gate voltage only.
2. The junction to ambient value is under worst case conditions, i.e., with #22 copper wire used for electrical contact to the terminals and natural convection.



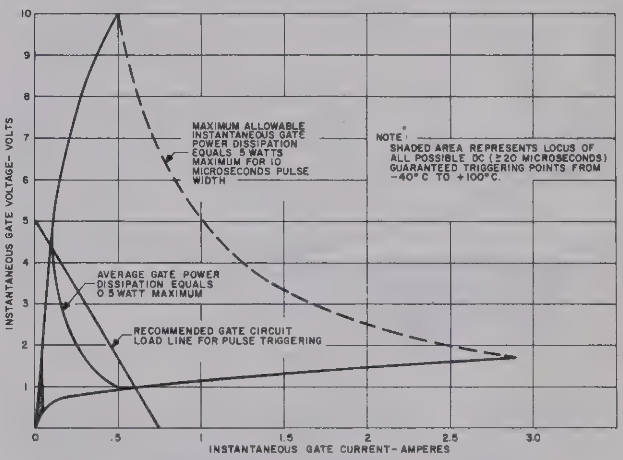
3. Max. On-State Voltage vs. On-State Current



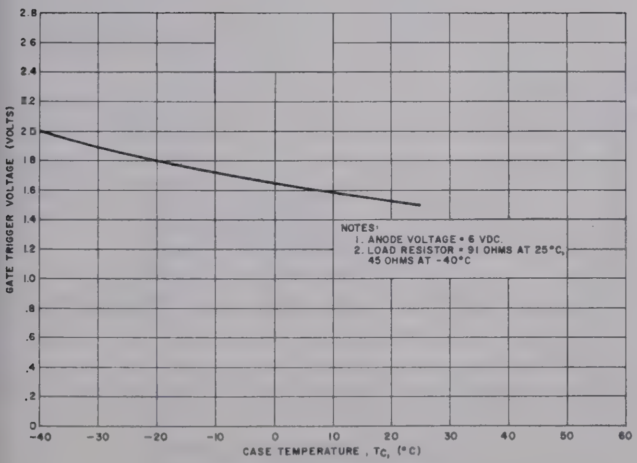
4. Max. On-State Power Dissipation for Half-Wave Rectified Sine Wave of Current



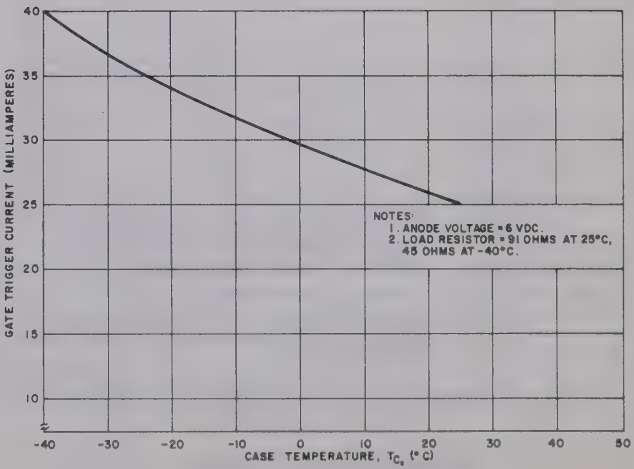
5. Max. Allowable On-State Power Dissipation for Full-Wave Sine Wave of Current



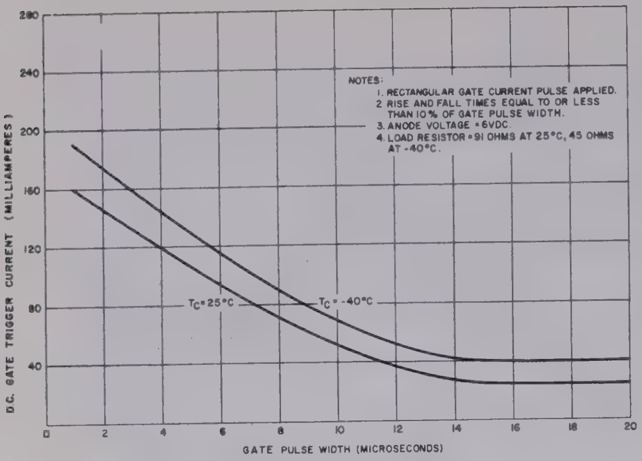
6. Gate Trigger Characteristics



7. Max. DC Gate Voltage to Trigger vs. Case Temperature

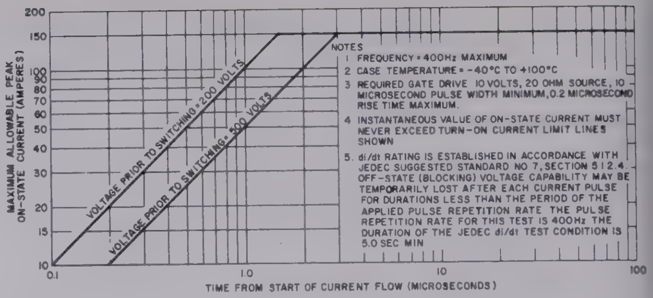


8. Max. DC Gate Current to Trigger vs. Case Temperature



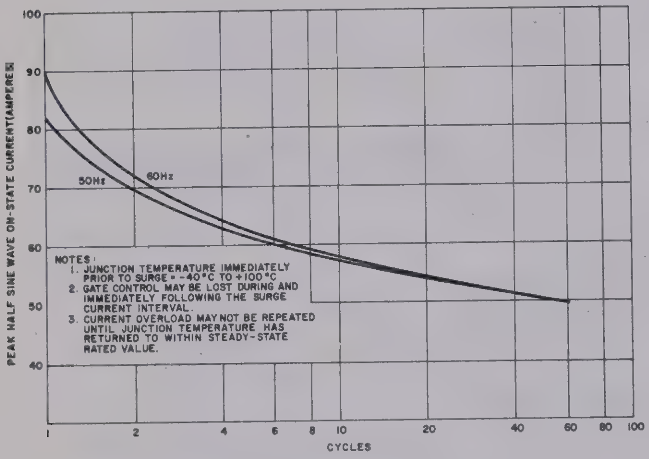
NOTES:
1. RECTANGULAR GATE CURRENT PULSE APPLIED.
2. RISE AND FALL TIMES EQUAL TO OR LESS THAN 10% OF GATE PULSE WIDTH.
3. ANODE VOLTAGE = 6VDC
4. LOAD RESISTOR = 91 OHMS AT 25°C, 45 OHMS AT -40°C.

9. Max. DC Gate Current to Trigger vs. Gate Pulse Width



NOTES
1. FREQUENCY = 400Hz MAXIMUM
2. CASE TEMPERATURE = -40°C TO +100°C
3. REQUIRED GATE DRIVE 10 VOLTS, 20 OHM SOURCE, 10 MICROSECOND PULSE WIDTH MINIMUM, 0.2 MICROSECOND RISE TIME MAXIMUM.
4. INSTANTANEOUS VALUE OF ON-STATE CURRENT MUST NEVER EXCEED TURN-ON CURRENT LIMIT LINES SHOWN
5. di/dt RATING IS ESTABLISHED IN ACCORDANCE WITH JEDEC SUGGESTED STANDARD NO 7, SECTION 5.1.2.4. OFF-STATE (BLOCKING) VOLTAGE CAPABILITY MAY BE TEMPORARILY LOST AFTER EACH CURRENT PULSE FOR DURATIONS LESS THAN THE PERIOD OF THE APPLIED PULSE REPETITION RATE. THE PULSE REPETITION RATE FOR THIS TEST IS 400Hz. THE DURATION OF THE JEDEC di/dt TEST CONDITION IS 5.0 SEC MIN

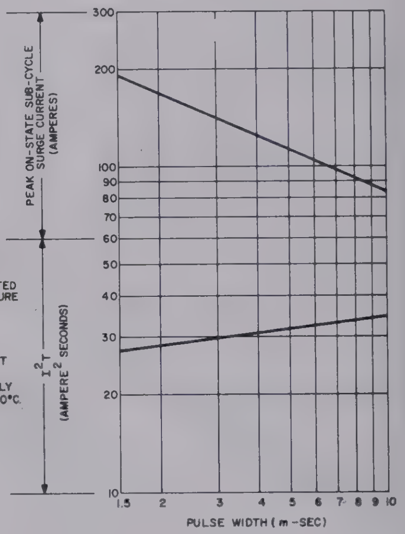
10. Turn-On Current Limit



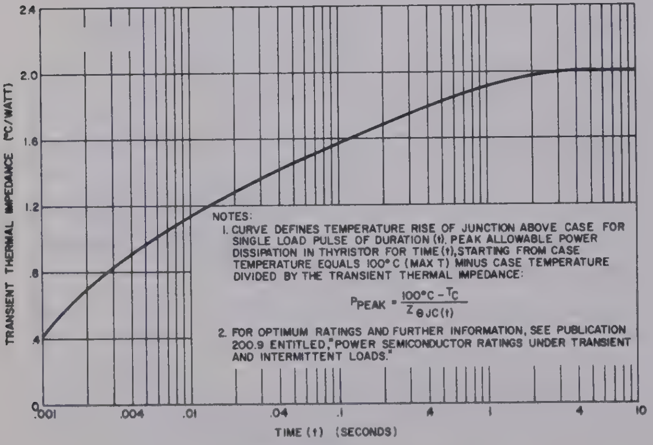
NOTES:
1. JUNCTION TEMPERATURE IMMEDIATELY PRIOR TO SURGE = -40°C TO +100°C
2. GATE CONTROL MAY BE LOST DURING AND IMMEDIATELY FOLLOWING THE SURGE CURRENT INTERVAL.
3. CURRENT OVERLOAD MAY NOT BE REPEATED UNTIL JUNCTION TEMPERATURE HAS RETURNED TO WITHIN STEADY-STATE RATED VALUE.

11. Max. Allowable Surge Current Following Rated Load Conditions

NOTES:
1. CURVES APPLY FOR HALF SINE WAVE CURRENT WAVEFORM.
2. THIS OVERLOAD MAY BE APPLIED FOLLOWING DEVICE OPERATION AT ANY VOLTAGE OR CURRENT WITHIN ITS STEADY-STATE RATING LIMITS.
3. THE OVERLOAD MAY NOT BE REPEATED UNTIL DEVICE JUNCTION TEMPERATURE HAS COOLED DOWN TO WITHIN STEADY STATE RATED VALUE.
4. NO BLOCKING VOLTAGE RATING IS IMPLIED DURING OR IMMEDIATELY FOLLOWING THE OVERLOAD CURRENT INTERVAL.
5. JUNCTION TEMPERATURE IMMEDIATELY PRIOR TO OVERLOAD = -40°C TO +100°C.



12. Sub-cycle Surge and I^2t Rating Following Rated Load Conditions

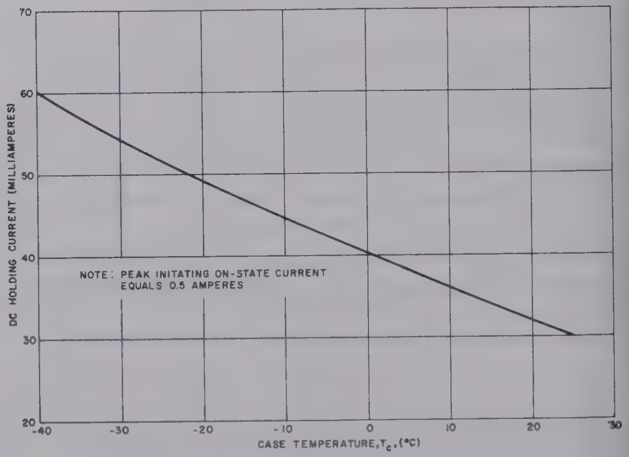


NOTES:
1. CURVE DEFINES TEMPERATURE RISE OF JUNCTION ABOVE CASE FOR SINGLE LOAD PULSE OF DURATION (t). PEAK ALLOWABLE POWER DISSIPATION IN THYRISTOR FOR TIME (t), STARTING FROM CASE TEMPERATURE EQUALS 100°C (MAX T) MINUS CASE TEMPERATURE DIVIDED BY THE TRANSIENT THERMAL IMPEDANCE:

$$P_{PEAK} = \frac{100°C - T_C}{Z_{\theta JC(t)}}$$

2. FOR OPTIMUM RATINGS AND FURTHER INFORMATION, SEE PUBLICATION 200.9 ENTITLED, "POWER SEMICONDUCTOR RATINGS UNDER TRANSIENT AND INTERMITTENT LOADS."

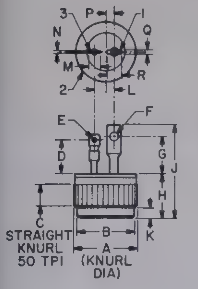
13. Max. Transient Thermal Impedance, Junction to Case



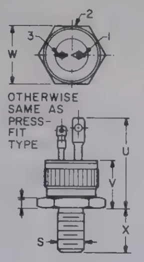
NOTE: PEAK INITATING ON-STATE CURRENT EQUALS 0.5 AMPERES

14. Max. DC Holding Current vs. Case Temperature

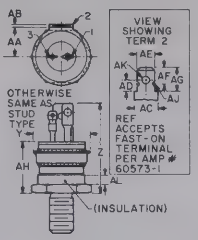
OUTLINE DRAWINGS



PRESS-FIT

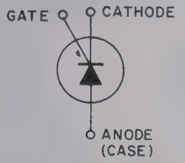


STUD


AB
AA
2
3
I
VIEW SHOWING TERM 2
AE
AK
AD
AF
AG
AJ
AC
REF
ACCEPTS FAST-ON TERMINAL PER AMP # 60573-1
OTHERWISE SAME AS STUD TYPE
Y
Z
AH
AL
(INSULATION)

ISOLATED STUD

SYM	DECIMAL (INCHES) MIN.	DECIMAL (INCHES) MAX.	METRIC (MM) MIN.	METRIC (MM) MAX.
A	.501	.505	12.73	12.83
B	.467	.475	11.86	12.07
C	.177 REF.		4.50 REF.	
D	.260	.301	6.60	7.65
E	.035	.045	.89	1.14
F	.065	.075	1.65	1.41
G		.350		8.89
H	.340	.376	8.64	9.55
J		.782		19.86
K	.083	.097	2.11	2.46
L	.130	.180	3.30	4.57
M	.085	.115	2.16	2.92
N	.016	.023	.41	.58
P	.065 REF.		1.65 REF.	
Q	.028	.035	.71	.89
R	.110	.135	2.79	3.43
S	1/4-28 UNF2A		1/4-28 UNF2A	
T	.086	.098	2.18	2.49
U		.865		21.79
V		.475		12.07
W	.552	.562	14.02	14.27
X	.432	.442	10.97	11.23
Y	.580	.610	14.73	15.49
Z		.975		24.77
AA	.290	.330	7.37	8.38
AB	.017	.024	.43	.61
AC	.235	.265	5.97	6.73
AD	.115	.121	2.29	3.07
AE	.186	.189	4.72	4.80
AF	.170 REF.		4.32 REF	
AG	.245	.255	6.22	6.48
AH		.585		14.86
AJ	.025	R-REF.	.64	R-REF.
AK	.065	.070	1.65	1.78
AL	.100	.110	2.54	2.79



TERMINAL ARRANGEMENT

NOTES: (1)Case temperature is measured at the center of any hex flat or press-fit base.
(2)One ext. tooth lock washer and one nut (both steel, cad. plated) supplied with each stud and isolated stud unit.
(3)Insulation hardware for stud device consisting of terminal, 2 mica washers and one nylon bushing available at extra cost upon request.

MOUNTING CONSIDERATIONS*

Installation of Press-Fit SCR in Heat Sink

When press fitting SCR into a heatsink, the following specifications and recommendations apply:

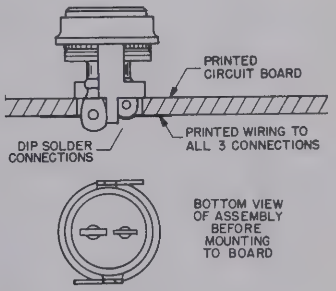
1. Heatsink materials may be copper, aluminum or steel. For maximum heat transfer and minimum corrosion problems, copper is recommended. The heatsink thickness, or amount of heatsink wall, in contact with the SCR should be 1/8 inch.
2. The hole diameter into which the SCR is pressed must be 0.4975 ± .001 inch. A slight chamfer on the hole should be used. This hole may be punched in a flat plate and reamed, or extruded and sized in sheet metal.
3. The entire knurled section of the SCR should be in contact with the heatsink to insure maximum heat transfer. The SCR must not be inserted into a heatsink deeper than the knurl height.
4. The SCR insertion force must not exceed 800 pounds. If the insertion force approaches this value before complete insertion, either the SCR is misaligned with the hole or the SCR-to-hole interference is excessive. The insertion force must be uniformly applied to the top face (terminal end) of the SCR within an annular ring which has an inside diameter of not less than 0.370 inch and not larger than 0.390 inch; the outside diameter of the insertion force must not be less than 0.500 inch.
5. The thermal resistance between the SCR case and a copper heatsink will not exceed 0.5°C/W, if the SCR is inserted in the manner described.

Soldering of Press-Fit Package to Heat Sink

The press-fit package may be soldered directly to a heat sink using 60/40 (Pb-Sn) solder at a temperature of about 200°C.

Attachment of Press Fit Device to Printed Circuit Board

For certain light load applications, the SCR can be inverted and, using a special brass bracket (A7149451), dip-soldered into a printed circuit board. The feet on the bracket act both as a mechanical support and anode electrical connection. For SCRs preassembled into the bracket, add -X123 to the type number, for example C222BX123.


PRINTED CIRCUIT BOARD
PRINTED WIRING TO ALL 3 CONNECTIONS
DIP SOLDER CONNECTIONS
BOTTOM VIEW OF ASSEMBLY BEFORE MOUNTING TO BOARD

Attachment of the Stud & Isolated Stud Device to a Heat Sink

These devices require certain precautions in order to insure good thermal transfer. The chassis hole must be drilled and deburred, and should be between .005 and .015 inches larger than the stud outside diameter. The use of a Torque wrench is highly recommended and must be used within the torque limits indicated on page 2. A good grade of silicone grease will minimize contact thermal resistance.

*A more detailed discussion may be found in the General Electric SCR Manual, 4th Edition (1967), Chapter 17, "Cooling the Power Semiconductor".

OTHER SCR AND APPLICATION INFORMATION AVAILABLE FROM GENERAL ELECTRIC

Publication Number	Specification Sheets
150.35	C122 (8 Amp, Plastic Package)
160.21	C36 (16 Amp)
160.27	C30/32 (25 Amp, Stud or Press Fit Package)
160.20	C35 (35 Amp)
160.45	C137 (35 Amp, High Voltage)

Publication Number	Application Notes
200.31	Phase Control of SCR's With Transformer and Other Inductive AC Loads
200.33	Regulated Battery Charges Using the Silicon Controlled Rectifier
200.43	Solid State Control for DC Motors Provides Variable Speed with Synchronous – Motor Performance
200.44	Speed Control for Shunt-Wound Motors
200.47	Speed Control for Universal Motors
200.48	Flashers, Ring Counters and Chasers
200.55	Thermal Mounting Considerations for Plastic Power Semiconductor Packages
201.1	A Plug-In Speed Control for Standard Portable Tools and Appliances
201.13	Universal Motor Control With Built-in Self-Timer
ETR 3875A	SCR Manual

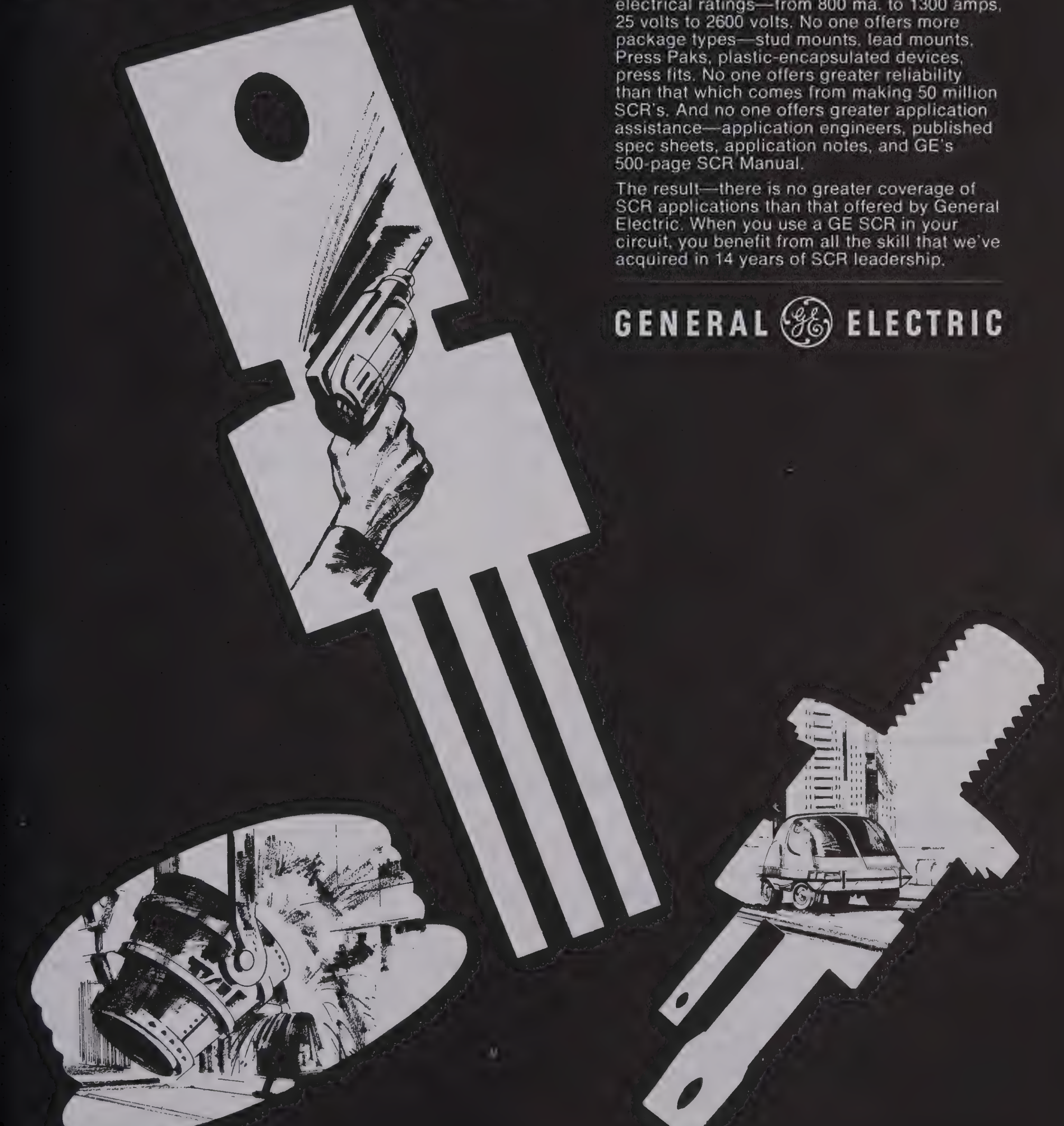
Over 50-million SCR's from General Electric... one for every application

In 1957, General Electric introduced the first silicon controlled rectifier. The SCR has gone on to prove itself a real workhorse in power-control applications. And GE has gone on to manufacture 50-million SCR's for use in power supplies, appliances, automobiles, business machines, industrial process controls . . . its uses are limitless.

GE took the lead in SCR technology and manufacture and extended it over the years. Fifty million SCR's later, GE still offers a broader and more complete line of high quality, high reliability devices than anyone else. No one offers a wider selection of electrical ratings—from 800 ma. to 1300 amps, 25 volts to 2600 volts. No one offers more package types—stud mounts, lead mounts, Press Paks, plastic-encapsulated devices, press fits. No one offers greater reliability than that which comes from making 50 million SCR's. And no one offers greater application assistance—application engineers, published spec sheets, application notes, and GE's 500-page SCR Manual.

The result—there is no greater coverage of SCR applications than that offered by General Electric. When you use a GE SCR in your circuit, you benefit from all the skill that we've acquired in 14 years of SCR leadership.

GENERAL ELECTRIC



Silicon
Controlled Rectifier

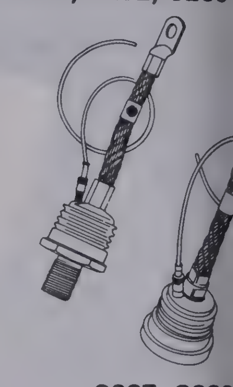
235-400 A RMS TO 1700 VOLTS

C286, C2

C282, C2

C280, C2

C286, C282, C280



C287, C283

The C280 thru C287 series of high power devices are for use in 50Hz to 400Hz phase control applications.

Special features of these devices:

- Years of proven field experience in operation.
- Use for load currents up to 250 amperes average in single-phase applications.
- High surge to average current ratio for ease of overcurrent protection.
- Mounting versatility of stud mounting–C280, C282, C286; and flat mounted clampdown version–C281, C283, C287.

Type	Repetitive Peak Off-State (Forward or Reverse) Voltage $T_J = -40°C$ to $+125°C$	Non-repetitive Peak Reverse Voltage $T_J = +25°C$ to $+125°C$ (< 5 Milliseconds)	Peak Forward Voltage (Non-Destructive) $T_J = +25°C$ to $+125°C$ (< 5 Milliseconds)
C280 thru C287S	700 volts	800 volts	1000 volts
C280 thru C287N	800 volts	900 volts	1000 volts
C280 thru C287T	900 volts	1000 volts	1200 volts
C280 thru C287P	1000 volts	1100 volts	1200 volts
C280 thru C287PA	1100 volts	1200 volts	1300 volts
C280 thru C287PB	1200 volts	1300 volts	1300 volts
C280 thru C287PC	1300 volts	1400 volts	1400 volts
C280 thru C287PD	1400 volts	1500 volts	1500 volts
C280 thru C287PE	1500 volts	1600 volts	1600 volts
C280 thru C287PM	1600 volts	1700 volts	1700 volts
C280 thru C283PS	1700 volts	1800 volts	1800 volts

MAXIMUM ALLOWABLE RATINGS

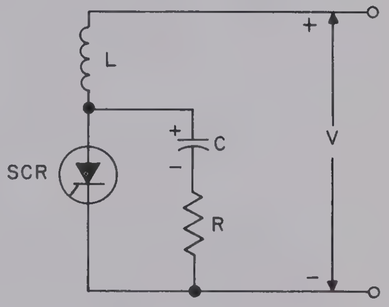
RMS Forward Current, On-State . . . . C280, C281 – 235 amperes (all conduction angles)
C282, C283, C286, C287 – 400
Average Forward Current, On-State . . . . Depends on conduction angle (see Chart 3)
Peak One-cycle Surge Forward Current, I_{FSM} . . . . C280, C281 – 3500
C282, C283 – 4500
C286, C287 – 5000
I^2t (for fusing) . . . . C280, C281 – 50,000 ampere^2 seconds (for times ≥ 8.3 milliseconds)
C282, C283 – 85,000
C286, C287 – 100,000
Peak Gate Power Dissipation, P_{GM} . . . . 16 watts
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 3 watts
Peak Forward Gate Voltage, V_{GFM} . . . . 20 volts
Peak Reverse Gate Voltage, V_{GRM} . . . . 5 volts
Storage Temperature, T_{STG} . . . . −40°C to +125°C
Operating Temperature, T_J . . . . −40°C to +125°C
Stud Torque (C280, C282, C286) . . . . 300 in.-lbs.
(346 kg-cm)

CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Gate Trigger Current	I_{GT}	 — — — —	 100 150 50 250	 150 200 — —	mAdc	V_D = 12 Vdc, R_L = 50 ohms T_J = +25°C T_J = 0°C T_J = +125°C T_J = −40°C
Gate Trigger Voltage	V_{GT}	 — 0.15	 1.25 —	 3.0 —	Vdc	V_D = 6 Vdc, R_L = 50 ohms T_J = −40°C to +125°C T_J = +125°C
Holding Current	I_H	—	25	100	mAdc	T_J = +25°C, Anode Supply = 22 Vdc
Turn-On Time (Delay Time + Rise Time)	$t_d + t_r$	—	10	—	μsec.	T_J = +25°C, I_T = 5 Adc, V_{DRM} = 50 volts Gate Supply: 10 volt open circuit, 10 ohm, 0.1 μsec. max; rise time
Circuit Commutated Turn-Off Time	t_q	—	250	—	μsec.	T_J = +125°C, I_T = 250 A, V_R = 50 V max. V_{DRM} (reapplied) = Rated. Rate of rise of reapplied forward blocking voltage = 20 volts/μsec. linear.
Linear Rate of Rise of Forward Blocking Voltage	dv/dt	100	—	—	V/μsec.	T_J = +125°C, Gate open circuited. V_{DRM} = 80% Rated.
Max. Allowable Rise of Forward Current (Sinusoidal Waveform)	di/dt	—	—	50	A/μsec.	T_J = +125°C, Max. Rep. Rate = 60 Hz., I_{TM} = 300 A peak. (1000 V turned on) (1)

(1) di/dt rating is a function of the voltage being turned on, the frequency, and the temperature (rating decreases as these parameters are increased). For pulse operation at a repetitive rate of 3 p.p.s. or lower, this rating is approximately an order of magnitude higher and can even be negotiated for 1000 amps/μ sec. A shunt RC network will also influence the result. A proved acceptable condition, guaranteed by factory test on all units, follows:

For $V = 0.8\ V_{DRM}$ (or 1000 volts max.) being turned on,
L = 22 μH (in series with SCR)
T_J = 125°C
f = 60 Hz.
R = 20 Ω } Shunt RC Network
C = 0.5 μF }
I_{TM} = 300 amps. peak



C286, C282, C280

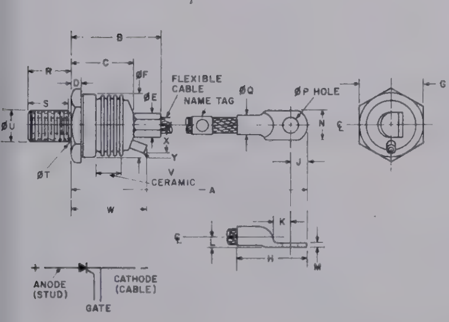
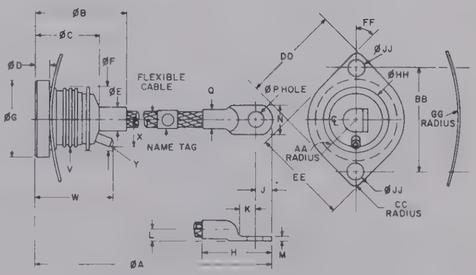
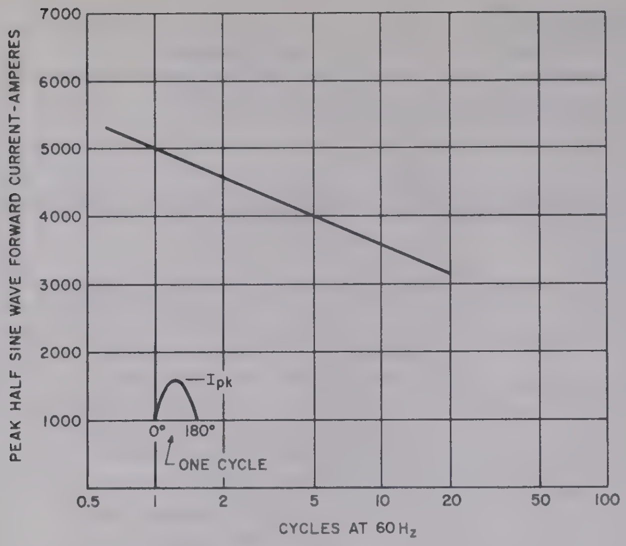


TABLE OF DIMENSIONS					
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	7.500	8.000	190.50	203.20	
ØA	7.625	8.125	193.68	206.38	
B		2.375		60.32	
ØB		2.500		63.50	
C		1.625		41.28	
ØC		1.750		44.45	
D	.235	.265	5.97	6.73	
ØD	.325	.355	8.25	9.01	
ØE		.750		19.05	
ØF		1.625		41.28	
G	1.605	1.640	40.77	41.66	
ØG	1.865	1.885	47.37	47.88	
H	1.625	2.000	41.28	50.80	
J	.375	.438	9.52	11.12	
K	.375		9.52		
L	.250	.297	6.35	7.54	
M	.094	.125	2.39	3.18	
N		.766		19.46	
ØP	.391	.422	9.93	10.72	
ØQ		.562		14.27	
R	1.037	1.087	26.34	27.61	
S	.912	1.009	23.16	25.63	
ØT	.660	.670	16.76	17.02	
ØU					5
V					1
W		2.000		50.80	
X		.750		19.05	
Y					4
AA	1.178	1.198	29.92	30.43	3
BB	2.484	2.516	63.09	63.91	3
CC	.172	.203	4.37	5.16	3
DD	2.355	2.395	59.82	60.83	3
EE	2.355	2.395	59.82	60.83	3
FF					2,3
GG	5.500	6.500	139.70	165.10	3
ØHH	1.610	1.630	40.89	41.40	3
ØJJ	.370	.380	9.40	9.65	3

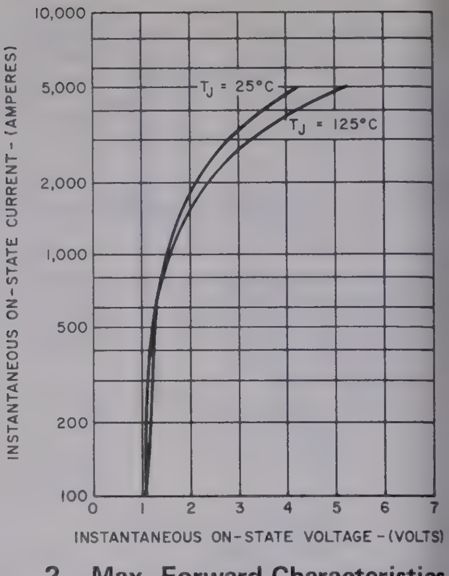
NOTES
1. 1.000" (25.40mm) MIN INSULATION CREEP
2. 44° MIN, 46° MAX
3. DIMENSIONS OF CLAMP BEFORE FORMING TO 6.000" (212.40mm) RADIUS
4. COAX RECEPTACLE WILL MATE WITH AMP INC COAXICON PLUG TNC TYPE (E.G. #32036)
5. 3/4"−16 UNF−2A

C287, C283, C281

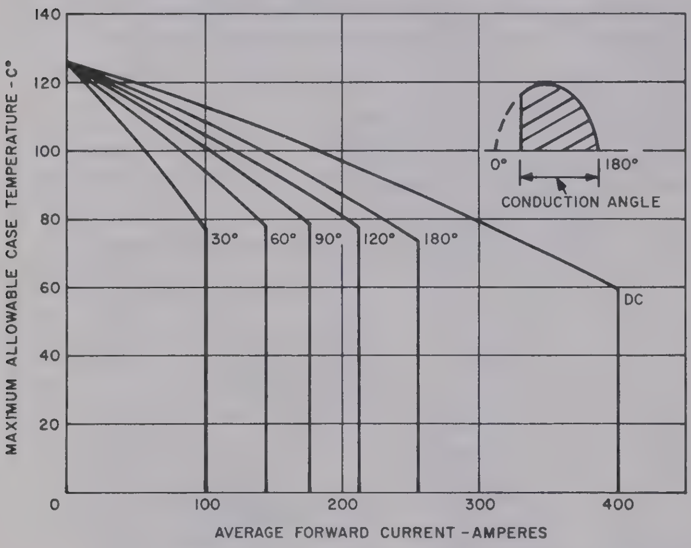




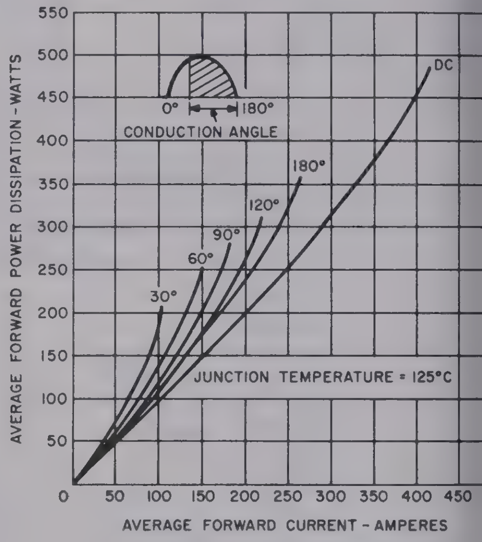
1. Multiple Surge Curve



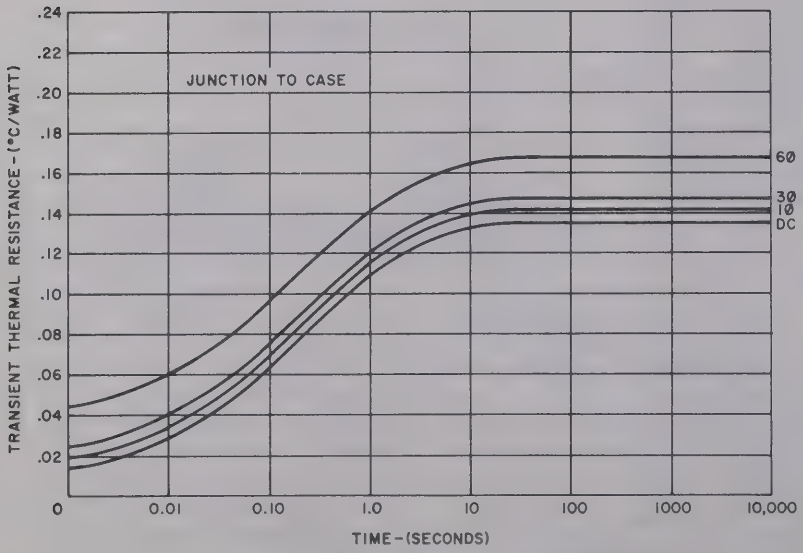
2. Max. Forward Characteristics



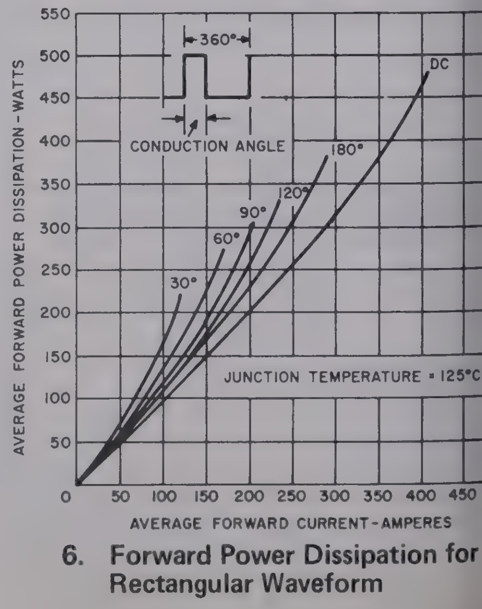
3. Max. Allowable Case Temperature



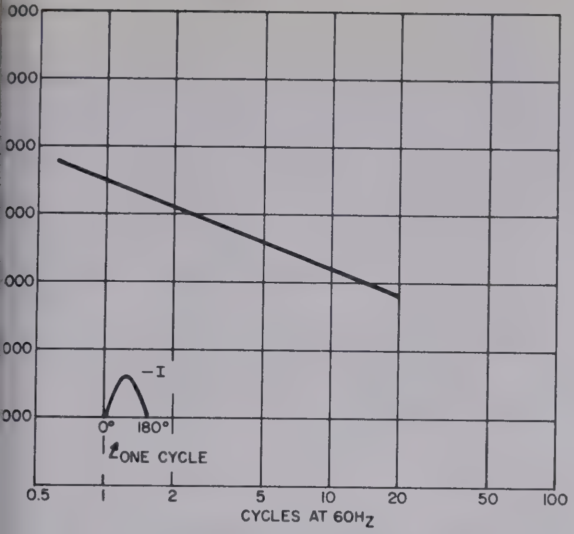
4. Forward Power Dissipation



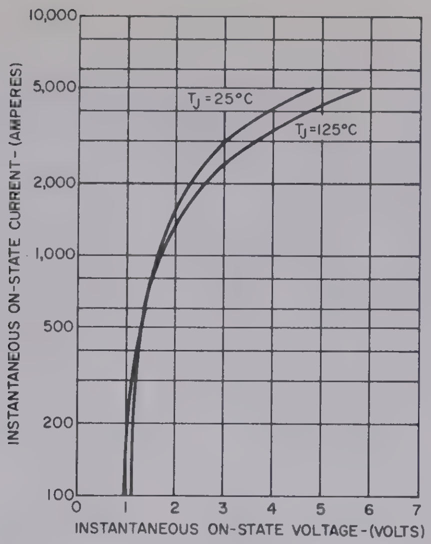
5. Transient Thermal Resistance



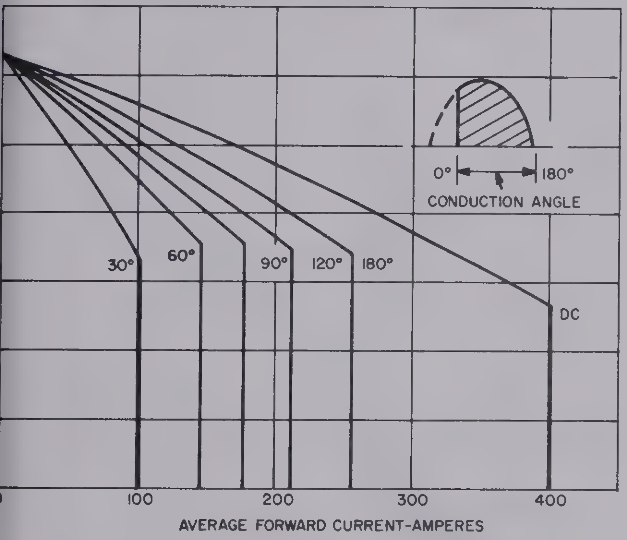
6. Forward Power Dissipation for Rectangular Waveform



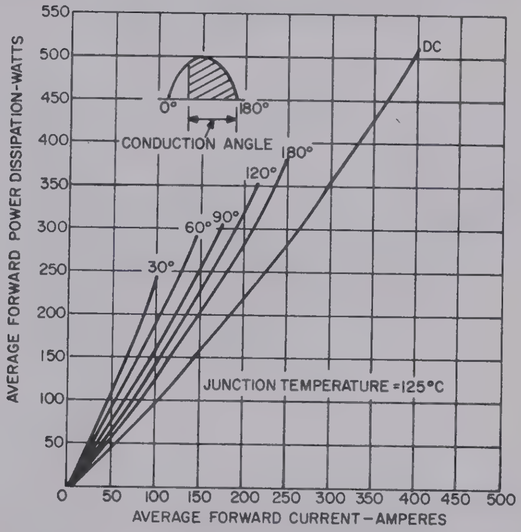
1. Multiple Surge Curve



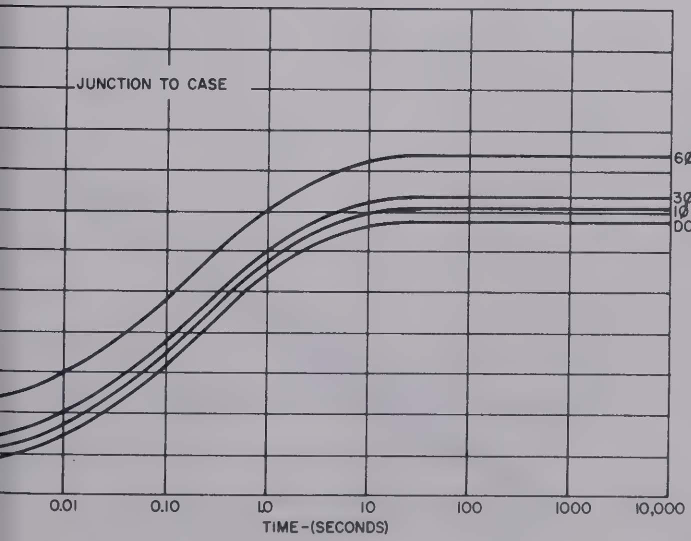
2. Max. Forward Characteristics



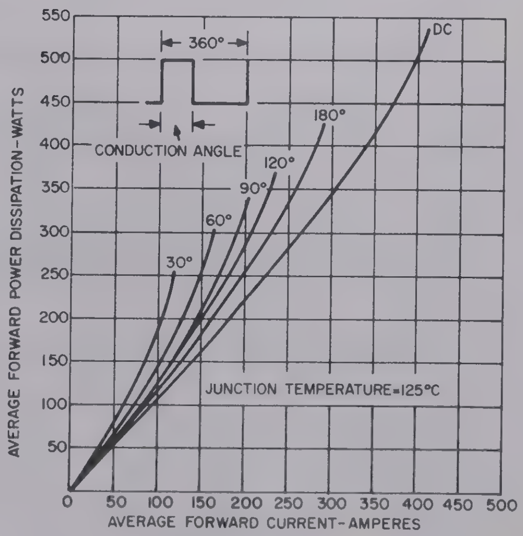
3. Max. Allowable Case Temperature



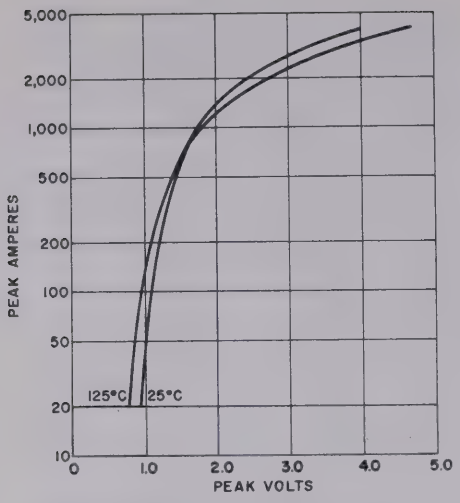
4. Forward Power Dissipation



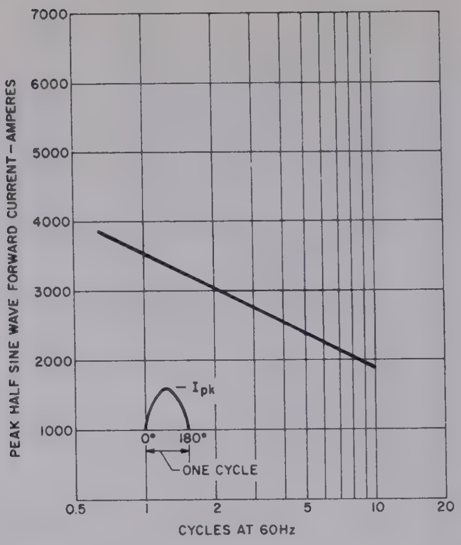
5. Transient Thermal Resistance



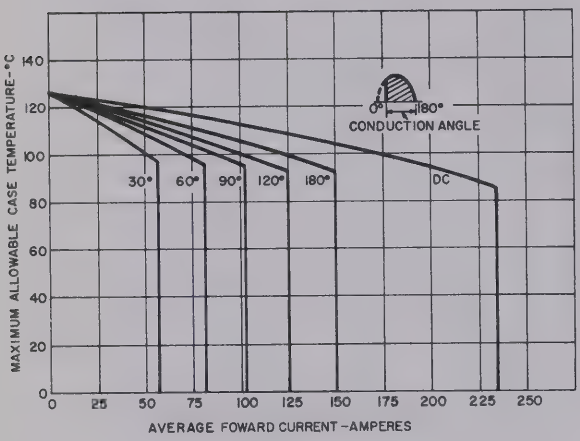
6. Forward Power Dissipation for Rectangular Waveform



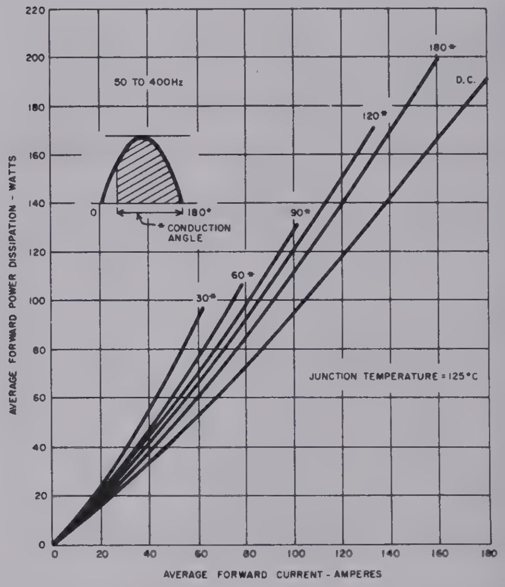
1. Forward Characteristics



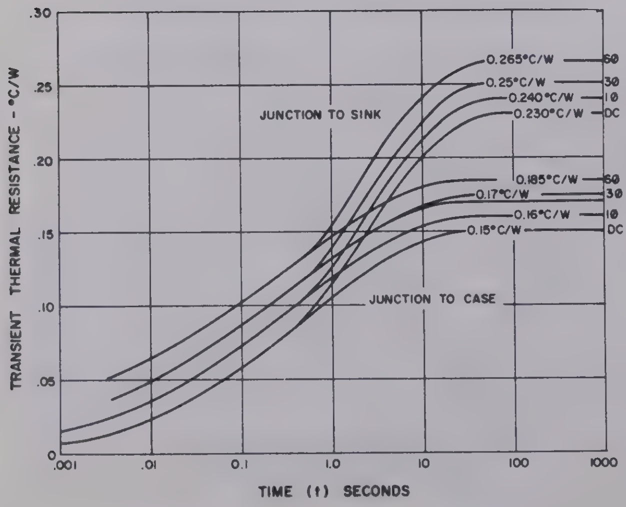
2. Multiple Surge Curve at Rated Current and Voltage (–40°C to +125°C) Full Reverse Voltage Applied After Surge



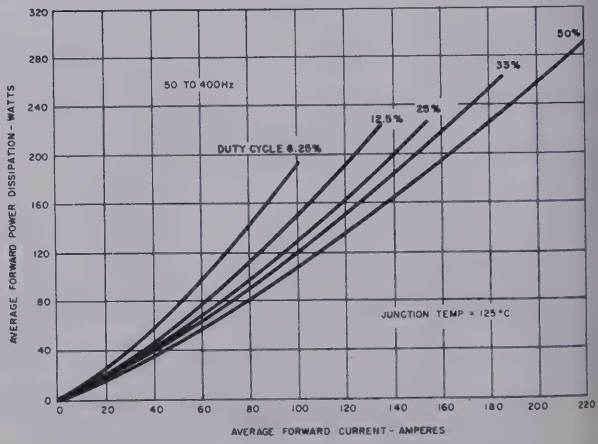
3. Maximum Allowable Case Temperature



4. Average Forward Power Dissipation



5. Transient Thermal Resistance



6. Forward Power Dissipation for Rectangular Waveform

MOUNTING PROCEDURE FOR C287, 283, 281

reparation of Heat Sink

urface Preparation

The heat sink surface should be clean and free of any foreign matter. If necessary, the area may be leaned with trichloroethylene, or tetrachloroethy-ene, or similar solvent, but the area must be wiped lean of solvent before proceeding. A $^{16}\surd$ heat sink urface finish is the approved finish. The heat sink urface must be flat within .0005″ across the mount-ng surface area of the rectifier base, which includes he spring clamp bolting region.

rilling

1. For all heat sinks over .88″ in thickness at mounting surface. See Fig. 1.
   Two holes are to be drilled as per the sketch at the right.
   Drill and tap for a .3125—18UNC-2A bolt to depth of .88″.
2. For all heat sinks .88″ and under in depth. See Figure 2.
   Two clearance holes are to be drilled for a .3125″ diameter bolt 2.500″±.015″ apart center line to center line.

Mounting Procedure

1. On the clean mounting area of the heat sink and on the base of the clamp-down cell apply a very thin layer of silicon grease (GE #G623 grease or its equivalent). If mounting area is also electric-current-conducting, it should be wire brushed thru the grease, to remove oxide. Wipe clean, without solvent, after brushing, and replace grease. Do not entrap metal chips. Locate cell on heat sink.
2. Place the spring washer down over the cell, (A) and insert the two bolts with washers in mounting holes of the spring clamp.
   When mounting this cell to the heat sink, insert two spacers (0.335 ± .001″ in height) between the spring clamp and heat sink on the bolts (See Figures 1 & 2).
3. Run both bolts or nuts down symmetrically with the fingers till they contact the spring; then with a torque wrench alternately turn the bolts or nuts ½ turn maximum apiece until they contact the spacers. (B) Then back off, 1 flat (60°). (C) Wipe excess grease from around the base of the cell.
   a) On heat sinks thicker than .88″ use .3125—18UNC-2A x 1.25″ long bolts. See Fig. 1.

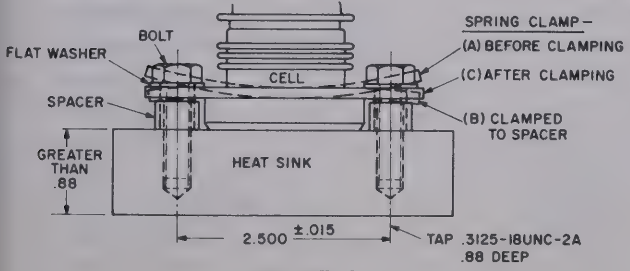
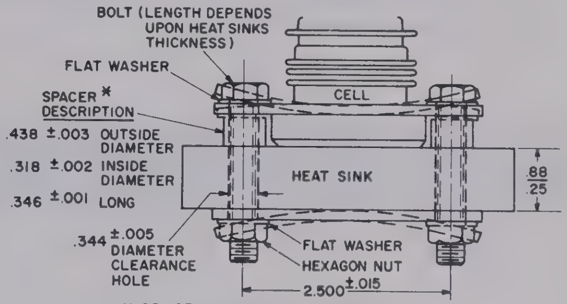

BOLT
FLAT WASHER
SPACER
GREATER THAN .88
HEAT SINK
CELL
SPRING CLAMP—
(A) BEFORE CLAMPING
(C) AFTER CLAMPING
(B) CLAMPED TO SPACER
2.500 ±.015
TAP .3125-18UNC-2A .88 DEEP

FIGURE 1

   b) On heat sinks from .25″ to .88″ thick use longer bolts and a back-up spring clamp or equivalent. See Fig. 2.
   c) Heat sinks under .25″ shall not be used.
4. When connecting the cell lead to its terminal do not put a strain on the lead by using a bolt or similar implement to bring the terminal hole in the lead in line with its contact point. This lead should be positioned so that the terminal lines up before assembling the bolt through the hole in the lug of the cell lead.
5. If current take-off is used as shown in Figure 4, the maximum thickness of the take-off should be added to spacer height. If a stud which incorporates the spacer is used, dimensions "C" and "D" should be increased by maximum thickness of the take-off. As an example, if take-off thickness is .094″±.003″ spacer height will be (.346″ + .097″) ±.001″.


BOLT (LENGTH DEPENDS UPON HEAT SINKS THICKNESS)
FLAT WASHER
SPACER *
DESCRIPTION
.438 ±.003 OUTSIDE DIAMETER
.318 ±.002 INSIDE DIAMETER
.346 ±.001 LONG
.344 ±.005 DIAMETER CLEARANCE HOLE
CELL
HEAT SINK
.88
.25
FLAT WASHER
HEXAGON NUT
2.500 ±.015

* OR USE A STUD WHICH INCORPORATES THE SPACER. SEE FIGURE 3.

FIGURE 2

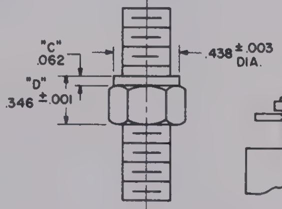

"C"
.062
"D"
.346 ±.001
.438 ±.003 DIA.

FIGURE 3

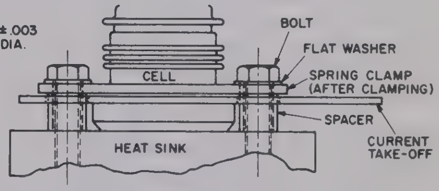

BOLT
FLAT WASHER
SPRING CLAMP (AFTER CLAMPING)
SPACER
CURRENT TAKE-OFF
CELL
HEAT SINK

FIGURE 4

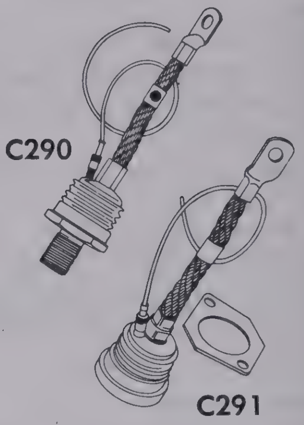
Specifications for Mounting Hardware

Item	GE Dwg.	Description
Bolts, 1.25″ long	N22P23020B11	Material: ASTM A325 Thread: ASA B1.1-1949 .3125—18UNC-2A
Washers	N402P12B11	Material: Steel Size: .344″ Inside Diameter .625″ Outside Diameter .063″ Thick
	0887B0889 P-1	Inconel X-750
Spring Clamp	0165A9165 P-1	Stainless Steel (17-7PH) with lead plating
Spacers	0195A9611 P-2	See Figure 2
Nuts	N258P23B11	Material: Steel Thread: ASA B1.1-1949 .3125—18UNC-2B

SCR

C290,1

The C290, C291 series of high power devices are for use in 40Hz to 400Hz phase control applications.



Special features of these devices:

- Years of proven field experience in operation.
- Use for load currents up to 300 amperes average in single phase applications.
- High surge to average current ratio for ease of overcurrent protection.
- Mounting versatility of stud mounting—C290; and flat mounted clampdown version—C291.

Type	Repetitive Peak Off-State (Forward or Reverse) Voltage $T_J = -40°C$ to $+125°C$.	Non-repetitive Peak Reverse Voltage $T_J = +25°C$ to $+125°C$ ($<$ 5 Milliseconds)	Peak Forward Voltage (Non-destructive) $T_J = +25°C$ to $+125°C$ ($<$ 5 Milliseconds)
C290F	50 Volts	100 Volts	400 Volts
C290A	100	200	400
C290B	200	300	400
C290C	300	400	400
C290D	400	500	500
C290E, C291E	500	600	600
C290M, C291M	600	700	700
C290S, C291S	700	800	800
C290N, C291N	800	900	900
C290T, C291T	900	1000	1000
C290P, C291P	1000	1100	1100
C290PA, C291PA	1100	1200	1200
C290PB, C291PB	1200	1300	1300

MAXIMUM ALLOWABLE RATINGS

RMS Forward Current, On-State	470 amperes (all conduction angles)
Average Forward Current, On-State	Depends on conduction angle (see Charts 3 and 5)
Peak One-cycle Surge Forward Current, I_{FSM}	5500 amperes
I^2t (for fusing)	Up to 120,000 ampere² seconds (for times ≧ 8.3 milliseconds) Up to 41,000 ampere² seconds (for times ≧ 1.5 milliseconds)
Peak Gate Power Dissipation, P_{GM}	16 watts
Average Gate Power Dissipation, $P_{G(AV)}$	3 watts
Peak Forward Gate Voltage, V_{GFM}	20 volts
Peak Reverse Gate Voltage, V_{GRM}	5 volts
Operating Temperature & Storage Temperature, T_J & T_{STG}	−40°C to +125°C
Stud Torque (C290)	300 in.-lbs. (346 kg-cm)

CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Gate Trigger Current	I_{GT}	— — — —	100 150 50 250	150 200 — —	mAdc	$T_J = +25°C$ $T_J = 0°C$ $T_J = +125°C$ $T_J = -40°C$ $V_D = 12$ Vdc, $R_L = 50$ ohms
Gate Trigger Voltage	V_{GT}	— 0.15	— —	3.5 —	Vdc	$T_J = -40°C$ to $+125°C$ $T_J = +125°C$ $V_D = 6$ Vdc, $R_L = 50$ ohms
Peak On-Voltage	V_{TM}			1.21	V	$T_J = +25°C$, $I_{TM} = 500$ A peak
Holding Current	I_H		25	100	mAdc	$T_J = +25°C$, Anode Supply = 22 Vdc
Turn-On Time (Delay Time + Rise Time)	$t_d + t_r$	—	10	—	μsec	$T_J = +25°C$, $I_F = 5$Adc, $V_{DRM} = 50$ Volts Gate Supply: 10 volts open circuit, 10 ohm, 0.1 μsec maximum rise time.[1]
Circuit Commutated Turn-Off Time	t_q	—	250	—	μsec	$T_J = +125°C$, $I_{TM} = 250$ A, $V_R = 50$ V max. V_{DRM} (reapplied) = Rated. Rate of rise of reapplied forward blocking voltage = 20 volts/μsec linear.
Effective Thermal Resistance DC	$R_{\theta JC}$			.118	°C/Watt	Junction to Case, Maximum. DC = .118, 1φ = .13, 3φ = .138, 6φ = .158
Linear Rate of Rise of Forward Blocking Voltage	dv/dt	100	—	—	V/μsec	$T_J = +125°C$. Gate open circuited. $V_{DRM} = 80\%$ Rated.
Max. Allowable Rise of Forward Current (Sinusoidal Waveform)	di/dt	—	—	50	A/μsec	$T_J = +125°C$, Rep rate = 60 Hz. max. $I_{TM} = 600$ A peak (1000 Volts turned on)[2]

(1) Selected Turn-On Times are available. Consult factory.

(2) di/dt rating is a function of the voltage being turned on, the frequency, and the temperature (rating decreases as these parameters are increased). For pulse operation at a repetitive rate of 3 p.p.s. or lower, this rating is approximately an order of magnitude higher and can even be negotiated for 1000 amps/μ sec. A shunt RC network will also influence the result. A proved acceptable condition, guaranteed by factory test on all units, follows:

For $V = 0.8\ V_{DRM}$ being turned on,

$L = 22\ \mu H$ (in series with SCR)

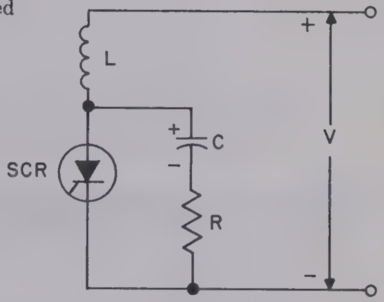
$T_J = 125°C$

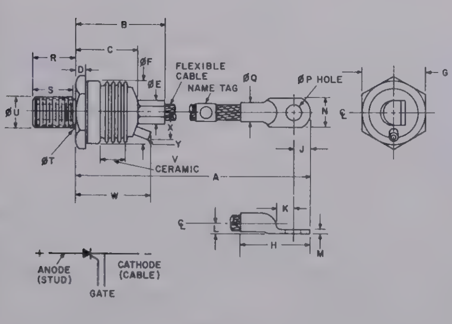
$f = 60$ Hz.

$R = 20\ \Omega$ } Shunt RC Network

$C = 0.5\ \mu F$

$I_{TM} = 600$ amps. peak



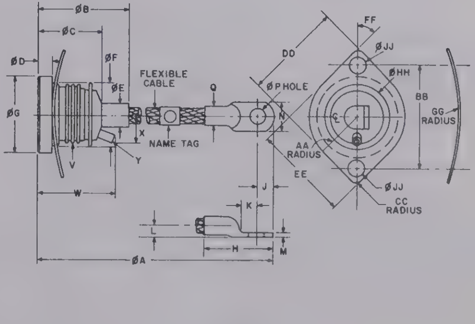


C290

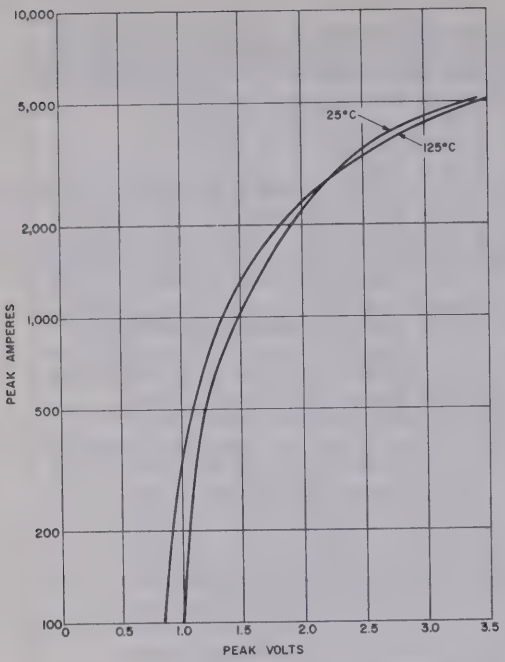
SYMBOL	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX.	NOTES
A	7.500	8.000	190.50	203.20	
ØA	7.625	8.125	193.68	206.38	
B		2 375		60 32	
ØB		2 500		63 50	
C		1 625		41.28	
ØC		1 750		44 45	
D	.235	265	5.97	6.73	
ØD	.325	355	8.25	9.01	
ØE		750		19.05	
ØF		1 625		41 28	
G	1.605	1 640	40.77	41 66	
ØG	1 865	1 885	47.37	47.88	
H	1.625	2 000	41.28	50.80	
J	375	438	9 52	11.12	
K	375		9 52		
L	250	.297	6 35	7.54	
M	.094	125	2.39	3 18	
N		766		19.46	
ØP	391	422	9 93	10.72	
ØQ		562		14 27	
R	1.037	1 087	26 34	27 61	
S	.912	1 009	23 16	25 63	
ØT	660	.670	16 76	17.02	
ØU					5
V					1
W		2 000		50 80	
X		750		19 05	
Y					4
AA	1 178	1 198	29 92	30.43	3
BB	2 484	2 516	63 09	63 91	3
CC	172	203	4 37	5.16	3
DD	2.355	2 395	59 82	60 83	3
EE	2 355	2 395	59 82	60 83	3
FF					2,3
GG	5 500	6 500	139 70	165.10	3
ØHH	1.610	1 630	40.89	41.40	3
ØJJ	370	.380	9 40	9 65	3

TABLE OF DIMENSIONS

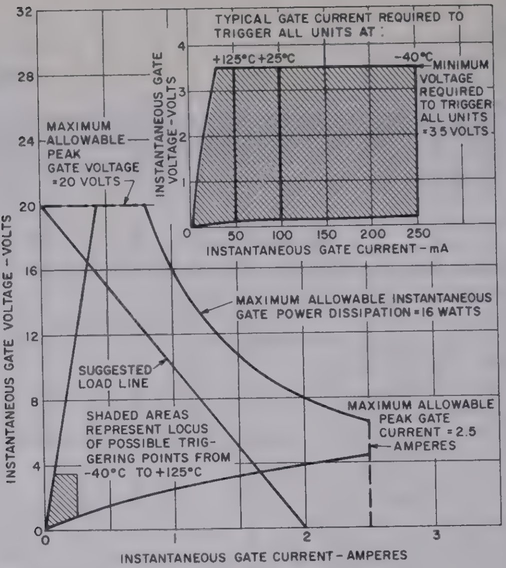
NOTES
1. 1.000" (25.40mm) MIN. INSULATION CREEP.
2. 44° MIN., 46° MAX
3. DIMENSIONS OF CLAMP BEFORE FORMING TO 6 000" (212.40mm) RADIUS
4. COAX RECEPTACLE WILL MATE WITH AMP INC COAXICON PLUG TNC TYPE (E.G. #32036)
5. 3/4"–16UNF–2A



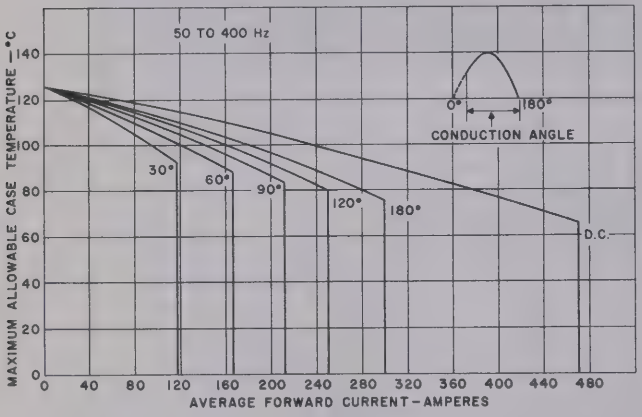
C291



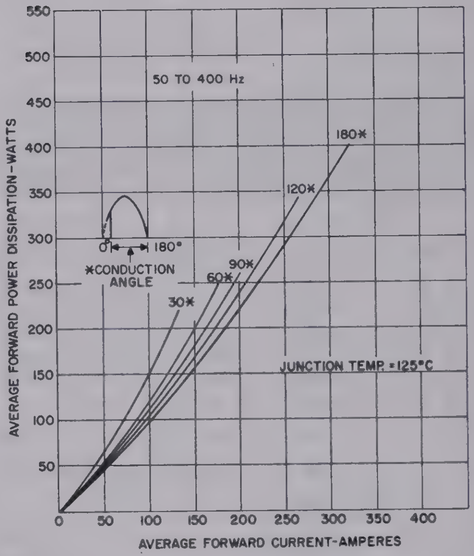
1. MAXIMUM FORWARD CHARACTERISTICS



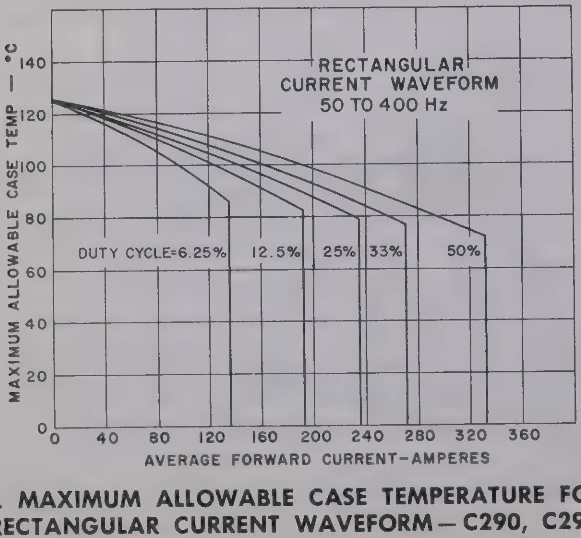
2. TRIGGERING CHARACTERISTICS



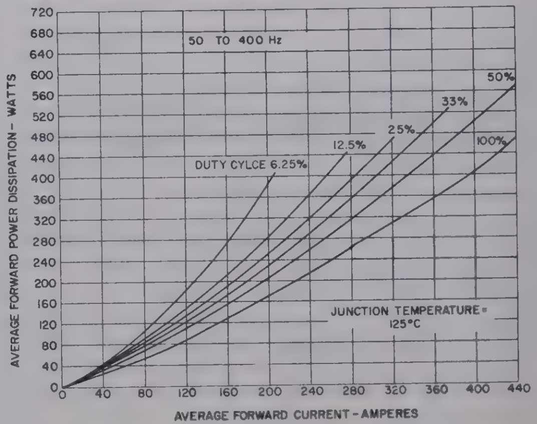
3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM — C290, C291



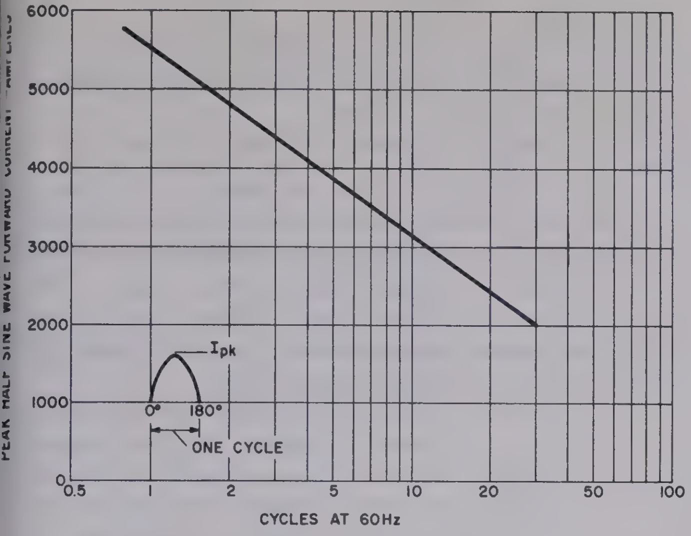
4. AVERAGE FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM — C290, C291



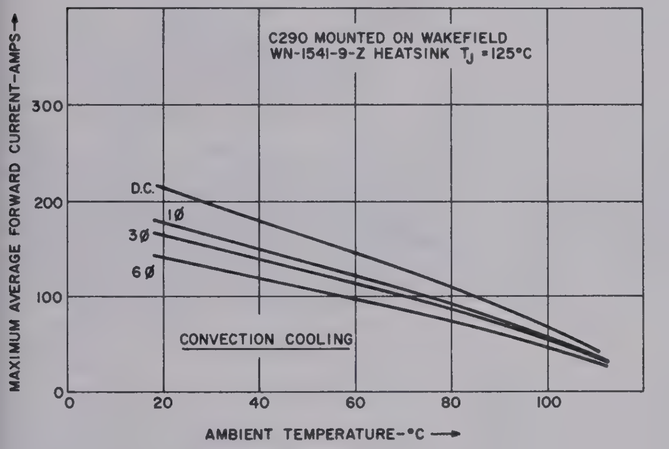
5. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM — C290, C291



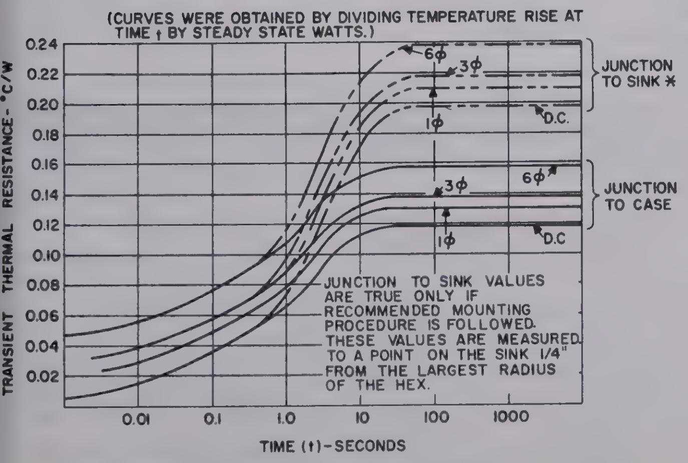
6. FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM — C290, C291



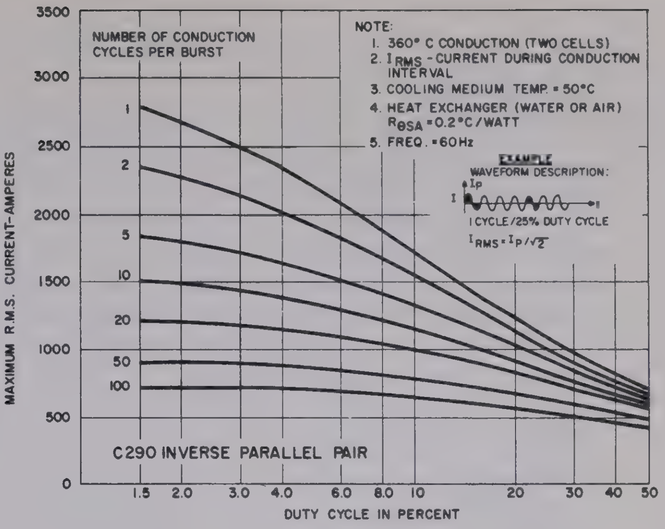
7. MULTIPLE SURGE CURVE AT RATED CURRENT AND VOLTAGE (−40°C to +125°C) FULL REVERSE VOLTAGE APPLIED AFTER SURGE



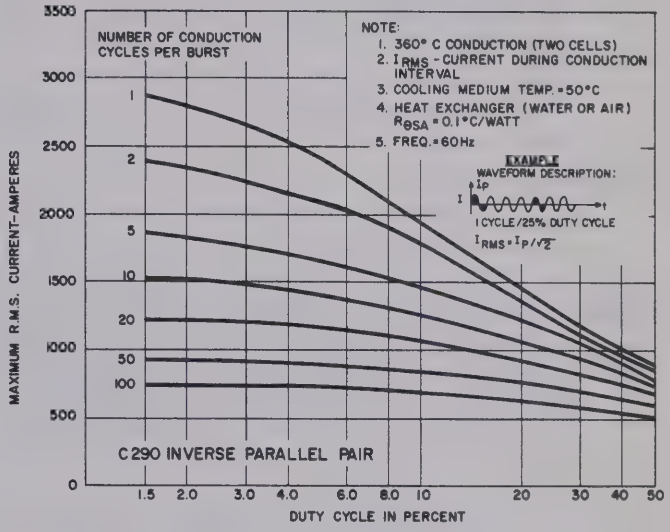
8. MAXIMUM AVE. FORWARD CURRENT (SINUSOIDAL) C290 ON HEAT SINK



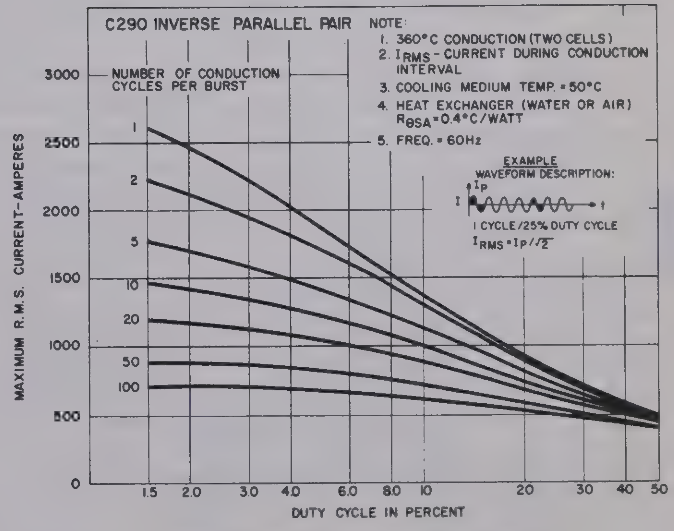
9. TRANSIENT THERMAL RESISTANCE — C290, C291



10. RESISTANCE WELDING RATING— $R_{\theta SA} = 0.2°C/WATT$



11. RESISTANCE WELDING RATING— $R_{\theta SA} = 0.1°C/WATT$



12. RESISTANCE WELDING RATING— $R_{\theta SA} = 0.4°C/WATT$

MOUNTING PROCEDURE FOR C291

Preparation of Heat Sink

Surface Preparation

The heat sink surface should be clean and free of any foreign matter. If necessary, the area may be cleaned with trichlorethylene, or tetrachloroethylene, or similar solvent, but the area must be wiped clean of solvent before proceeding. A $^{16}\surd$ heat sink surface finish is the approved finish. The heat sink surface must be flat within .0005″ across the mounting surface area of the rectifier base, which includes the spring clamp bolting region.

Drilling

1. For all heat sinks over .88″ in thickness at mounting surface. See Fig. 1.
   Two holes are to be drilled as per the sketch at the right.
   Drill and tap for a .3125—18UNC-2A bolt to depth of .88″.
2. For all heat sinks .88″ and under in depth. See Figure 2.
   Two clearance holes are to be drilled for a .3125″ diameter bolt 2.500″±.015″ apart center line to center line.

Mounting Procedure

1. On the clean mounting area of the heat sink and on the base of the clamp-down cell apply a very thin layer of silicone grease (GE #G623 grease or its equivalent). If mounting area is also electric-current-conducting, it should be wire brushed thru the grease, to remove oxide. Wipe clean, without solvent, after brushing and replace grease. Do not entrap metal chips. Locate cell on heat sink.
2. Place the spring washer down over the cell, (A) and insert the two bolts with washers in mounting holes of the spring clamp.
   When mounting this cell to the heat sink, insert two spacers (0.335 ± .001″ in height) between the spring clamp and heat sink on the bolts (See Figures 1 & 2).
3. Run both bolts or nuts down symmetrically with the fingers till they contact the spring; then with a torque wrench alternately turn the bolts or nuts ½ turn maximum apiece until they contact the spacers. (B) Then back off, 1 flat (60°). (C) Wipe excess grease from around the base of the cell.
   a) On heat sinks thicker than .88″ use .3125—18UNC-2A x 1.25″ long bolts. See Fig. 1.
   b) On heat sinks from .25″ to .88″ thick use longer bolts and a back-up spring clamp or equivalent. See Fig. 2.
   c) Heat sinks under .25″ shall not be used.
4. When connecting the cell lead to its terminal do not put a strain on the lead by using a bolt or similar implement to bring the terminal hole in the lead in line with its contact point. This lead should be positioned so that the terminal lines up before assembling the bolt through the hole in the lug of the cell lead.
5. If current take-off is used as shown in Figure 4, the maximum thickness of the take-off should be added to spacer height. If a stud which incorporates the spacer is used, dimensions "C" and "D" should be increased by maximum thickness of the take-off. As an example, if take-off thickness is .094″±.003″ spacer height will be (.346″ + .097″) ± .001″.

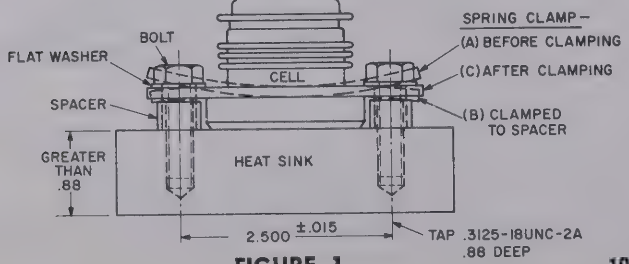
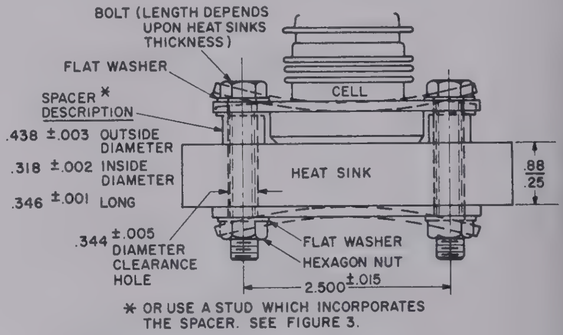

SPRING CLAMP—
(A) BEFORE CLAMPING
(C) AFTER CLAMPING
(B) CLAMPED TO SPACER
BOLT
FLAT WASHER
CELL
SPACER
GREATER THAN .88
HEAT SINK
2.500 ±.015
TAP .3125-18UNC-2A .88 DEEP

FIGURE 1


BOLT (LENGTH DEPENDS UPON HEAT SINKS THICKNESS)
FLAT WASHER
SPACER *
DESCRIPTION
.438 ±.003 OUTSIDE DIAMETER
.318 ±.002 INSIDE DIAMETER
.346 ±.001 LONG
.344 ±.005 DIAMETER CLEARANCE HOLE
CELL
HEAT SINK
.88
.25
FLAT WASHER
HEXAGON NUT
2.500 ±.015

* OR USE A STUD WHICH INCORPORATES THE SPACER. SEE FIGURE 3.

FIGURE 2

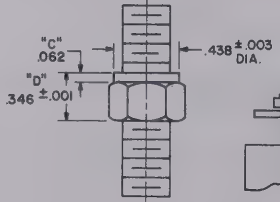

"C"
.062
"D"
.346 ±.001
.438 ±.003 DIA.

FIGURE 3

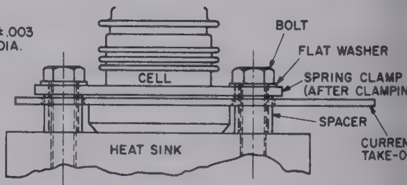

BOLT
FLAT WASHER
SPRING CLAMP (AFTER CLAMPIN
CELL
SPACER
HEAT SINK
CURREN TAKE-O

FIGURE 4

Specifications for Mounting Hardware

Item	GE Dwg.	Description
Bolts, 1.25″ long	N22P23020B11	Material: ASTM A325 Thread: ASA B1.1-1949 .3125—18UNC-2A
Washers	N402P12B11	Material: Steel Size: .344″ Inside Diameter .625″ Outside Diamete .063″ Thick
Spring Clamp	0887B0889 P-1	Inconel X-750
	0165A9165 P-1	Stainless Steel (17-7PH) with lead plating
Spacers	0195A9611 P-2	See Figure 2
Nuts	N258P23B11	Material: Steel Thread: ASA B1.1-1949 .3125—18UNC-2B

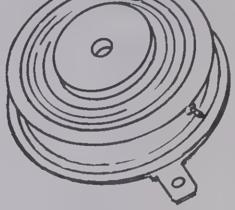
SCR

C350 SERIES

The C350 Series of high power devices feature the proven, all-diffused construction used in the C150 Series in a new General Electric PRESS PAK.

Special characteristics of these new devices are:

- Pressure contacts
- Increased current capability when double-sided cooling is used
- Smaller size and lighter weight
- Reversibility eliminates need for special reverse polarity units
- Hermetically sealed



MAXIMUM ALLOWABLE RATINGS

TYPE	PEAK FORWARD BLOCKING VOLTAGE, V_{FOM}* T_C = -40°C to + 120°C	REPETITIVE PEAK REVERSE VOLTAGE, V_{ROM} (rep)* T_C = -40°C to + 120°C	TRANSIENT PEAK REVERSE VOLTAGE (Non-recurrent < 5 Millisec.), V_{ROM}(non-rep) T_C = -40°C to + 120°C
C350E	500 Volts	500 Volts	600 Volts
C350M	600	600	720
C350S	700	700	850
C350N	800	800	950
C350T	900	900	1075
C350P	1000	1000	1200
C350PA	1100	1100	1325
C350PB	1200	1200	1450
C350PC	1300	1300	1550

Average Forward Current, On State		Depends on conduction angle (See Charts 1 and 3)
Peak One-Cycle Surge Forward Current, I_{FM} (surge)		2000 amperes
Maximum Rate of Rise of Anode Current During Turn-on Interval (High Gate Drive Required. See Chart 11) (Switching Rates ≦ 400 Hz.)	Switch From <500V	100A/μsec
	Switch From <1000V	75A/μsec
	Switch From <1300V	50A/μsec
I^2t (for fusing) (for times ≧ 1.5 milliseconds)		10,500 ampere^2 seconds
I^2t (for fusing) (at 8.3 milliseconds)		16,250 ampere^2 seconds
Peak Gate Power Dissipation, P_{GM}		10 Watts
Average Gate Power Dissipation, $P_{G(AV)}$		2 Watts
Peak Reverse Gate Voltage, V_{GRM}		5 Volts
Storage and Operating Temperature, T_C.		-40°C to +120°C
External Force Required		800 lbs. ±10%

*Ratings apply for zero or negative gate voltage. Maximum heatsink thermal resistance for which maximum PRV ratings apply equal 1.1°C/watt.

C350 SERIES

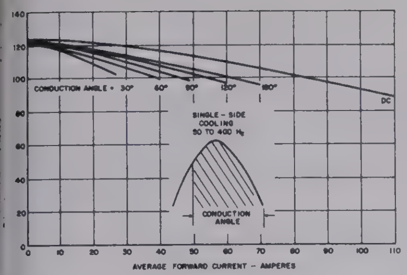
CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Peak Reverse and Forward Blocking Current	I_{ROM} and I_{FOM}				mA	$T_C = +25^{\circ}C$
C350E		—	3	10		$V_{FOM} = V_{ROM} =$ 500 Volts peak
C350M		—	3	10		600 Volts peak
C350S		—	3	10		700 Volts peak
C350N		—	3	10		800 Volts peak
C350T		—	3	9		900 Volts peak
C350P		—	3	7		1000 Volts peak
C350PA		—	3	7		1100 Volts peak
C350PB		—	3	6		1200 Volts peak
C350PC		—	3	5		1300 Volts peak
Peak Reverse and Forward Blocking Current	I_{ROM} and I_{FOM}				mA	$T_C = 120^{\circ}C$
C350E		—	15	20		V_{FOM} V_{ROM} 500 Volts peak
C350M		—	15	20		600 Volts peak
C350S		—	15	20		700 Volts peak
C350N		—	15	20		800 Volts peak
C350T		—	15	18		900 Volts peak
C350P		—	12	15		1000 Volts peak
C350PA		—	11	14		1100 Volts peak
C350PB		—	10	13		1200 Volts peak
C350PC		—	8	11		1300 Volts peak
Effective Thermal Resistance (DC)	θ_{J-C}	—	—	0.20	°C/watt	Junction to Case - One side cooled
		—	—	0.135		Junction to Case - Two sides cooled
Critical Exponential Rate of Rise of Forward Blocking Voltage (Higher values may cause device switching)	Dv/Dt	200	500	—	V/μsec	V_{FOM} = Rated, $T_C = +120^{\circ}C$, Gate open.
		300	500	—	V/μsec	V_{FOM} =.8 Rated, $T_C = +120^{\circ}C$, Gate open.
Holding Current	I_{HO}	—	20	500	mAdc	$T_C = +25^{\circ}C$, Anode supply = 24Vdc. Initial forward current = 2 amps.
Latching Current	I_{LX}	—	—	2	Adc	$T_C = +25^{\circ}C$, Anode voltage = 24Vdc, Load resistance 12 ohms max.
Turn-On Time (Delay Time + Rise Time)	$t_d + t_r$	—	8	—	μsec	$T_C = +25^{\circ}C$, I_F = 50 Adc, V_{FXM} = Rated. Gate supply: 10 volt open circuit, 20 ohm, 0.1 μsec max. rise time.
Gate Pulse Width Necessary to Trigger		—	8	10	μsec	$T_C = +25^{\circ}C$. Gate Supply: 5 volt open circuit, 5 ohm, 0.1 μsec rise time.
Gate Trigger Current	I_{GT}	—	16	150	mAdc	$T_C = +25^{\circ}C$, V_{FX} = 6Vdc, R_L = 3 ohms
		—	30	200	mAdc	$T_C = -40^{\circ}C$, V_{FX} = 6Vdc, R_L = 3 ohms
		—	5	125	mAdc	$T_C = +120^{\circ}C$, V_{FX} = 6Vdc, R_L = 3 ohms
Gate Trigger Voltage	V_{GT}	—	1.25	3.0	Vdc	$T_C = -40^{\circ}C$ to $+120^{\circ}C$, V_{FX} = 6Vdc, R_L = 3 ohms.
		0.15	—	—	Vdc	$T_C = +120^{\circ}C$, V_{FX} = Rated, R_L = 1000 ohms.
Peak On-Voltage	V_{FM}	—	2.0	2.6	Volts	$T_C = +25^{\circ}C$, I_{FM} = 500A peak. Duty cycle ≦ 0.01%
Circuited Commutated Turn-Off Time**	t_{off}	—	100	—†	μsec	$T_C = +120^{\circ}C$, I_{FM} = 50A, V_{RX} = 50 volts min., V_{FXM} (reapplied) = Rated, Rate of rise of reapplied forward blocking voltage = 20V/μsec linear, Gate bias = 0V and 100 ohms during turn-off interval Duty cycle ≦ 0.01%

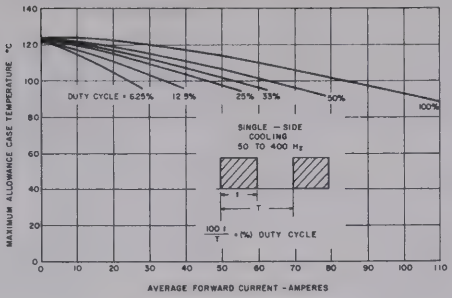
†Consult Factory if guaranteed Turn-Off Time is required

**Typical Turn-Off Time increases 30%, if I_{FM} is increased to 500A.

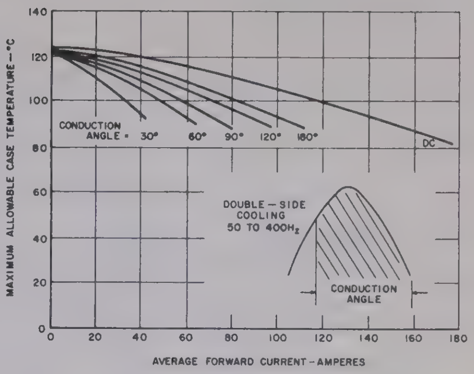
NOTE: T_C = Case Temperature (measured on side of either anode or cathode pedestal — whichever is in contact with the heat sink)



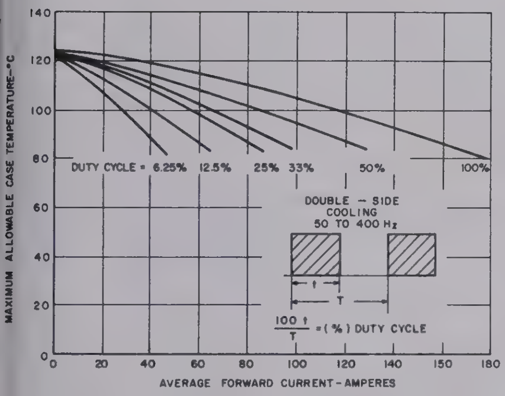
1. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



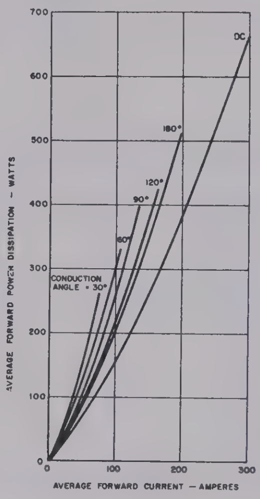
2. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



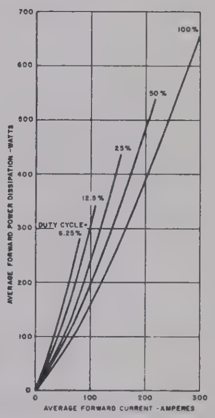
3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



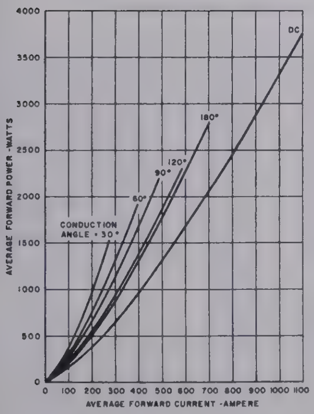
4. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



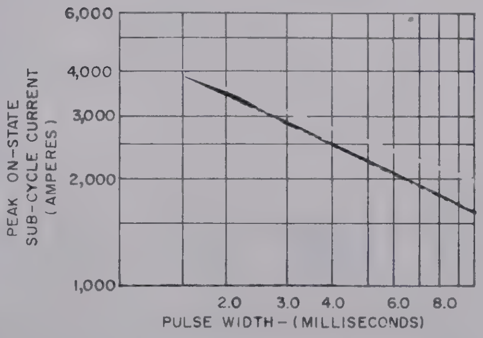
5. AVERAGE FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



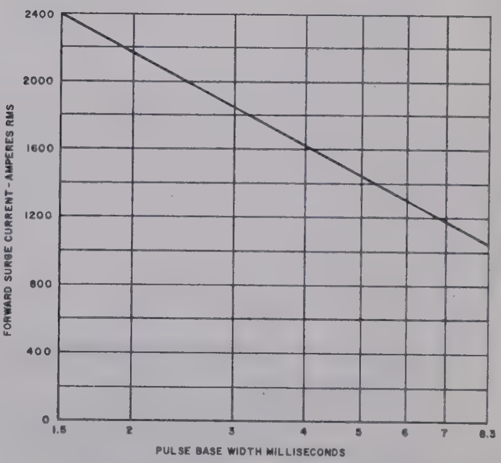
6. AVERAGE FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



7. EXTENDED FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM

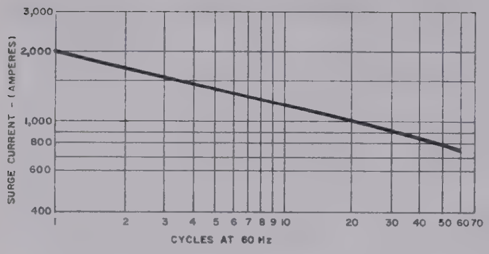


8. SUB-CYCLE SURGE RATING FOLLOWING RATED LOAD CONDITIONS

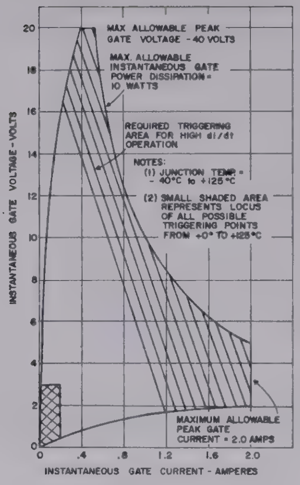


9. SUB-CYCLE SURGE RATING FOLLOWING RATED LOAD CONDITIONS

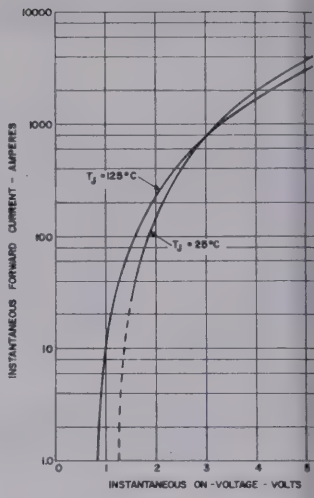
C350 SERIES



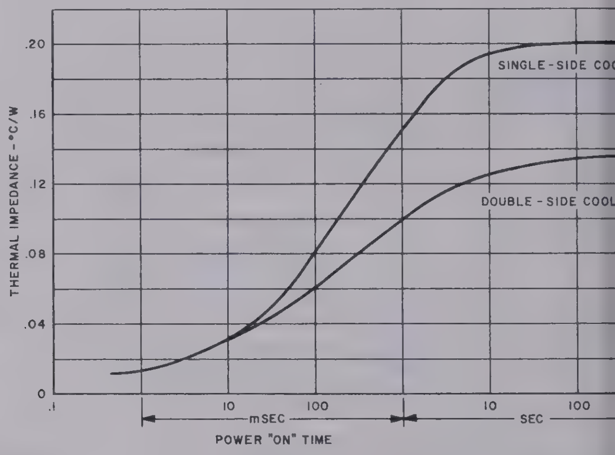
9. MAXIMUM ALLOWABLE SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS



10. GATE TRIGGERING CHARACTERISTICS



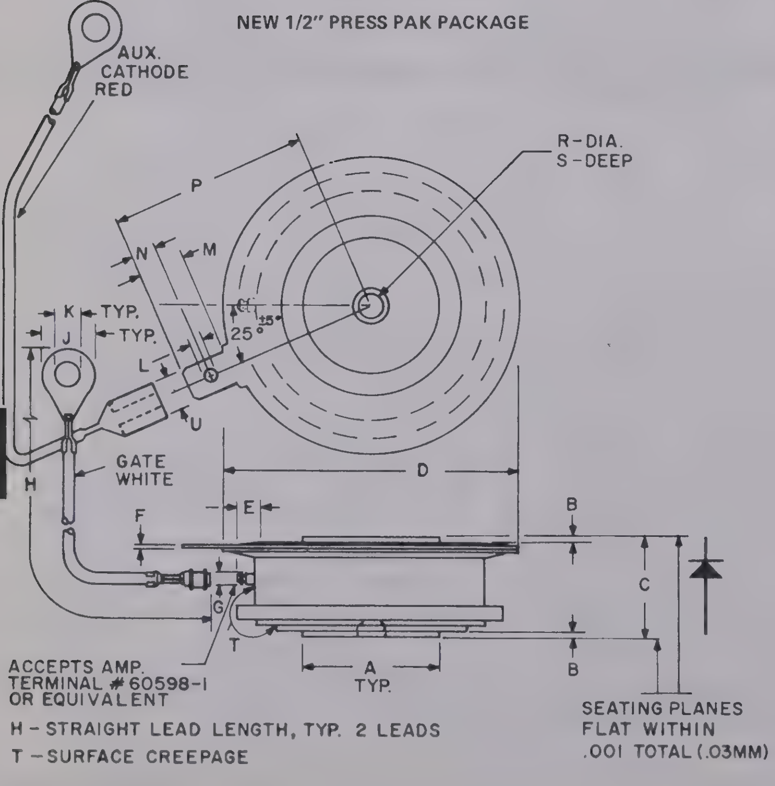
11. FORWARD CONDUCTIO CHARACTERISTIC, ON-STAT



12. TRANSIENT THERMAL IMPEDANCE JUNCTION TO FIN

OUTLINE DRAWINGS

NEW 1/2" PRESS PAK PACKAGE


AUX. CATHODE RED
R-DIA. S-DEEP
P
N
M
K
TYP.
J
TYP.
α
25°
±5°
L
U
GATE WHITE
H
D
E
F
B
C
G
T
A TYP.
B
ACCEPTS AMP. TERMINAL # 60598-1 OR EQUIVALENT
SEATING PLANES FLAT WITHIN .001 TOTAL (.03MM)
H - STRAIGHT LEAD LENGTH, TYP. 2 LEADS
T - SURFACE CREEPAGE

FOR MOUNTING HARDWARE SEE SELECTOR GUIDE PAGE 171

TABLE OF DIMENSIONS

Conversion Table

SYM	DECIMAL INCHES MIN	DECIMAL INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.
A	.744	.752	18.897	19.101
B	.030	.060	.762	1.524
C	.515	.565	13.081	14.351
D	1.600	1.656	40.64	42.06
E	.110	—	2.794	—
F	.031	.017	.330	.432
G	.057	.059	1.447	1.449
H	7.980	8.115	202.70	206.11
J	—	.300	—	7.620
K	.137	.153	3.479	3.886
L	.065	.070	1.651	1.778
M	.245	.260	6.223	6.604
N	.120	.140	3.048	3.556
P	1.090	1.125	27.69	28.55
R	.135	.145	3.429	3.683
S	.067	.083	1.701	2.108
T	.340	—	8.636	—
U	.186	.189	4.724	4.801

HIGH SPEED

Silicon Controlled Rectifier

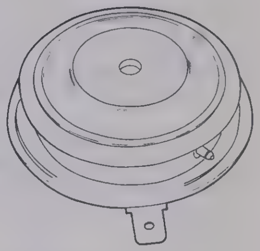
600 Volts **215A RMS**

C354
C355

The General Electric C354, C355 Series of Silicon Controlled Rectifiers are reverse blocking triode thyristors designed primarily for power switching from 60–1000 Hz. This rugged SCR has been proven by 6 years field experience in applications like Battery Vehicle choppers, PWM motor controls, uninterruptible power supplies, and inverters.

For efficient operation in high speed applications, the C354/C355 SCR provides a superior mix of capabilities:

- Forward and reverse blocking voltage to 600 volts
- 10 μsec turn-off-time maximum (C354) with shorter turn-off-times available from factory on special request
- High di/dt and dv/dt at rated frequency
- Low switching losses
- Reversibility eliminating need for reverse polarity units
- Increased current ratings when double side cooling is employed



MAXIMUM ALLOWABLE RATINGS

Types	Repetitive Peak Off-State Voltage, V_{DRM} $T_C = -40°C$ to $+125°C$	Repetitive Peak Reverse Voltage, V_{RRM}(1) $T_C = -40°C$ to $+125°C$	Non-repetitive Peak Reverse Voltage, V_{RRM}(1)(2) $T_C = -40°C$ to $+125°C$
C354A, C355A	100 Volts	100 Volts	200 Volts
C354B, C355B	200	200	300
C354C, C355C	300	300	400
C354D, C354D	400	400	500
C354E, C355E	500	500	600
C355M	600	600	650

(1) Ratings apply for zero or negative gate voltage. Maximum case to ambient thermal resistance for which maximum V_{DRM} and maximum V_{RRM} ratings apply equals 1.1°C/watt.
(2) Half sine wave voltage pulse, 10 millisecond maximum duration.

Peak Positive Anode Voltage . . . . None*
Average On-State Current, $I_{T(AV)}$. . . . . (See Charts)
Peak One Cycle Surge (non-rep) On-State Current, I_{TSM} . . . . 1,800 Amperes
I^2t (for fusing) for times ≧ 1.5 milliseconds. . . . . 9,500 Ampere^{2}seconds
I^2t (for fusing) for times ≧ 8.3 milliseconds . . . . .13,000 Ampere^{2}seconds
Critical Rate-of-Rise of On-State Current, di/dt, During Turn-On Interval . . . . 100 Amperes per microsecond**
Peak Gate Power Dissipation, P_{GM} . (Pulse Width = 10 μsec) . . . . 400 Watts
Average Gate Power Dissipation, $P_{G(AV)}$. . . . . .2 Watts
Peak Negative Gate Voltage, V_{GM} . . . . 20 Volts
Storage Temperature, T_{stg} . . . . –40°C to +150°C
Operating Temperature, T_J. . . . . –40°C to +125°C
Mounting Force . . . . 800 lbs. ± 10%, 360 Kg. ± 10%

* This SCR may be, non-repetitively, turned-on in the forward direction by exceeding the breakover voltage (V_{DRM}) with either a rapidly or slowly rising waveform. At breakover, di/dt must be limited to 20 amps/μsec and peak current to 1000 amperes.

** Required trigger source–20 volts, 20 ohms; maximum switching voltage–V_{DRM}: short-circuit gate supply current risetime–0.25 μsec. (This short-circuit current may be measured with a TEKTRONICS current probe.) RC Snubber circuit used across SCR–(see Figure 5).

di/dt rating is established in accordance with JEDEC Suggested Standard No. 7, Section 5.1.2.4. Immediately after each current pulse, off-state (blocking) voltage capability may be temporarily lost for durations less than the period of the applied pulse repetition rate. The pulse repetition rate for this test is 400 Hz. The duration of the JEDEC di/dt test condition is 5.0 seconds (minimum).

di/dt up to 100 amps/μsec at specified gate drive and switching voltage is part of the rectangular current wave ratings (see rating curves of Figures 13 through 30.) This is a repetitive, long term rating confirmed by life test.

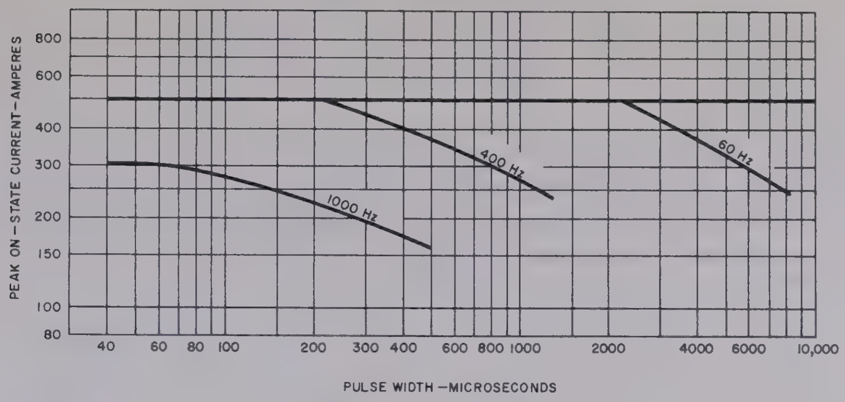
CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Peak Reverse and Off-State Current	I_{DRM} and I_{RRM}				mA	T_C = +25°C
C354A, C355A		–	8	18		$V_{DRM} = V_{RRM}$ = 100 Volts peak
C354B, C355B		–	7	17		200 Volts peak
C354C, C355C		–	6	16		300 Volts peak
C354D, C355D		–	6	16		400 Volts peak
C354E, C355E		–	5	15		500 Volts peak
C355M		–	5	15		600 Volts peak
Peak Reverse and Off-State Current	I_{DRM} and I_{RRM}				mA	T_C = 125°C
C354A, C355A		–	14	18		$V_{DRM} = V_{RRM}$ = 100 Volts peak
C354B, C355B		–	13	17		200 Volts peak
C354C, C355C		–	12	16		300 Volts peak
C354D, C355D		–	12	16		400 Volts peak
C354E, C355E		–	10	15		500 Volts peak
C355M		–	10	15		600 Volts peak
Effective Thermal Resistance	$\theta_{J\text{-}C}$	– –	– –	.26 .13	°C/watt °C/watt	Junction to case (DC) single-side cooled Junction to case (DC) double-side cooled
Critical Exponential Rate of Rise of Forward Blocking Voltage (Higher values may cause device switching)	dv/dt				V/µsec	V_{DRM}, T_C = +125°C, Gate open.
C354		200	500	–		
C355		100	300	–		
Holding Current	I_H	–	30	200	mAdc	T_C = +25°C, Anode supply = 24 Vdc. Initial forward current = 2 amps.
Pulse Gate Trigger Current Voltage	$i_{GT(pulse)}$ $V_{GT(pulse)}$	– –	1 8	2 10	Amps Volts	T_C = +25°C, t_p = 10 µsec. 0.25 µsec rise time.
DC Gate Trigger Current	I_{GT}	– – –	50 100 30	150 200 120	mAdc mAdc mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 3 ohms. T_C = –40°C, V_D = 6 Vdc, R_L = 3 ohms. T_C = +125°C, V_D = 6 Vdc, R_L = 3 ohms.
DC Gate Trigger Voltage	V_{GT}	– 0.25	1.25 –	3.0 –	Vdc Vdc	T_C = –40°C to +125°C, V_D = 6 Vdc, R_L = 3 ohms. T_C = +125°C, V_{DRM}, R_L = 1000 ohms.
Peak On-State Voltage	V_{TM}	–	2.2	3.0	Volts	T_C = +25°C, I_{TM} = 500A peak. Duty cycle ≤ .01%.
Delay Time	t_d	–	1	2	µsec	T_C = +25°C, I_T = 50 Adc, V_{DRM}. Gate supply: 10 volt open circuit, 20 ohm, 0.1 µsec rise time.
Conventional Circuit Commutated Turn-Off-Time (with Reverse Voltage)	t_q				µsec	(1) T_C = +125°C, (2) I_T = 50A, (3) V_R = 50 volts min., (4) V_{DRM} (reapplied), (5) Rate of rise of reapplied forward blocking voltage = 20 V/µsec (linear). (6) Commutation di/dt = 5 Amps/µsec. (7) Duty cycle ≤ .01%. (8) Gate bias during turn-off interval = 0 volts, 100 ohms.
C354		–	7	10		
C355		–	12	20		
Conventional Circuit Commutated Turn-Off-Time (with Feedback Diode)	$t_{q(diode)}$				µsec	(1) T_C = +125°C, (2) I_T = 150A, (3) V_R = 1 volt Forward drop of GE A96 rectifier diode at I_T = 150A), (4) V_{DRM}, (5) Rate of rise of reapplied forward blocking voltage = 20 V/µsec (linear). (6) Commutation di/dt = 5 Amps/µsec. (7) Duty cycle ≤ .01%. (8) Gate bias during turn-off interval = 0 volts, 100 ohms.
C354		–	12	–		
C355		–	15	–		
Pulse Circuit Commutated Turn-Off-Time (with Reverse Voltage)	$t_{q(pulse)}$				µsec	(1) T_C = +125°C, V_{DRM} (reapplied), (2) Rate of rise of reapplied forward blocking voltage = 200 V/µsec (linear) (C354), 100 V/µsec (C355) (3) Rep. rate = 400 Hz., (4) Gate supply = 20 volts, 20 ohms, 0.25 µsec max. rise time, (5) I_T = 500 A peak, t_p = 3 µsec (half sine wave), (6) V_R = 50 volts min.
C354		–	15	20		
C355		–	25	30		
Pulse Circuit Commutated Turn-Off-Time (with Feedback Diode)	$t_{q(pulse)}$ (diode)				µsec	(1) T_C = +125°C, V_{DRM} (reapplied), (2) Rate of rise of reapplied forward blocking voltage = 20 V/µsec (linear), (3) Rep. rate = 400 Hz., (4) Gate supply = 20 volts, 20 ohms, 0.25 µsec max. rise time, (5) I_T = 500 A peak, t_p = 3 µsec (half sine wave), (6) V_R = 1.5 volt (Forward drop of GE A96 rectifier diode at I_T = 500 A).
C354		–	17	20		
C355		–	–	–†		

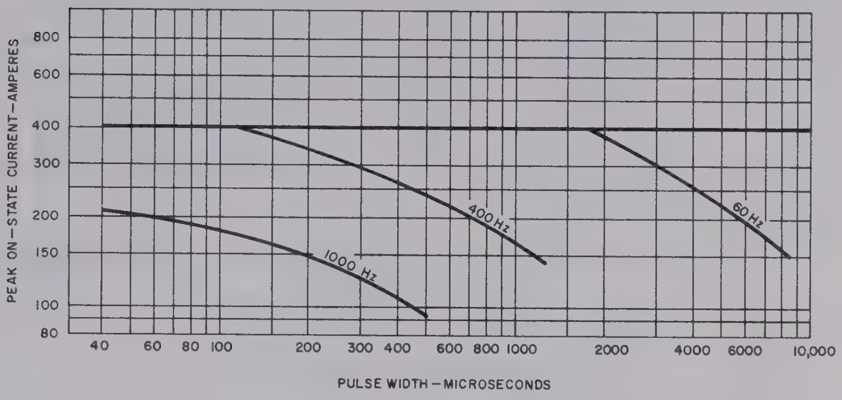
†Consult Factory for specified maximum Turn-Off-Time.

SINE WAVE DATA

SINGLE-SIDE COOLING

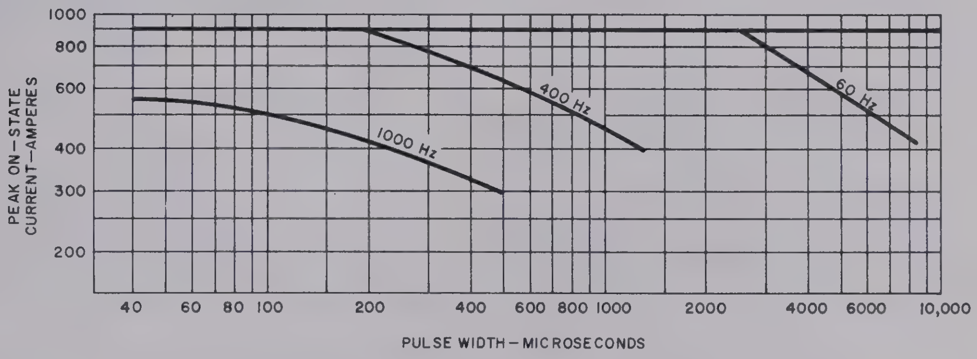


1. Maximum allowable peak on-state current vs. pulse width (T_C = 65°C)

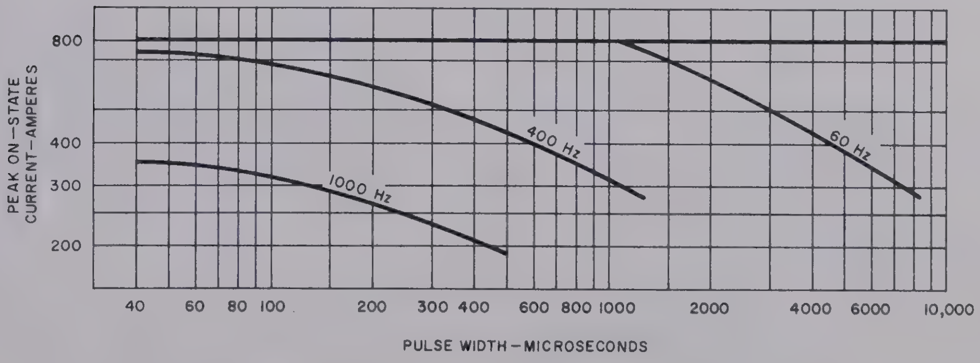


2. Maximum allowable peak on-state current vs. pulse width (T_C = 90°C)

DOUBLE-SIDE COOLING



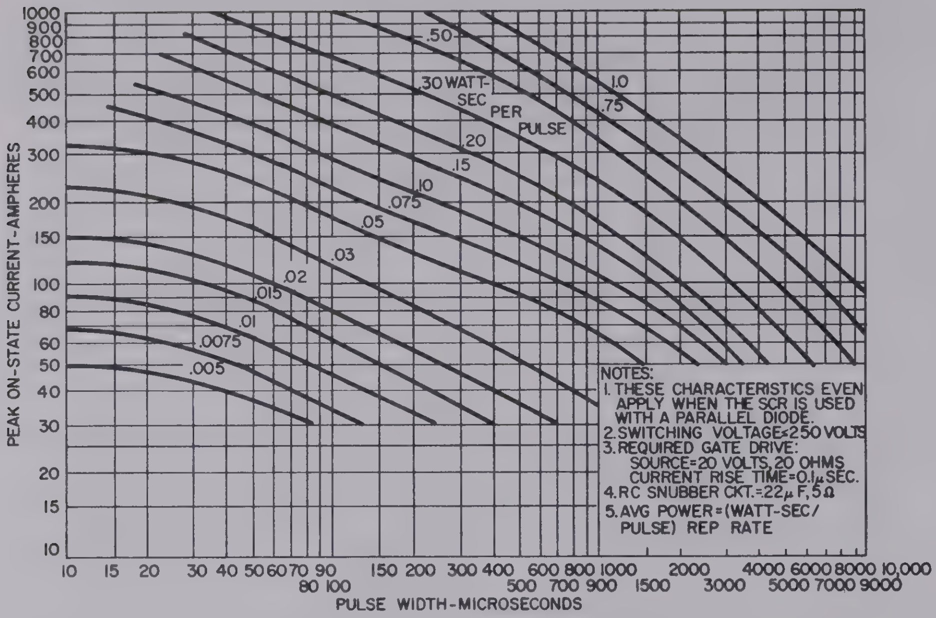
3. Maximum allowable peak on-state current vs. pulse width (T_C = 65°C)



4. Maximum allowable peak on-state current vs. pulse width (T_C = 90°C)

NOTES:
(1) Switching voltage ≤ 250 volts. (2) Min. circuit turn-off-time ≥ 20 μsec. (3) Max. circuit dv/dt ≤ 200 V/μsec. (4) Required gate drive: source–20 volts, 20 ohms; risetime–.1 μsec. (5) RC Snubber–.22 μf, 5 ohm.

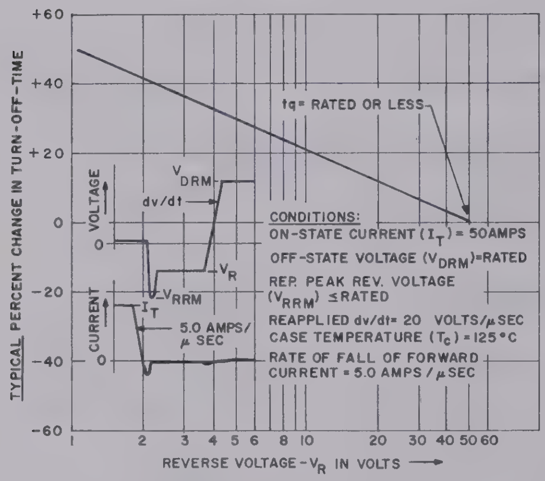
SINE WAVE DATA



NOTES:
1. THESE CHARACTERISTICS EVEN APPLY WHEN THE SCR IS USED WITH A PARALLEL DIODE.
2. SWITCHING VOLTAGE≤250 VOLTS
3. REQUIRED GATE DRIVE:
SOURCE=20 VOLTS, 20 OHMS
CURRENT RISE TIME=0.1μSEC.
4. RC SNUBBER CKT.=.22μF, 5Ω
5. AVG POWER=(WATT-SEC/PULSE) REP RATE

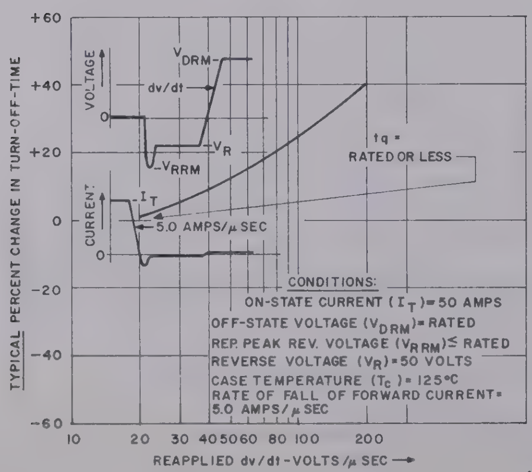
5. Energy per pulse for sinusoidal pulses

TURN-OFF-TIME DATA



CONDITIONS:
ON-STATE CURRENT (I_T) = 50AMPS
OFF-STATE VOLTAGE (V_{DRM})=RATED
REP. PEAK REV. VOLTAGE (V_{RRM}) ≤RATED
REAPPLIED dv/dt= 20 VOLTS/μSEC
CASE TEMPERATURE (T_c) = 125°C
RATE OF FALL OF FORWARD CURRENT = 5.0 AMPS / μSEC

6. This curve shows a typical variation of conventional circuit commutated SCR turn-off-time with applied reverse voltage (V_R) during the turn-off interval. Testing at V_R = "1 volt" is done with a GE A96 fact recovery diode in inverse parallel with the C354/C355. For SCR's with specified maximum turn-off-time with an inverse parallel diode—consult the factory.

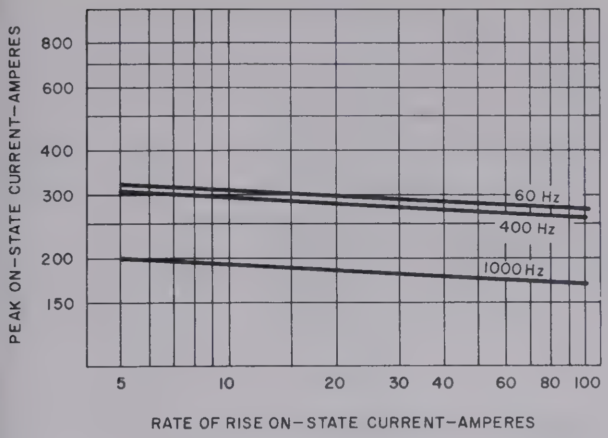


CONDITIONS:
ON-STATE CURRENT (I_T)=50 AMPS
OFF-STATE VOLTAGE (V_{DRM})= RATED
REP. PEAK REV. VOLTAGE (V_{RRM})≤ RATED
REVERSE VOLTAGE (V_R)=50 VOLTS
CASE TEMPERATURE (T_c) = 125°C
RATE OF FALL OF FORWARD CURRENT= 5.0 AMPS/μ SEC

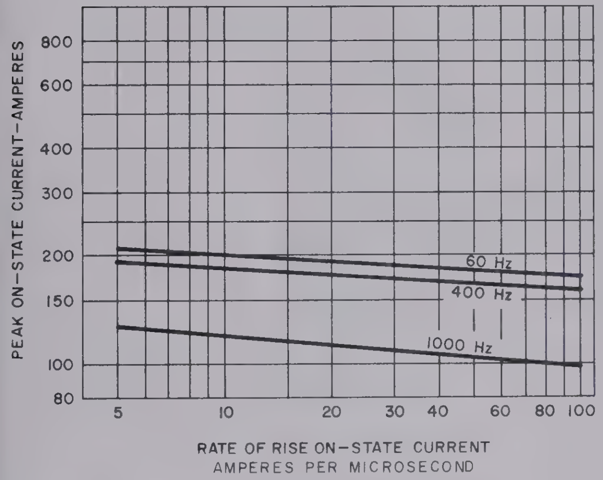
7. This curve shows a typical variation of conventional circuit commutated SCR turn-off-time-with reapplied dv/dt. Specified turn-off-time is with reapplied dv/dt of 20 volts/μsec. Note turn-off-time increase at higher dv/dt. When requesting selected turn-off-time also specify maximum reapplied dv/dt.

RECTANGULAR WAVE DATA SWITCHING
VOLTAGE - 500 VOLTS DOUBLE-SIDE COOLING

DUTY CYCLE–50%

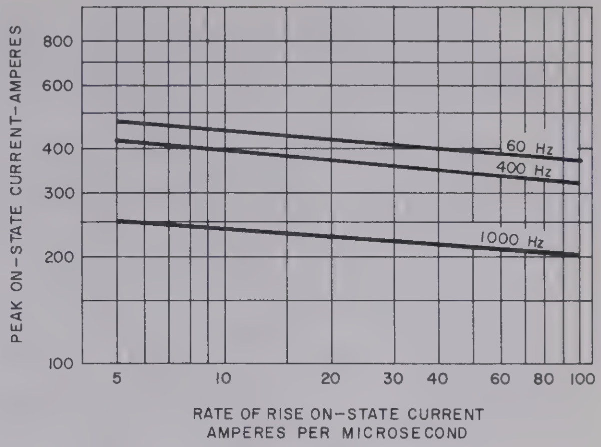


8. **Maximum allowable peak on-state current vs. di/dt (T_C = 65°C)**

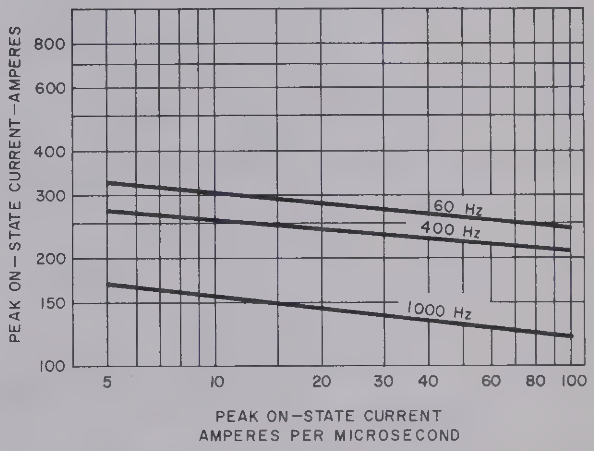


9. **Maximum allowable peak on-state current vs. di/dt (T_C = 90°C)**

DUTY CYCLE–25%

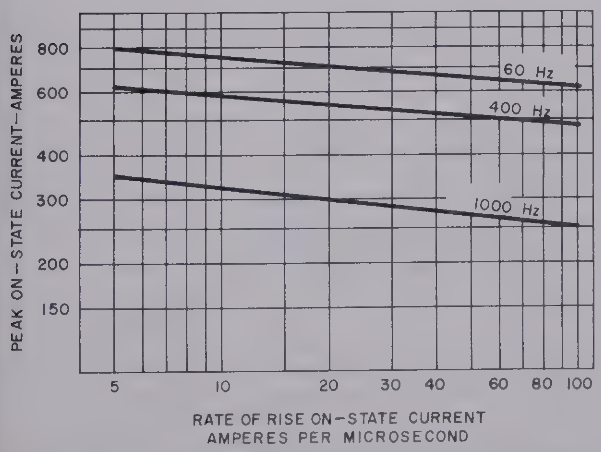


10. **Maximum allowable peak on-state current vs. di/dt (T_C = 65°C)**

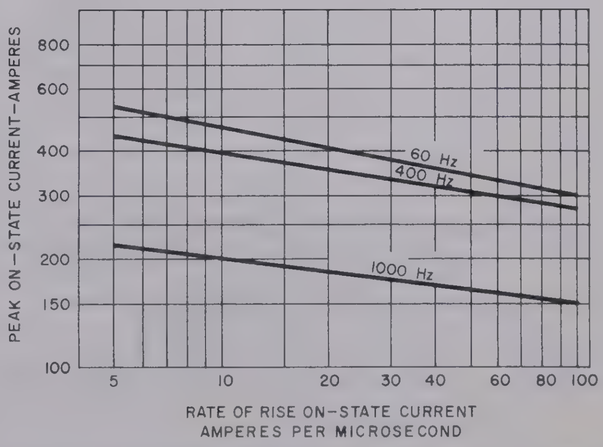


11. **Maximum allowable peak on-state current vs. di/dt (T_C = 90°C)**

DUTY CYCLE–10%



12. **Maximum allowable peak on-state current vs. di/dt (T_C = 65°C)**

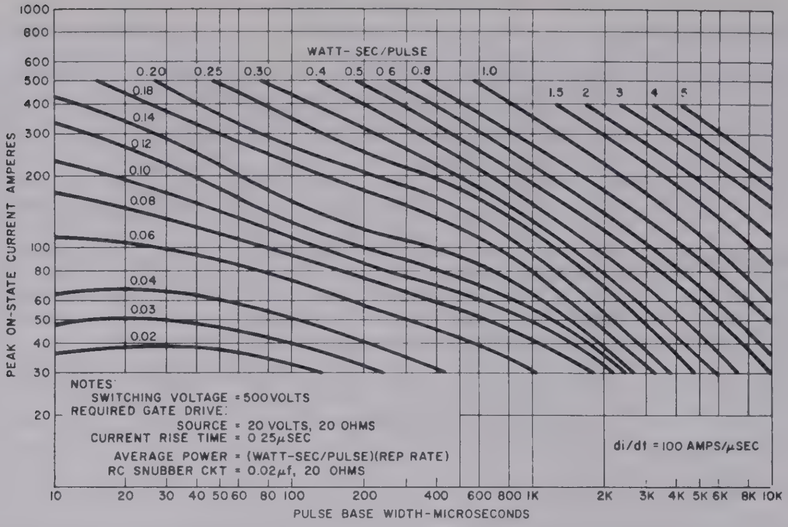


13. **Maximum allowable peak on-state current vs. di/dt (T_C = 90°C)**

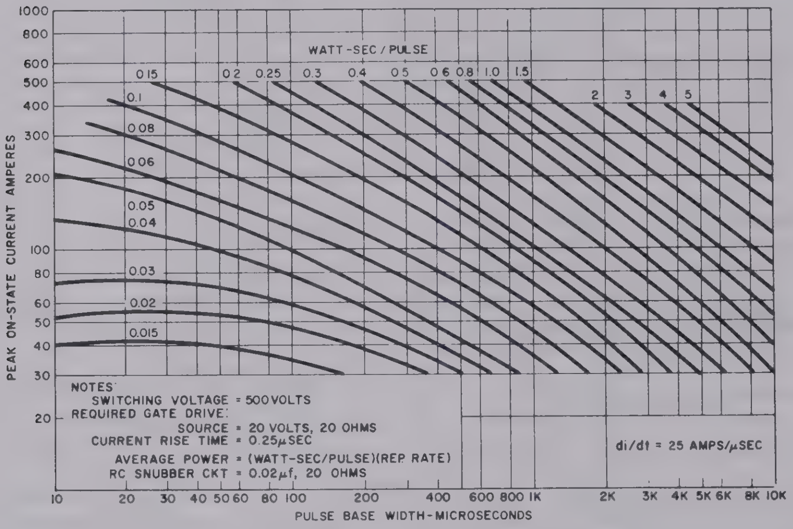
NOTES:

RECTANGULAR WAVE DATA WATT-SECOND PER PULSE SWITCHING VOLTAGE

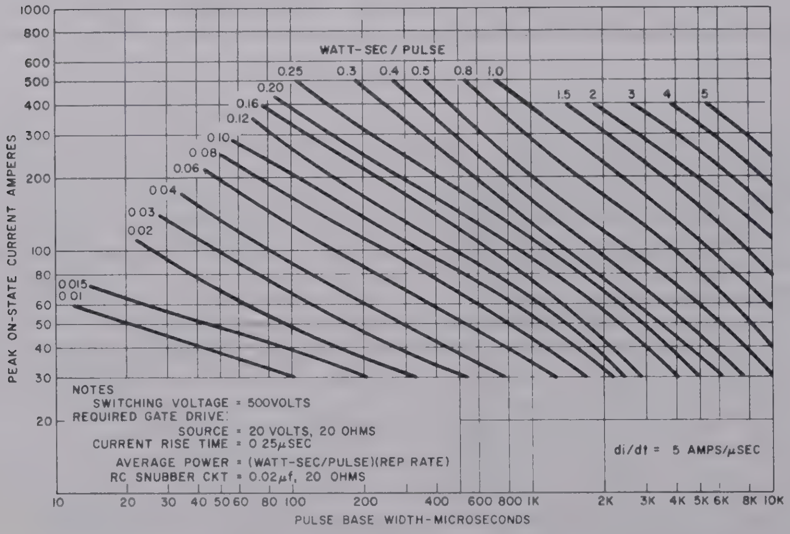
500 VOLTS



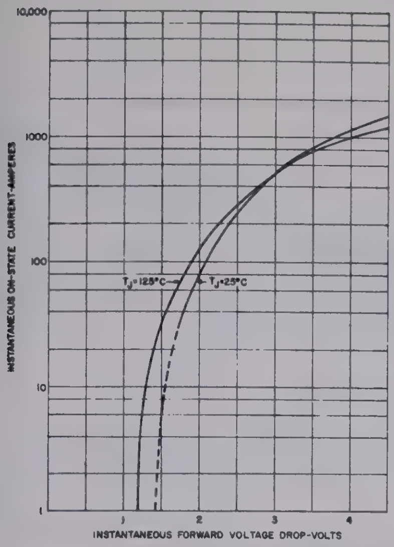
14. Energy per pulse vs. peak current and pulse width (di/dt = 100 A/μsec.)



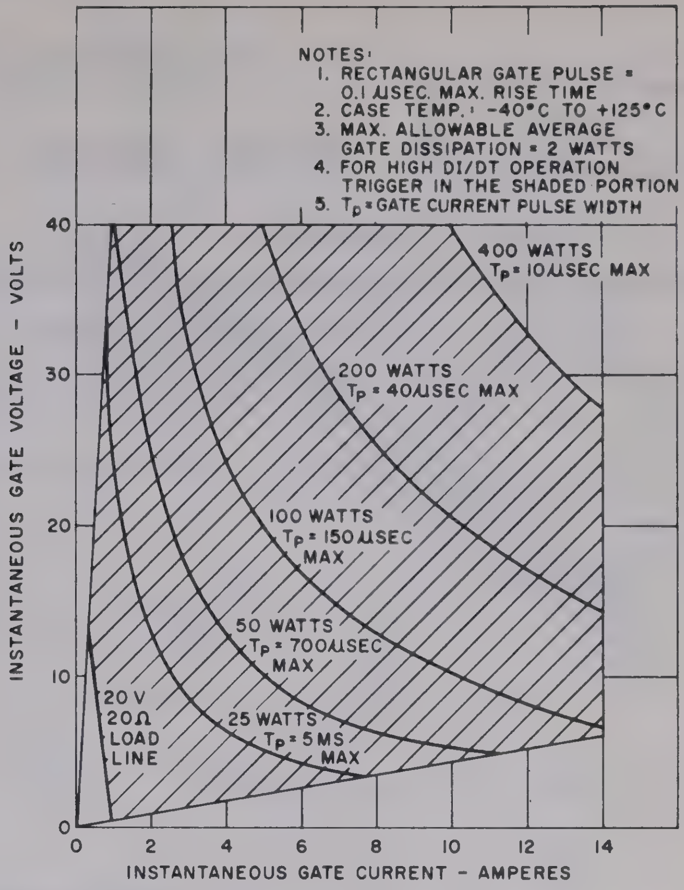
15. Energy per pulse vs. peak current and pulse width (di/dt = 25 A/μsec.)



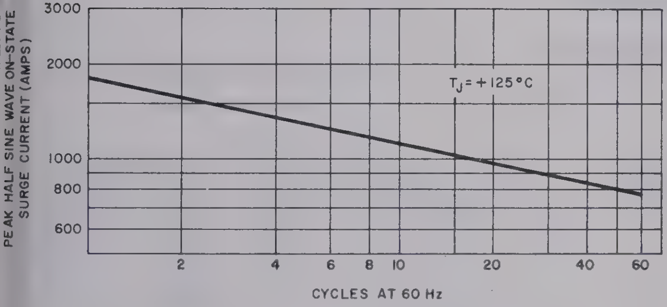
16. Energy per pulse vs. peak current and pulse width (di/dt = 5 A/μsec.)



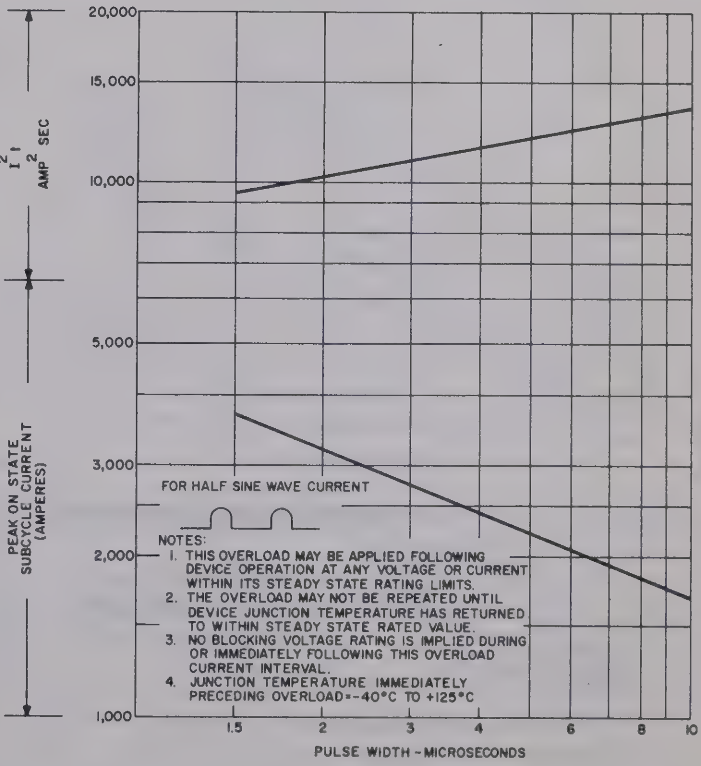
17. Forward conduction characteristic, on-state


NOTES:
1. RECTANGULAR GATE PULSE = 0.1 μSEC. MAX. RISE TIME
2. CASE TEMP.: −40°C TO +125°C
3. MAX. ALLOWABLE AVERAGE GATE DISSIPATION = 2 WATTS
4. FOR HIGH DI/DT OPERATION TRIGGER IN THE SHADED PORTION
5. T_p = GATE CURRENT PULSE WIDTH

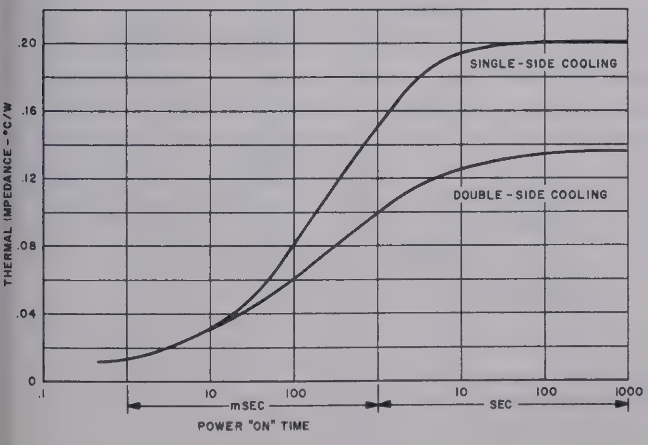
18. Maximum allowable peak gate power vs. gate pulse width



19. Maximum allowable surge current following rated load conditions


FOR HALF SINE WAVE CURRENT

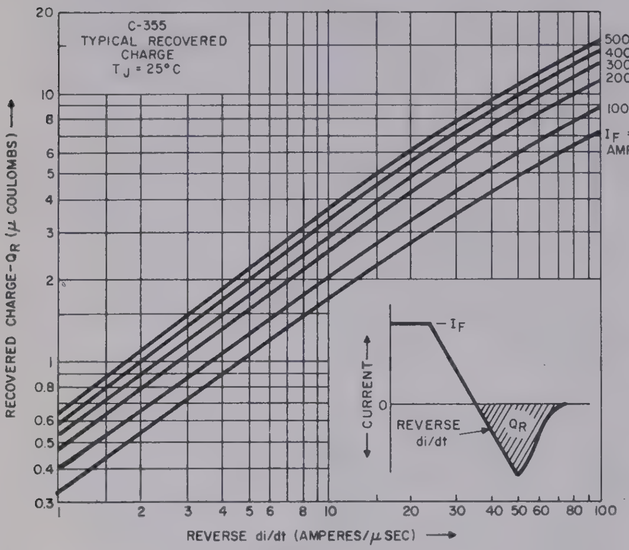
NOTES:
1. THIS OVERLOAD MAY BE APPLIED FOLLOWING DEVICE OPERATION AT ANY VOLTAGE OR CURRENT WITHIN ITS STEADY STATE RATING LIMITS.
2. THE OVERLOAD MAY NOT BE REPEATED UNTIL DEVICE JUNCTION TEMPERATURE HAS RETURNED TO WITHIN STEADY STATE RATED VALUE.
3. NO BLOCKING VOLTAGE RATING IS IMPLIED DURING OR IMMEDIATELY FOLLOWING THIS OVERLOAD CURRENT INTERVAL.
4. JUNCTION TEMPERATURE IMMEDIATELY PRECEDING OVERLOAD = −40°C TO +125°C



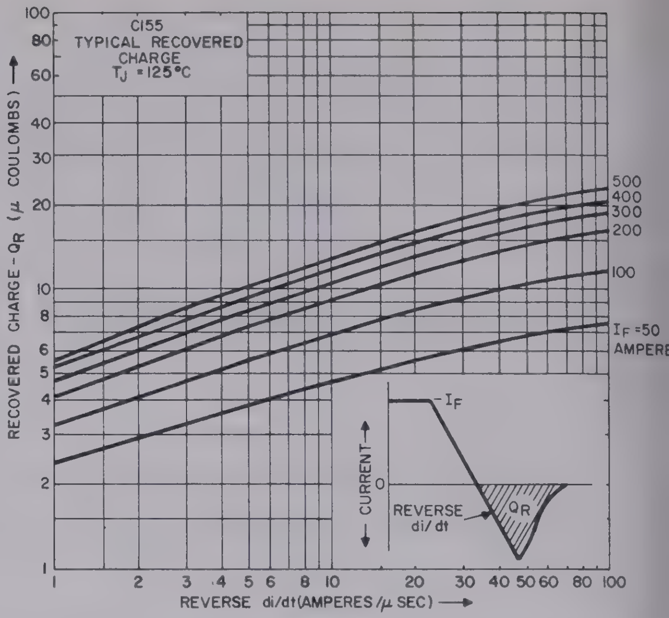
21. Transient thermal impedance, junction to case

20. Sub-cycle surge and I^2t rating following rated load conditions (sinusoidal waveform)

C355 RECOVERED CHARGE DATA



22. Typical recovered charge at 25°C



23. Typical recovered charge at 125°C

OUTLINE DRAWINGS

NEW 1/2" PRESS PAK PACKAGE

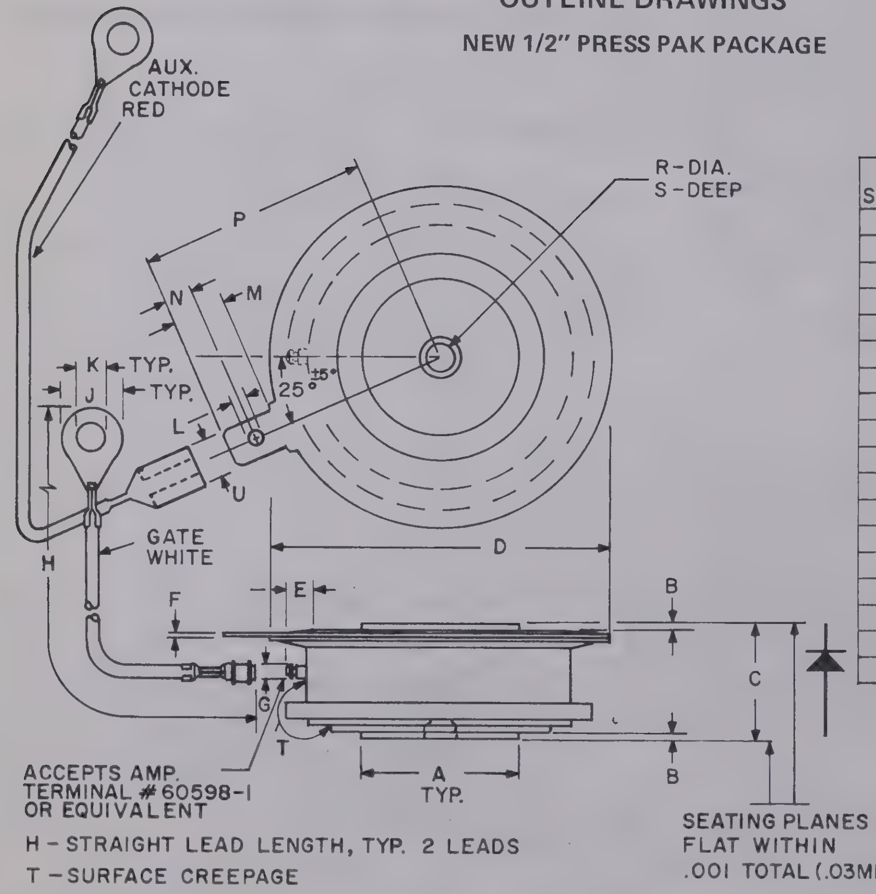

AUX. CATHODE RED
R-DIA.
S-DEEP
P
N
M
K
TYP.
J
TYP.
25° ±5°
L
U
H
GATE WHITE
D
E
F
B
C
G
T
B
A TYP.
ACCEPTS AMP. TERMINAL # 60598-1 OR EQUIVALENT
H - STRAIGHT LEAD LENGTH, TYP. 2 LEADS
T - SURFACE CREEPAGE
SEATING PLANES FLAT WITHIN .001 TOTAL (.03MM)

TABLE OF DIMENSIONS

Conversion Table

SYM	DECIMAL INCHES MIN	DECIMAL INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.
A	.744	.752	18.897	19.101
B	.030	.060	.762	1.524
C	.515	.565	13.081	14.351
D	1.600	1.656	40.64	42.06
E	.110	—	2.794	—
F	.031	.017	.330	.432
G	.057	.059	1.447	1.449
H	7.980	8.115	202.70	206.11
J	—	.300	—	7.620
K	.137	.153	3.479	3.886
L	.065	.070	1.651	1.778
M	.245	.260	6.223	6.604
N	.120	.140	3.048	3.556
P	1.090	1.125	27.69	28.55
R	.135	.145	3.429	3.683
S	.067	.083	1.701	2.108
T	.340	—	8.636	—
U	.186	.189	4.724	4.801

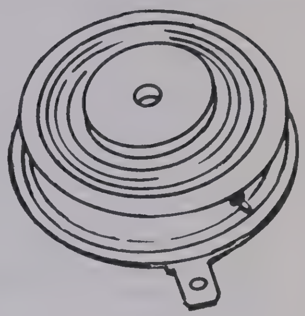
HIGH SPEED

Silicon Controlled Rectifier

C358

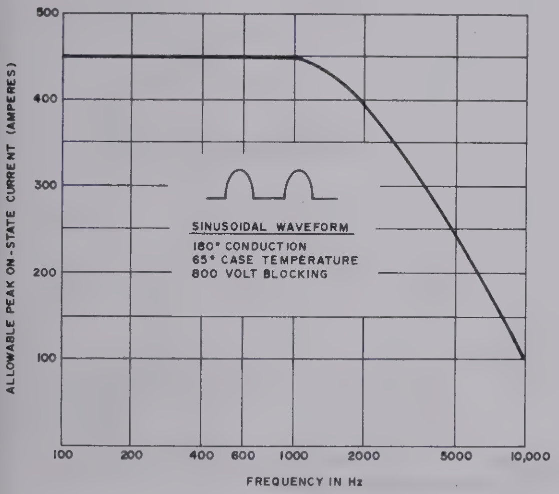
1200 Volts **225A RMS**

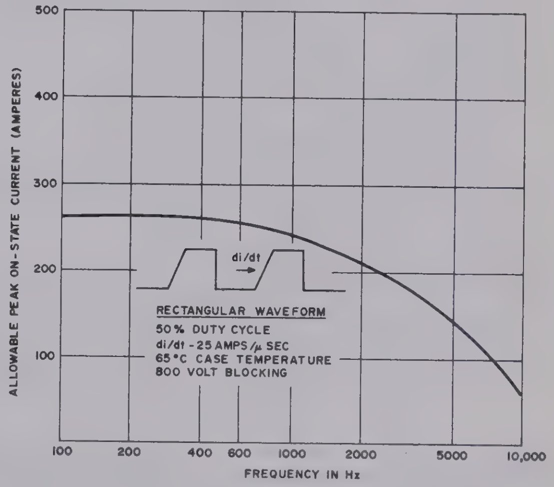
The General Electric Type C358 Press Pak silicon controlled rectifier is a reverse blocking triode thyristor designed primarily for power switching at frequencies considerably higher than the prevalent 50 to 400 Hz. The Type C358 is explicitly rated for half sine wave current up to 10k Hz. and rectangular current waveshape up to 5k Hz.



For efficient operation in high speed applications, the C358 SCR provides a superior mix of capabilities:

- Forward and reverse blocking voltage to 1200 volts
- 40 μsec turn-off-time at severe operating conditions
- 25 μsec turn-off-time at less severe operating conditions
- High di/dt and dv/dt at high frequency
- Very low switching losses at high frequency
- Amplifying gate permits soft-fire characteristics





Equipment designers can use the C358 SCR in demanding applications, such as:

- **Choppers**
- **Inverters**
- **Regulated power supplies**
- **Sonar transmitters**
- **Induction heaters**
- **Radio transmitters**
- **Cycloconverters**
- **DC to DC converters**
- **High frequency lighting**

FOR SINE WAVE OPERATION

Like the Type C140/141 SCR (GE's first high frequency SCR), the C358 SCR is rated for:

- **Peak current**

vs.

- **Pulse width**
- **Frequency**
- **Case temperature**

FOR RECTANGULAR WAVE OPERATION

GE now introduces a new, high-frequency rating for the C358 SCR, which is:

- **Peak current**

vs.

- **di/dt of leading edge**
- **Frequency**
- **Duty cycle**
- **Case temperature**

---

†Shorter turn-off-time available upon special request.

MAXIMUM ALLOWABLE RATINGS

Types	Repetitive Peak Off-State Voltage, V_{DRM}	Repetitive Peak Reverse Voltage, $V_{RRM}^{(1)}$	Non-repetitive Peak Reverse Voltage, $V_{RSM}^{(1)}$
	T_C = –40°C to +125°C$^{(2)}$	T_C = –40°C to +125°C$^{(2)}$	T_C = –40°C to +125°C$^{(2)}$
C358E	500 Volts	500 Volts	600 Volts
C358M	600	600	720
C358S	700	700	840
C358N	800	800	960
C358T	900	900	1080
C358P	1000	1000	1200
	T_C = 0°C to +125°C$^{(3)}$	T_C = 0°C to +125°C$^{(3)}$	T_C = 0°C to +125°C$^{(3)}$
C358PA	1100	1100	1300
C358PB	1200	1200	1400

(1) Half sine wave voltage pulse, 10 millisecond maximum duration.

(2) Ratings apply for zero or negative gate voltage. Maximum case to ambient thermal resistance for which maximum V_{DRM} and maximum V_{RRM} ratings apply equals 1.1°C/watt.

(3) Ratings apply for zero or negative gate voltage. Maximum case to ambient thermal resistance for which maximum V_{DRM} and maximum V_{RRM} ratings apply equals 0.5°C/watt.

Peak Positive Anode Voltage	None†
RMS On-State Current, $I_{T(RMS)}$	225 Amperes
Average On-State Current, $I_{T(AV)}$	(see Charts)
Peak One Cycle Surge (non-rep) On-State Current, I_{TSM}	1600 Amperes
I^2t (for fusing) for times $\geqq$ 1.5 milliseconds	5200 Ampere^{2}seconds
I^2t (for fusing) for times $\geqq$ 8.3 milliseconds	10,500 Ampere^{2}seconds
Critical Rate-of-Rise of On-State Current, di/dt, During Turn-On Interval	800 Amperes per microsecond††
Peak Gate Power Dissipation, P_{GM} . . (Pulse Width = 10μsec)	400 Watts
Average Gate Power Dissipation, $P_{G(AV)}$	2 Watts
Peak Negative Gate Voltage, V_{GM}	20 Volts
Storage Temperature, T_{STG}	–40°C to +125°C
Operating Temperature, T_J	–40°C to +125°C
Mounting Force	800 lbs ± 10% 360 kg ± 10%

†This SCR may be, non-repetitively, turned on in the forward direction by exceeding the breakover voltage (V_{DRM}) with either a rapidly or slowly rising waveform. At breakover, di/dt must be limited to 20 amps/μsec and peak current to 1000 amperes.

††Required trigger source—20 volts, 20 ohms; maximum switching voltage—1200 volts; short-circuit gate supply current risetime—0.5 μsec. (This short-circuit current may be measured with a TEKTRONICS current probe.); RC Snubber circuit used across SCR—(see Figure 3).

di/dt rating is established in accordance with JEDEC Suggested Standard No. 7, Section 5.1.2.4. Immediately after each current pulse, off-state (blocking) voltage capability may be temporarily lost for durations less than the period of the applied pulse repetition rate. The pulse repetition rate for this test is 400 Hz: The duration of the JEDEC di/dt test condition is 5.0 seconds (minimum).

See notes for Figure 19 for repetitive di/dt rating.

CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
Peak Reverse and Off-State Current	I_{DRM} and I_{RRM}				mA	T_C = +25°C
C358E		–	3	10		$V_{DRM} = V_{RRM}$ = 500 Volts peak
C358M		–	3	10		600 Volts peak
C358S		–	3	10		700 Volts peak
C358N		–	3	10		800 Volts peak
C358T		–	3	9		900 Volts peak
C358P		–	3	7		1000 Volts peak
C358PA		–	3	7		1100 Volts peak
C358PB		–	3	7		1200 Volts peak

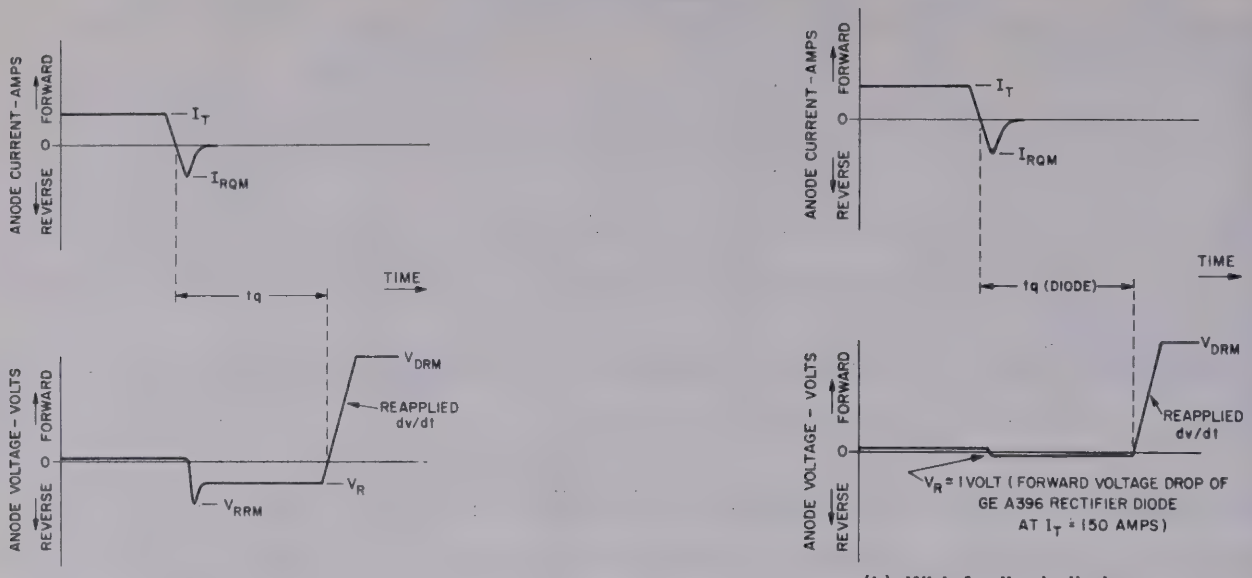
CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
Peak Reverse and Off-State Current	I_{DRM} and I_{RRM}				mA	T_C = 125°C
C358E		–	12	15		$V_{DRM} = V_{RRM}$ = 500 Volts peak
C358M		–	12	15		600 Volts peak
C358S		–	12	15		700 Volts peak
C358N		–	12	15		800 Volts peak
C358T		–	12	15		900 Volts peak
C358P		–	12	15		1000 Volts peak
C358PA		–	12	16		1100 Volts peak
C358PB		–	12	17		1200 Volts peak
Effective Thermal Resistance	$\theta_{J\text{-}C}$	–	.12 .15	.135 .2	°C/watt	Junction to case (DC) Double Side Cooled. Junction to case (DC) Single Side Cooled.
Critical Exponential Rate of Rise of Forward Blocking Voltage (Higher values may cause device switching)	dv/dt	200 ★	500	–	V/µsec	V_{DRM}, T_C = +125°C, Gate open.
Holding Current	I_H	–	20	500	mAdc	T_C = +25°C, Anode supply = 24Vdc. Initial forward current = 2 amps.
DC Gate Trigger Current	I_{GT}	– – –	50 75 15	150 300 125	mAdc mAdc mAdc	T_C = +25°C, V_D = 6Vdc, R_L = 3 ohms. T_C = –40°C, V_D = 6Vdc, R_L = 3 ohms. T_C = +125°C, V_D = 6Vdc, R_L = 3 ohms.
DC Gate Trigger Voltage	V_{GT}	– – 0.15	3 1.25 –	5 3.0 –	Vdc Vdc Vdc	T_C = –40°C to 0°C, V_D = 6Vdc, R_L = 3 ohms. T_C = 0°C to +125°C, V_D = 6 Vdc, R_L = 3 ohms. T_C = 125°C, V_{DRM}, R_L = 1000 ohms.
Peak On-State Voltage	V_{TM}	–	2.8	3.5	Volts	T_C = +25°C, I_{TM} = 500A peak. Duty cycle ≤ .01%.
Turn-On Time (Delay Time + Rise Time)	t_{GT}	–	2	–	µsec	T_C = +25°C, I_T = 50 Adc, V_{DRM}. Gate supply: 10 volt open circuit, 20 ohm, 1.0 µsec max. rise time.†††
Delay Time	t_d	–	0.5	2.0	µsec	T_C = +25°C, I_T = 50 Adc, V_{DRM}, Gate supply: 10 volt open circuit, 20 ohm, 0.1 µsec max. rise time.††,†††
Conventional Circuit Commutated Turn-Off-Time (with Reverse Voltage) Faster Maximum Turn-Off Times Available, Consult Factory	t_q	–	20	30	µsec	(1) T_C = +125°C, (2) I_T = 50A, (3) V_R = 50 volts min., (4) V_{DRM} (reapplied), (5) Rate-of-rise of reapplied forward blocking voltage = 20 V/µsec (linear). (6) Commutation di/dt = 5 amps/µsec. (7) Repetition rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts, 100 ohms.
		–	25	40	µsec	(1) T_C = +125°C, (2) I_T = 150A, (3) V_R = 50 volts min., (4) V_{DRM} (reapplied), (5) Rate-of-rise of reapplied forward blocking voltage = 200 V/µsec (linear). (6) Commutation di/dt = 5 amps/µsec. (7) Repetition rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts, 100 ohms.
Conventional Circuit Commutated Turn-Off-Time (with Feedback Diode)	t_q (diode)	–	40	–†	µsec	(1) T_C = +125°C, (2) I_T = 150A. (3) V_R = 1 volt (forward drop of GE A96 rectifier diode at I_T = 150A), (4) V_{DRM}, (5) Rate-of-rise of reapplied forward blocking voltage = 200 V/µsec (linear). (6) Commutation di/dt = 5 amps/µsec. (7) Repetition rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts, 100 ohms.
Pulse Circuit Commutated Turn-Off-Time (with Reverse Voltage)	t_q (pulse)	–	25	40	µsec	(1) T_C = +125°C, V_{DRM} (reapplied), (2) Rate-of-rise of reapplied forward blocking voltage = 200 V/µsec (linear), (3) Rep. rate = 400 Hz., (4) Gate supply = 20 volts, 80 ohms, 1.0 µsec max. rise time. (5) I_T = 500 A peak, t_p = 3 µsec (half sine wave), (6) V_R = 50 volts min.
Pulse Circuit Commutated Turn-Off-Time (with Feedback Diode)	t_q (pulse) (diode)	–	40	–†	µsec	(1) T_C = +125°C, V_{DRM} (reapplied), (2) Rate-of-rise of reapplied forward blocking voltage = 200 V/µsec (linear), (3) Rep. Rate = 400 Hz., (4) Gate supply = 20 volts, 80 ohms, 1.0 µsec max. rise time, (5) I_T = 500 A peak, t_p = 3 µsec (half sine wave), (6) V_R = 1 volt (forward drop of GE A96 rectifier diode at I_T = 150A).

† Consult Factory for specified maximum Turn-Off Time.
†† Delay Time may increase significantly as the gate drive approaches the I_{GT} of the Device Under Test (D.U.T.).
††† Current risetime as measured with a current probe, or voltage risetime across a non-inductive resistor.
★ Selections of static dv/dt to 300, 400, 500 volts/µsec readily available, consult factory.

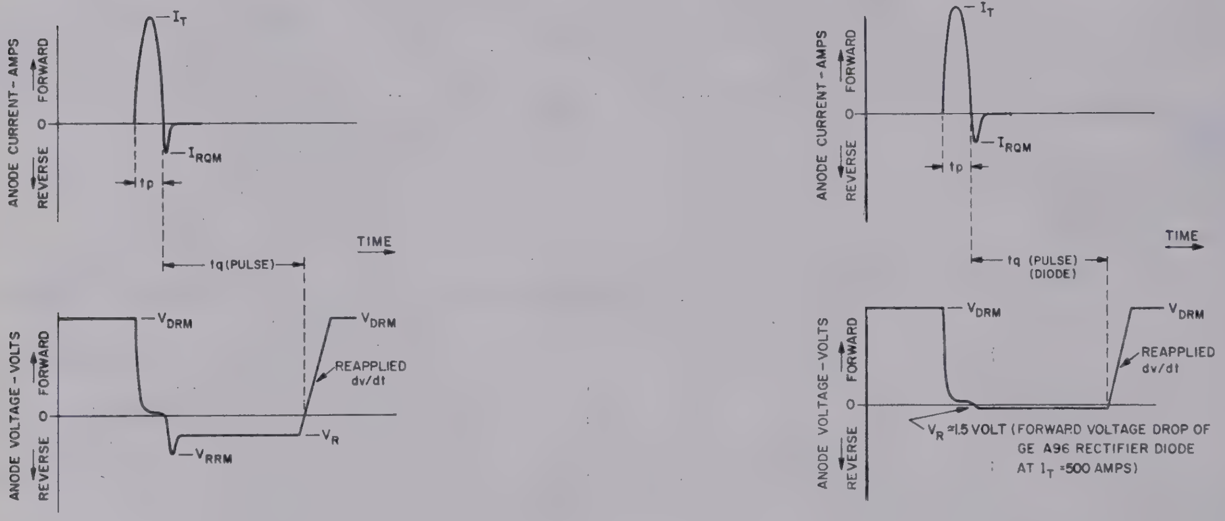
WAVEFORM DEFINITION OF TURN-OFF-TIME

(not to scale)



(a) With reverse voltage **(b) With feedback diode**

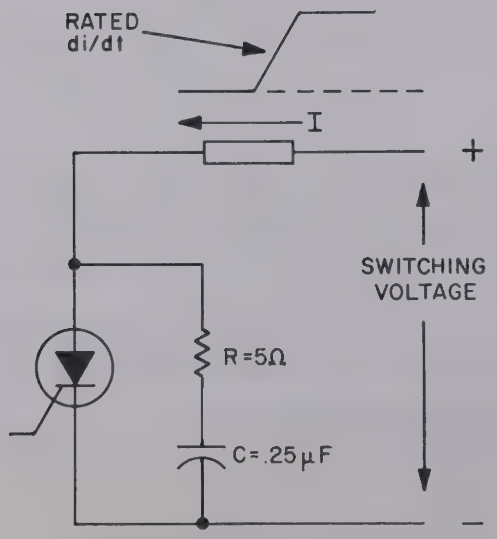
Conventional circuit commutated turn-off-time



(a) With reverse voltage **(b) With feedback diode**

Pulse circuit commutated turn-off-time

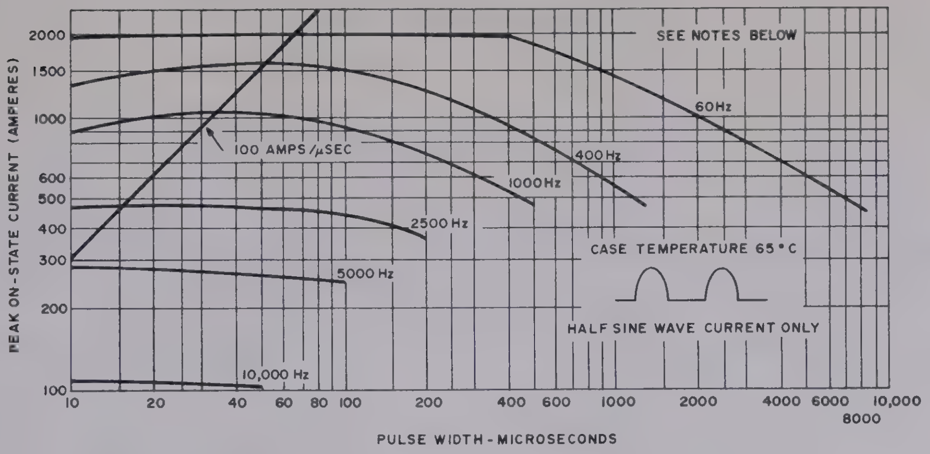
RATED di/dt AND THE RC SNUBBER CIRCUIT



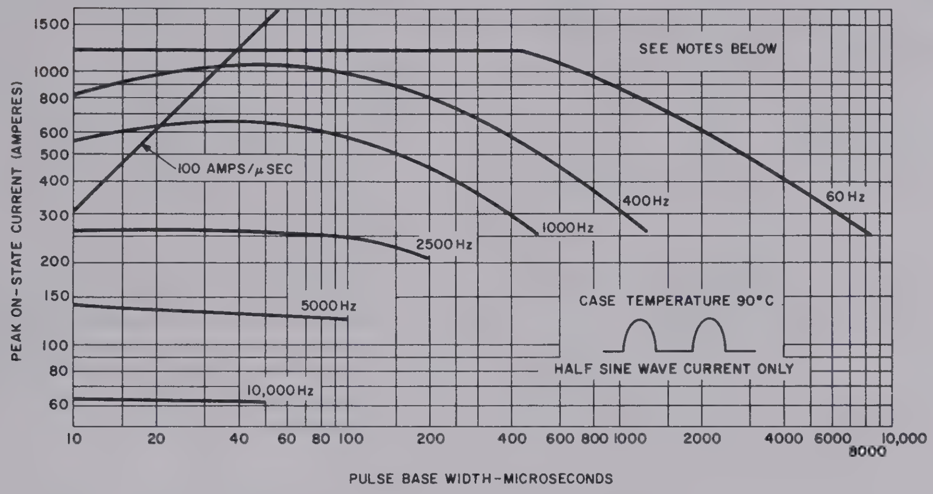
RC Snubber circuit

The rated di/dt for the Type C358 SCR includes the discharge of the RC Snubber circuit shown connected in parallel with the SCR.

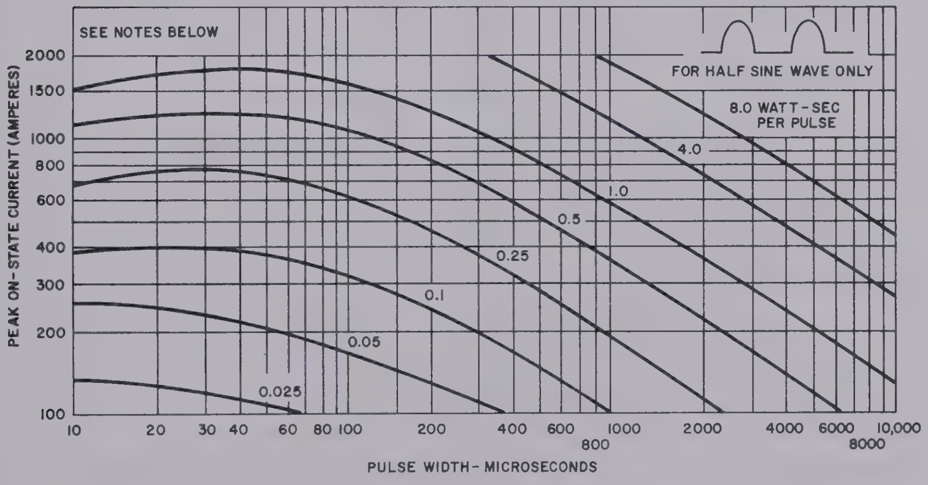
SINE WAVE DATA



3. Maximum allowable peak on-state current vs. pulse width ($T_C = 65°C$)



4. Maximum allowable peak on-state current vs. pulse width ($T_C = 90°C$)



5. Energy per pulse for sinusoidal pulses

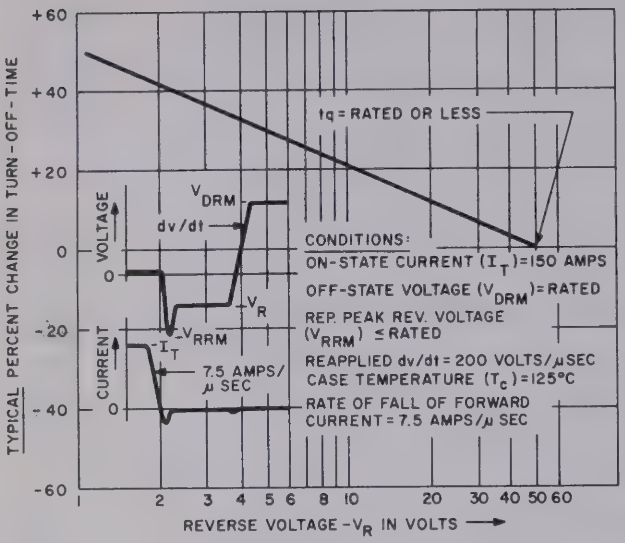
Charts 3 and 4 give the maximum value of peak on-state current at which the specified turn-off-time and dv/dt still apply.

NOTES: Charts 3, 4, 5

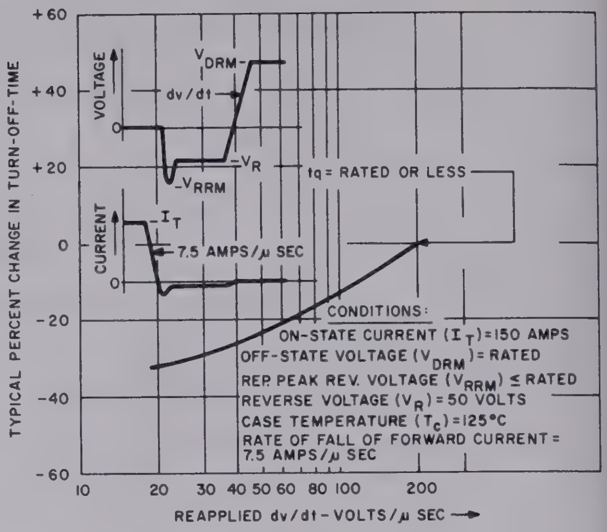
1. Switching voltage = 800 volts
2. Minimum ckt. turn-off-time = 40 μsec
3. Maximum ckt. dv/dt = 200 volts/μsec
4. Reverse voltage applied = 50 V ≤ V_R ≤ 800 V
5. Required gate drive:
   20 volts, 65 ohms, 1 μsec risetime for less than 100 amps/μsec
   20 volts, 20 ohms, .5 μsec risetime for greater than 100 amps/μsec
6. RC Snubber ckt. = .2 μF, 5Ω
7. Double Side Cooled

If the circuit dI/dt remains below 100 amps/μs, and normally constructed snubbers using the components specified are employed, then the "soft" gate drive shown under "conditions" for each current rating curve is sufficient.

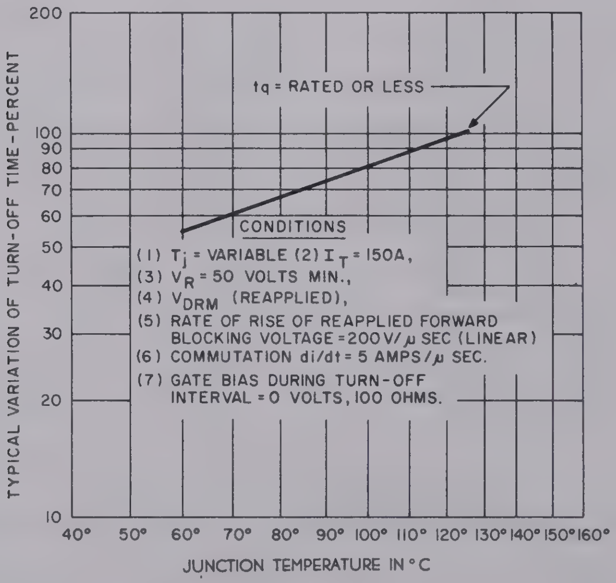
If the circuit dI/dt exceeds 100 amps/μs shown by the boundary lines, (on the sine wave curves) then the stiff gate source (20 V – 20Ω), t_r = .5 μs, specified in Chart #19 must be used. In addition the total device dI/dt must be checked to insure that it is not above the 500 amps/μs which is the long term repetitive limit noted in Chart #19 for stiff gate source.



6. This curve shows a typical variation of SCR turn-off-time with applied reverse voltage (V_R) during the turn-off interval. Testing at V_R = "1 volt" is done with a GE A396 fast recovery diode in inverse parallel with the C358. For SCR's with specified maximum turn-off-time with an inverse parallel diode — consult the factory.



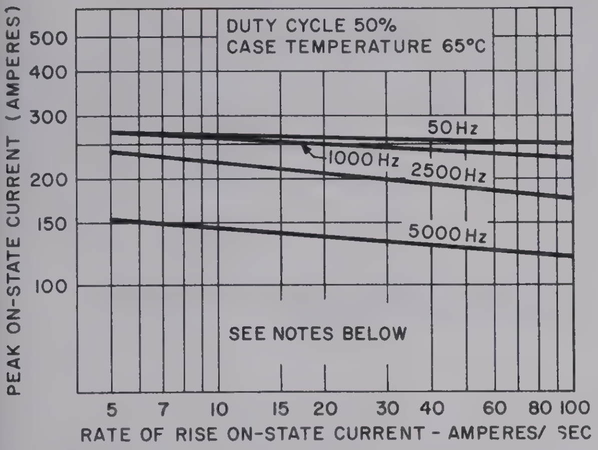
7. This curve shows a typical variation of SCR turn-off-time with reapplied dv/dt. Specified turn-off-time (40 µsec) is with reapplied dv/dt of 200 volts/µsec. Note turn-off-time enhancement at lower dv/dt. When requesting selected turn-off-time (less than 40 µsec) also specify maximum reapplied dv/dt.



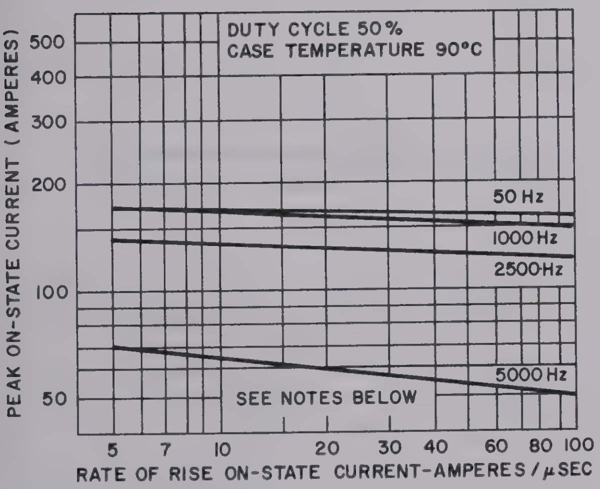
8. This curve shows typical variation of SCR turn-off-time with junction temperature (T_J). Specified turn-off-time is based on a 125°C junction temperature. Note turn-off-time enhancement at lower temperatures.

RECTANGULAR WAVE DATA

DUTY CYCLE – 50%

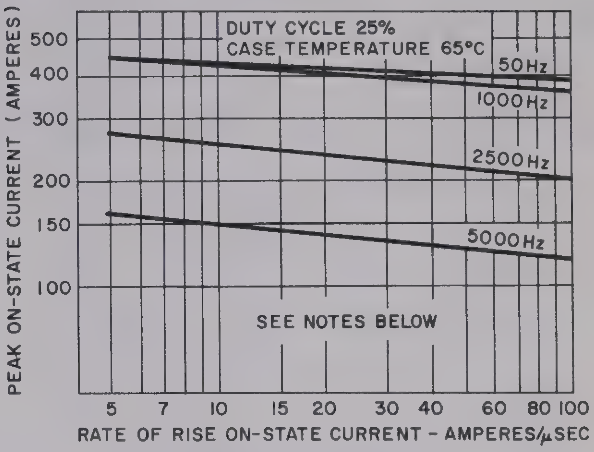


9. Maximum allowable peak on-state current vs. di/dt ($T_C = 65°C$)

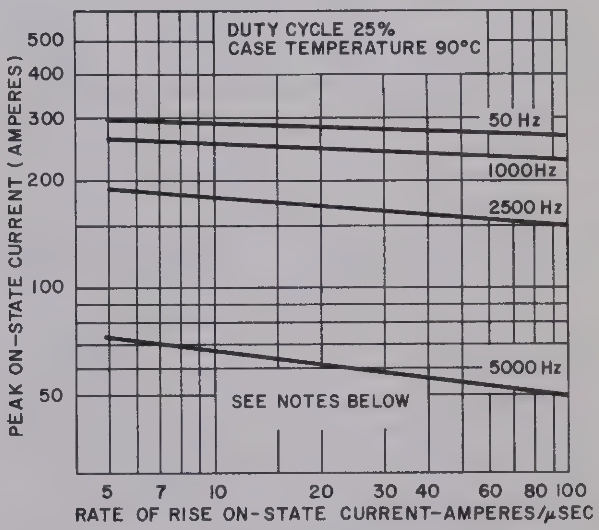


10. Maximum allowable peak on-state current vs. di/dt ($T_C = 90°C$)

DUTY CYCLE – 25%



11. Maximum allowable peak on-state current vs. di/dt ($T_C = 65°C$)

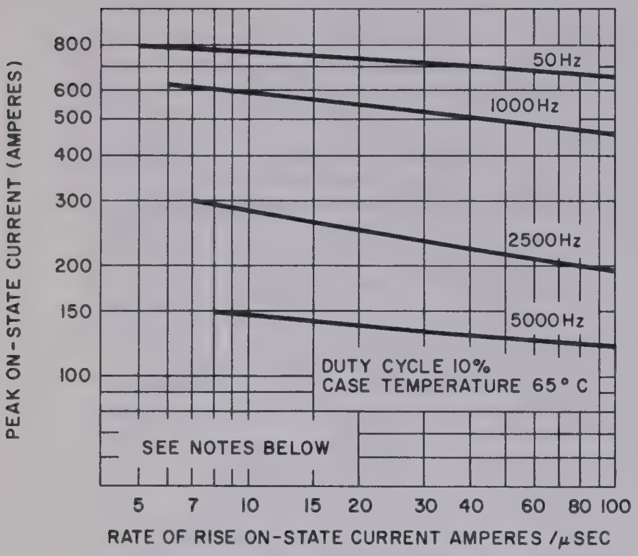


12. Maximum allowable peak on-state current vs. di/dt ($T_C = 90°C$)

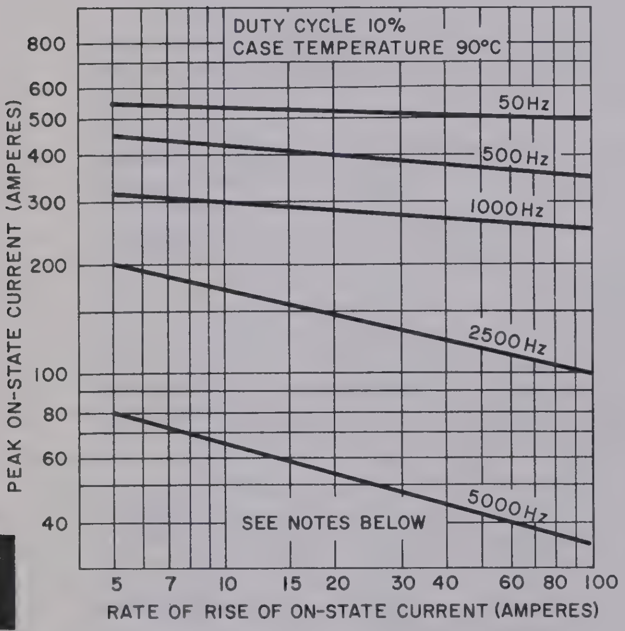
NOTES:
1. RC Snubber ckt. = .25μF, 5Ω 2. Off-state voltage = 800 volts 3. Reverse voltage = 50 V ≤ V_R ≤ 800 V 4. Turn-off-time = 40 μsec
5. dv/dt (maximum) = 200 volts/μsec 6. Required gate drive: 20 volts, 65 ohms, 1 μsec risetime 7. Double Side Cooled

RECTANGULAR WAVE DATA

DUTY CYCLE – 10%

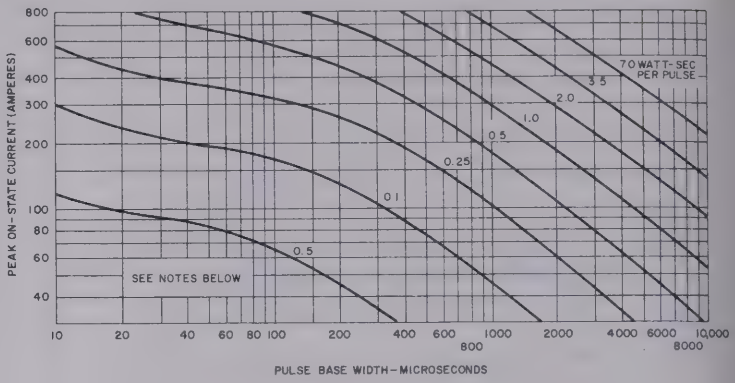


13. Maximum allowable peak on-state current vs. di/dt ($T_C = 65°C$)

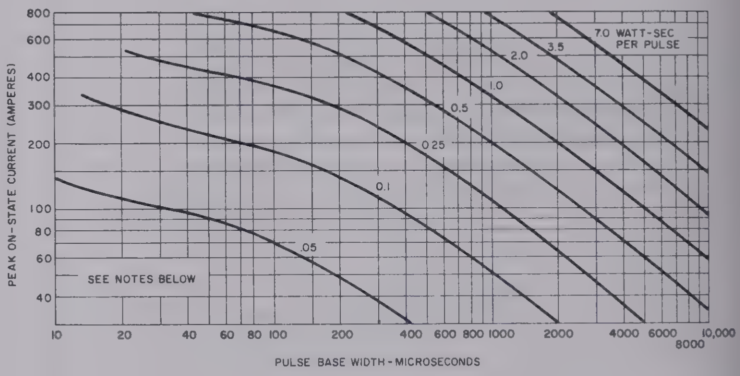


14. Maximum allowable peak on-state current vs. di/dt ($T_C = 90°C$)

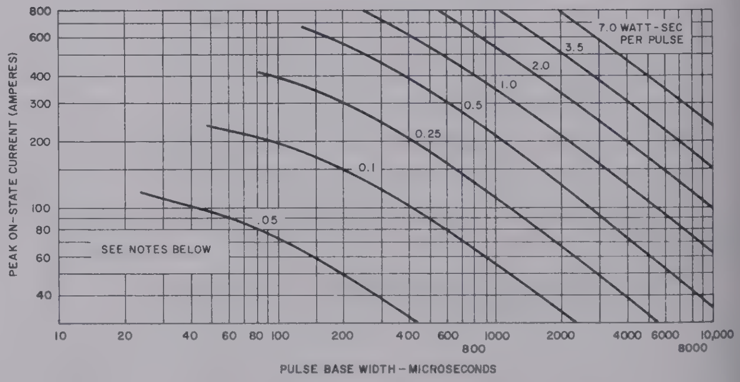
WATT-SECOND PER PULSE



15. Energy per pulse vs. peak current and pulse width (di/dt = 100A/μsec)



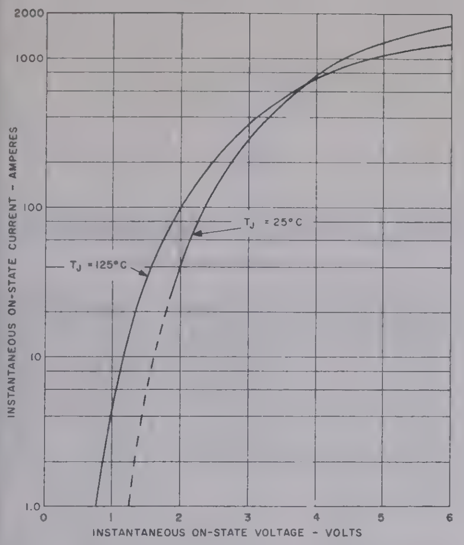
16. Energy per pulse vs. peak current and pulse width (di/dt = 25A/μsec)



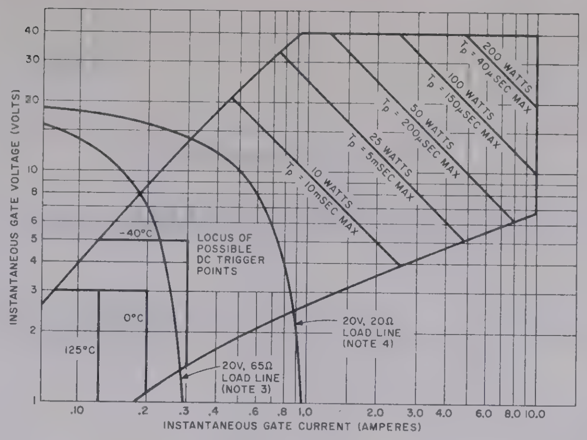
17. Energy per pulse vs. peak current and pulse width (di/dt = 5A/μsec)

NOTES:

1. Switching voltage = 800 volts 2. Required gate drive: 20 volts, 65 ohms, 1 μsec risetime 3. Average power = (watt-sec/pulse)(rep. rate)
4. RC Snubber ckt. = .25 μF, 5Ω



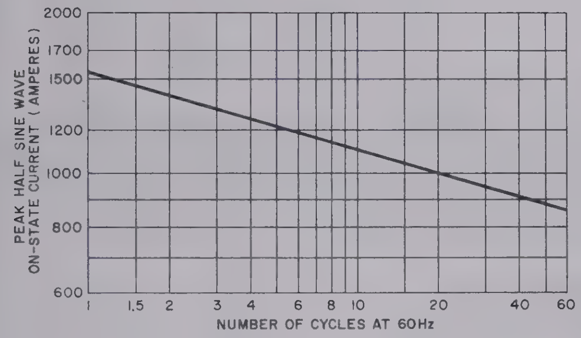
18. Forward conduction characteristic, on-state



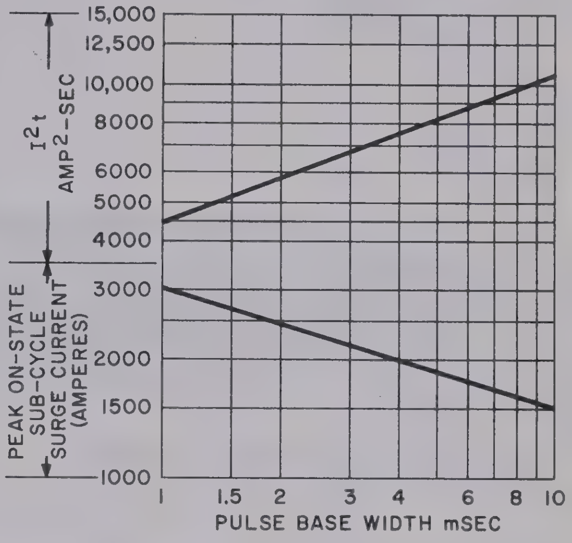
NOTES:

1. Maximum allowable average gate dissipation = 2 watts
2. The locus of possible dc trigger points lie outside the boundaries shown at various case temperatures
3. T_p = Rectangular gate current pulse width (5 μs min duration; 1.0 μs max rise time for 20 V, 65Ω source)
4. 20 V – 20Ω is the minimum gate source load line when rate of circuit current rise > 100 amp/μs or anode rate of current rise > 200 amps/μs (T_p = 5μs min, 0.5 μs max rise time)
   Maximum long term repetitive anode dI/dt = 500 amps/μs with 20 V – 20Ω gate source.

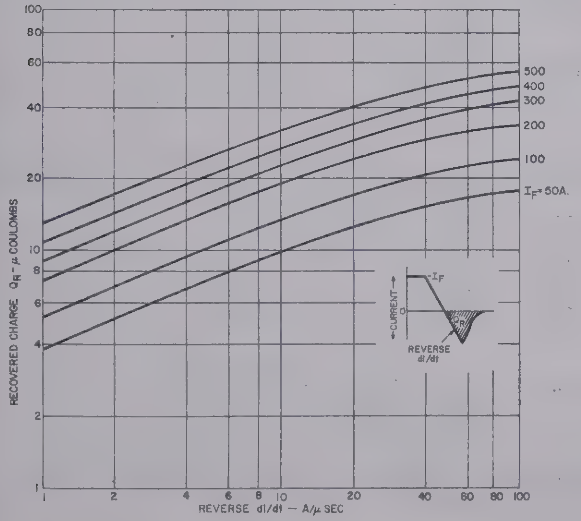
19. Maximum allowable peak gate power vs. gate pulse width



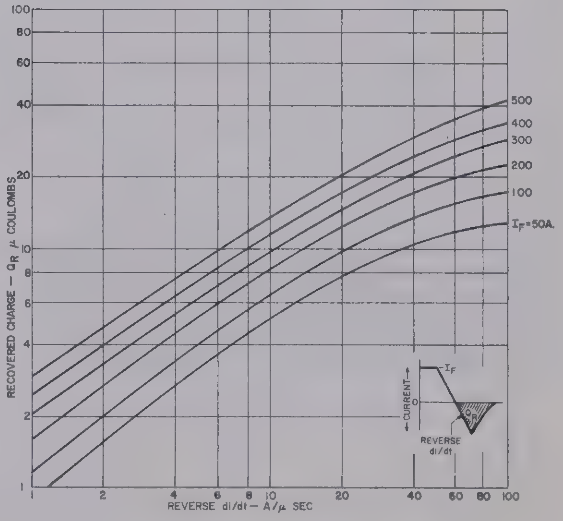
20. Maximum allowable surge current following rated load conditions



21. Sub-cycle surge and I^2t rating following rated load conditions



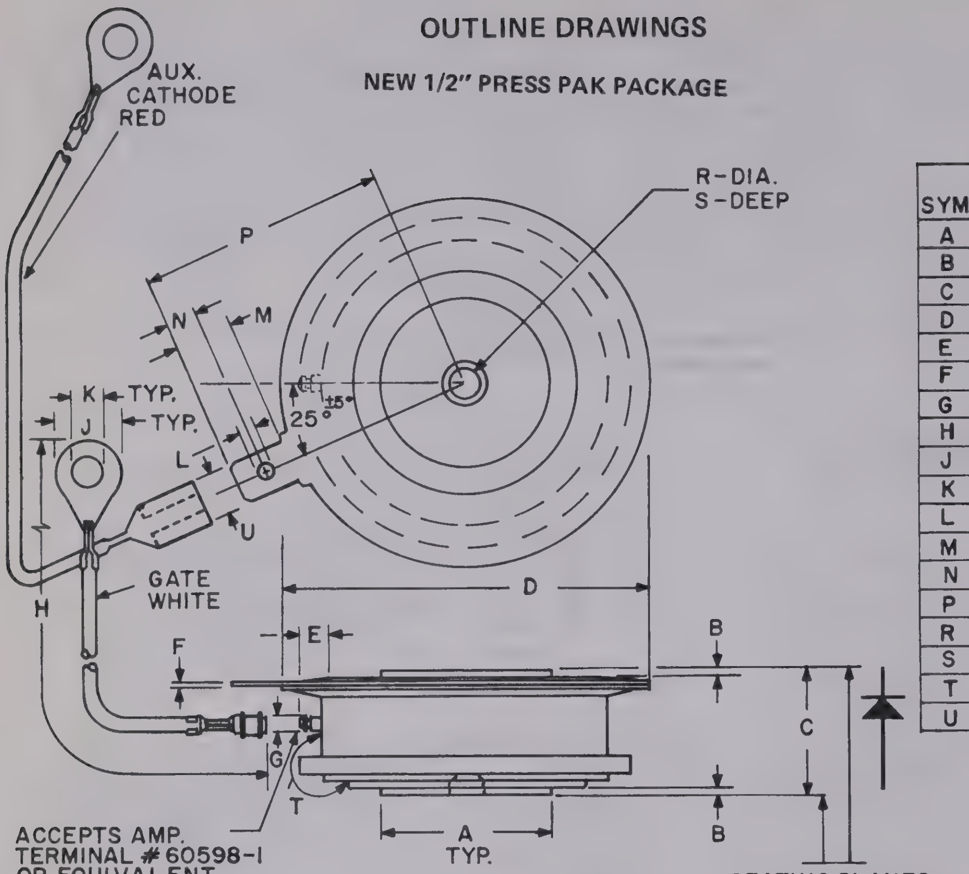
22. Typical Recovered Charge (125°C)



23. Typical Recovered Charge (25°C)

OUTLINE DRAWINGS

NEW 1/2" PRESS PAK PACKAGE



ACCEPTS AMP.
TERMINAL #60598-1
OR EQUIVALENT

H - STRAIGHT LEAD LENGTH, TYP. 2 LEADS

T - SURFACE CREEPAGE

SEATING PLANES
FLAT WITHIN
.001 TOTAL (.03MM)

TABLE OF DIMENSIONS
Conversion Table

SYM	DECIMAL INCHES		METRIC MM	
	MIN	MAX.	MIN.	MAX.
A	.744	.752	18.897	19.101
B	.030	.060	.762	1.524
C	.515	.565	13.081	14.351
D	1.600	1.656	40.64	42.06
E	.110	—	2.794	—
F	.031	.017	.330	.432
G	.057	.059	1.447	1.449
H	7.980	8.115	202.70	206.11
J	—	.300	—	7.620
K	.137	.153	3.479	3.886
L	.065	.070	1.651	1.778
M	.245	.260	6.223	6.604
N	.120	.140	3.048	3.556
P	1.090	1.125	27.69	28.55
R	.135	.145	3.429	3.683
S	.067	.083	1.701	2.108
T	.340	—	8.636	—
U	.186	.189	4.724	4.801

FOR MOUNTING HARDWARE SEE SELECTOR GUIDE PAGE 171

Specification Sheets

140.12	1N3879 Series (6 amp) Fast Recovery Diode
140.22	1N3889 Series (12 amp) Fast Recovery Diode
140.23	A28 Series (12 amp) Very Fast Recovery Diode
140.47	1N3899 Series (20 amp) Fast Recovery Diode
140.48	1N3909 Series (30 amp) Fast Recovery Diode
145.55	A96 Series (250 amp) Fast Recovery Diode
160.35	C140 Series (35A) 50-400V High Speed SCR
160.39	C144 Series (35A) 500-800V High Speed SCR
170.35	C154-7 Series (110 amp) High Speed SCR
170.36	C158, 9 Series (110 amp) High Speed SCR
170.37	C385 Series (250 amp) High Speed SCR
170.38	C358 Series (225A) High Speed SCR
170.42	C395 Series (550A) up to 600V, High Speed SCR
170.44	C388, C387 Series (550A) High Speed SCR
170.45	C398, C397 Series (700A) High Speed SCR
170.53	C185 Series (235 amp) High Speed SCR
170.57	C354, 5 Series (115 amp) High Speed SCR
170.76	C506 Series (625 amp) High Speed SCR
170.80	C510 Series (625 amp) High Speed SCR

Application Notes

200.38	"Application of Fast Recovery Rectifiers"
200.41	"Simple Circuits For Triggering SCR's Into Fast-Rising Load Currents"
200.42	"Commutation Behavior of Diffused High Current Rectifier Diodes"
200.49	"A Low Cost Ultrasonic Frequency Inverter Using A Single SCR"

Technical Paper Reprints

660.13	"The Rating and Application of SCR's Designed for Switching at High Frequencies"
660.14	"Basic Magnetic Functions in Converters and Inverters Including New Soft Commutations"
660.15	"SCR Inverter Commutated By An Auxiliary Impulse"
660.16	"An SCR Inverter With Good Regulation and Sine Wave Output"

Seminar Notes

671.4	"The Widening World of The Fast Recovery Rectifier Diode"
671.15	"The Amplifying Gate SCR"

¹For copies of any published information, please order by decimal publication number from: General Electric Company, Distribution Services, 1 River Road, Schenectady, N. Y. 12305.

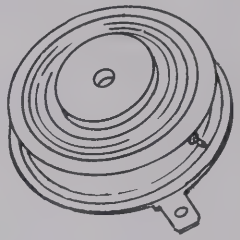
SCR

C380 SERIES

The C380 Series of high power devices feature the proven, all-diffused construction used in the C180 Series in a new General Electric PRESS PAK.

Special characteristics of these new devices are:

- Pressure contacts
- Increased current capability when double-sided cooling is used
- Smaller size and lighter weight
- Reversibility eliminates need for special reverse polarity units
- Hermetically sealed



MAXIMUM ALLOWABLE RATINGS

TYPE	PEAK FORWARD BLOCKING VOLTAGE, V_{FOM}* T_C = -40°C to + 120°C	REPETITIVE PEAK REVERSE VOLTAGE, V_{ROM} (rep)* T_C = -40°C to + 120°C	TRANSIENT PEAK REVERSE VOLTAGE (Non-recurrent < 5 Millisec.), V_{ROM} (non-rep) T_C = -40°C to + 120°C
C380A	100 Volts	100 Volts	200 Volts
C380B	200	200	300
C380C	300	300	400
C380D	400	400	500
C380E	500	500	600
C380M	600	600	720
C380S	700	700	840
C380N	800	800	950
C380T	900	900	1075
C380P	1000	1000	1200
C380PA	1100	1100	1325
C380PB	1200	1200	1450
C380PC	1300	1300	1550

Average Forward Current, On-State . . . . Depends on conduction angle. (See Charts 1 and 3)
Peak One-Cycle Surge Forward Current, I_{FM}(surge) . . . . 3500 amperes
Maximum Rate of Rise of Anode Current During Turn-on Interval
(High Gate Drive Required, Chart 11) (Switching Rates ≤ 400 Hz.) . . . . Switch From <500V 100A/μsec
Switch From <1000V 75A/μsec
Switch From <1200V 50A/μsec
Switch From <1300V 25A/μsec
I^2t (for fusing) (for times ≧ 1.5 milliseconds) . . . . 32,000 ampere^2 seconds
I^2t (for fusing) (at 8.3 milliseconds) . . . . 50,000 ampere^2 seconds
Peak Gate Power Dissipation, P_{GM} . . . . 10 watts
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 2 watts
Peak Reverse Gate Voltage, V_{GRM}. . . . . 5 volts
Storage and Operating Temperature, T_C. . . . . -40°C to +120°C
External Force Required. . . . . 800 lbs. ±10%

*Ratings apply for zero or negative gate voltage. Maximum heatsink thermal resistance for which maximum PRV ratings apply equal 1.5°C/watt.

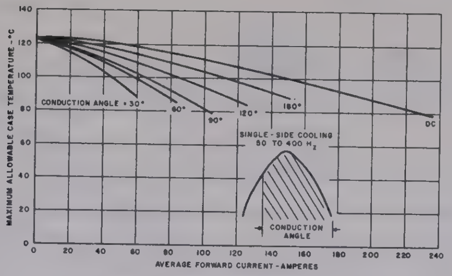
C380 SERIES

CHARACTERISTICS

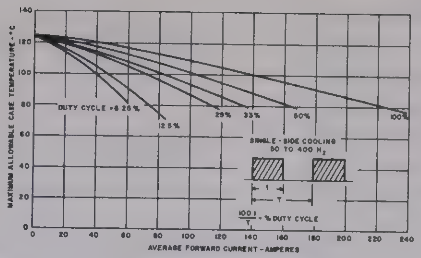
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Peak Reverse and Forward Blocking Current	I_{ROM} and I_{FOM}				mA	$T_C = 25^oC$
C380A		—	3	10		$V_{FOM} = V_{ROM} =$ 100V peak
C380B		—	3	10		200V peak
C380C		—	3	10		300V peak
C380D		—	3	10		400V peak
C380E		—	3	10		500V peak
C380M		—	3	10		600V peak
C380S		—	3	10		700V peak
C380N		—	3	10		800V peak
C380T		—	3	9		900V peak
C380P		—	3	7		1000V peak
C380PA		—	3	7		1100V peak
C380PB		—	3	6		1200V peak
C380PC		—	3	5		1300V peak
Peak Reverse and Forward Blocking Current	I_{ROM} and I_{FOM}				mA	$T_C = 120^oC$
C380A		—	15	20		$V_{FOM} = V_{ROM} =$ 100V peak
C380B		—	15	20		200V peak
C380C		—	15	20		300V peak
C380D		—	15	20		400V peak
C380E		—	15	20		500V peak
C380M		—	15	20		600V peak
C380S		—	15	20		700V peak
C380N		—	15	20		800V peak
C380T		—	15	18		900V peak
C380P		—	12	15		1000V peak
C380PA		—	11	14		1100V peak
C380PB		—	10	13		1200V peak
C380PC		—	8	11		1300V peak
Effective Thermal Resistance (DC)	θ_{J-C}	—	—	0.15	^oC/watt	Junction to Case - One side cooled
		—	—	0.095		Junction to Case - Two sides cooled
Exponential Rate of Rise of Forward Blocking Voltage that will not turn-on SCR	dv/dt	200	500	—	V/μsec	$T_C = +120^oC$, Gate open circuited. V_{FOM} = Rated.
Holding Current	I_{HO}	—	75	500	mAdc	$T_C = +25^oC$, Anode supply = 24Vdc, Initial Forward Current = 2.5A
Latching Current	I_{LX}	—	—	2	Adc	$T_C = +25^oC$, Anode voltage = 24Vdc, Load resistance 12 ohm max.
Turn-On Time (Delay Time + Rise Time)	$t_d + t_r$	—	8	—	μsec	$T_C = +25^oC$, I_F = 100Adc, V_{FXM} = rated. Gate supply: 10 volt open circuit, 25 ohm. 0.1 μsec max. rise time.
Gate Pulse Width Necessary to Trigger		—	8	10	μsec	Gate supply: 5 volt open circuit, 5 ohm, 0.1 μsec rise time. I_F = 1 amp. For high di/dt capability see Chart 11.
Gate Trigger Current	I_{GT}	—	10	150	mAdc	$T_C = +25^oC$, V_{FX} = 6Vdc, R_L = 3 ohms
		—	20	200		$T_C = -40^oC$, V_{FX} = 6Vdc, R_L = 3 ohms
		—	4	125		$T_C = +125^oC$, V_{FX} = 6Vdc, R_L = 3 ohms
Gate Trigger Voltage	V_{GT}	—	1.25	3.0	Vdc	$T_C = -40^oC$ to $+125^oC$, V_{FX} = 6Vdc, R_L = 3 ohms
		0.15	—	—		$T_C = +125^oC$, V_{FX} = 6Vdc, R_L = 3 ohms
Peak On-Voltage	V_{FM}	—	2.3	2.85	V	$T_C = +25^oC$, I_{FM} = 1500A Peak Duty Cycle $\leq$ 0.01%
Circuit Commutated Turn-Off Time	t_{off}	—	125	—	μsec	$T_C = +120^oC$, I_{FM} = 250A, V_{RX} = 50V min. V_{FXM} (reapplied) = Rated Rate of rise of reapplied Forward Blocking Voltage = 20 volts/μsec. linear i_{RM} = 25A min. Gate bias: 0 volts. 100 ohms during turn-off interval. Duty Cycle $\leq$ 0.01%

†Consult factory if guaranteed time is required

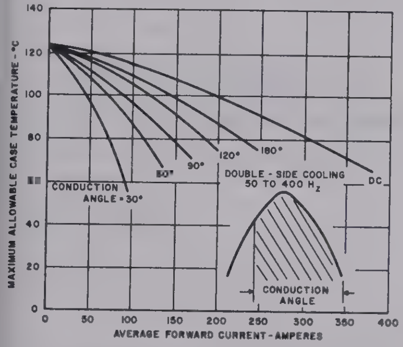
Note: T_C = Case Temperature (measured on side of either anode or cathode pedestal — whichever is in contact with the heatsink).



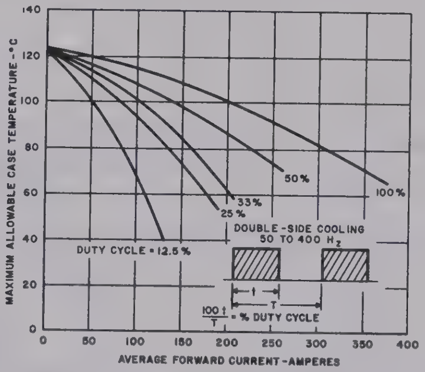
1. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



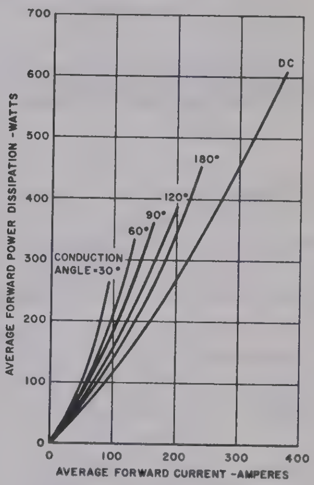
2. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



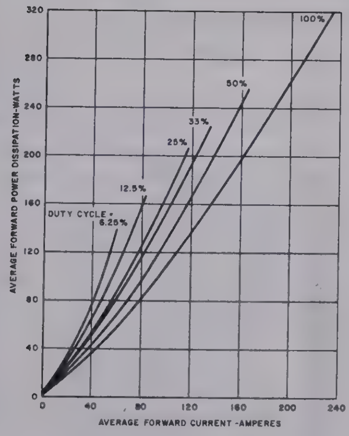
3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



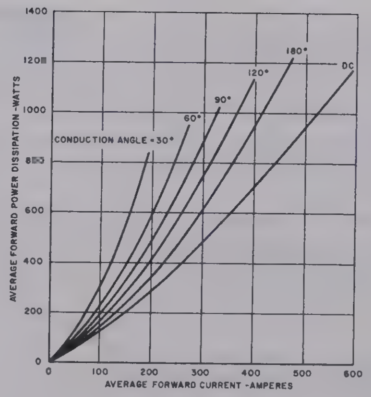
4. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



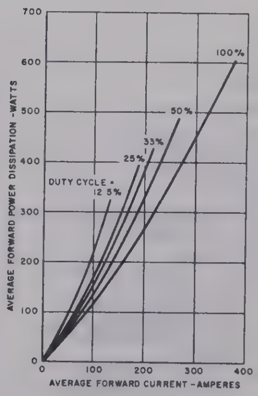
5. AVERAGE FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



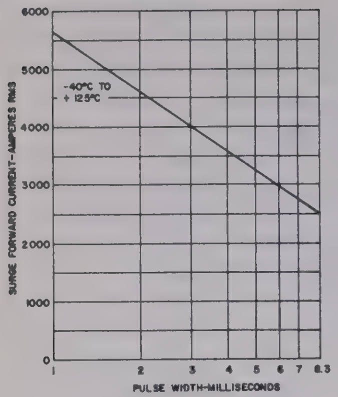
6. AVERAGE FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



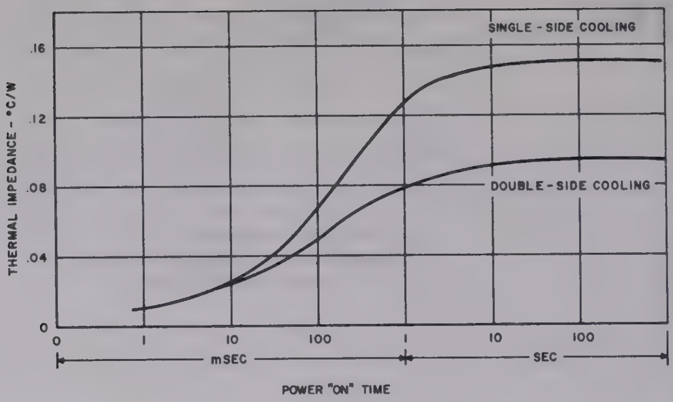
7. EXTENDED FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



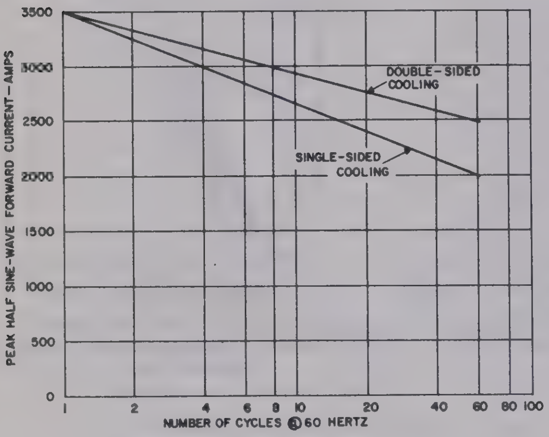
8. EXTENDED FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



9. SUB-CYCLE SURGE RATING FOLLOWING RATED LOAD CONDITIONS



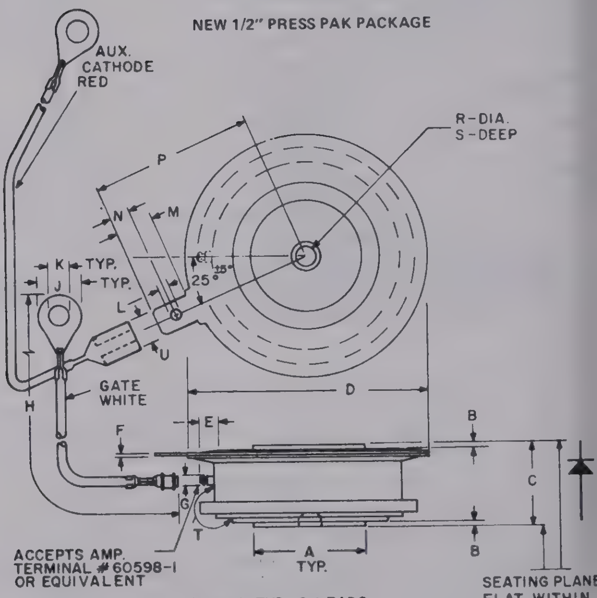
13. TRANSIENT THERMAL IMPEDANCE JUNCTION TO FIN



10. MAXIMUM ALLOWABLE SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS

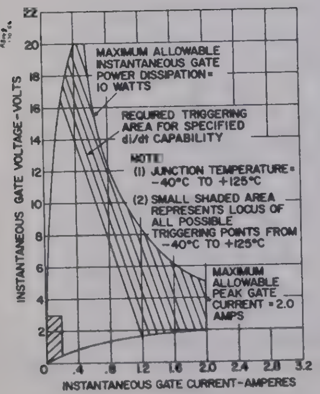
OUTLINE DRAWINGS

NEW 1/2" PRESS PAK PACKAGE

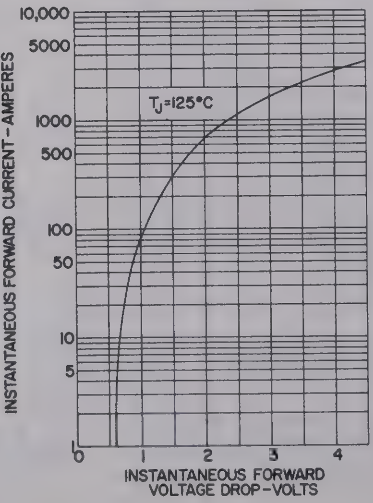

AUX. CATHODE RED
P
R-DIA.
S-DEEP
N
M
K TYP.
J TYP.
25°
25°
L
U
GATE WHITE
H
D
E
F
B
C
G
T
B
A TYP.
ACCEPTS AMP. TERMINAL #60598-1 OR EQUIVALENT
SEATING PLANE
FLAT WITHIN
.001 TOTAL (.0

H - STRAIGHT LEAD LENGTH, TYP. 2 LEADS

T - SURFACE CREEPAGE



11. GATE TRIGGERING CHARACTERISTICS



12. FORWARD CONDUCTION CHARACTERISTIC, ON-STATE

TABLE OF DIMENSIONS

Conversion Table

SYM	DECIMAL INCHES		METRIC MM	
	MIN	MAX.	MIN.	MAX.
A	.744	.752	18.897	19.101
B	.030	.060	.762	1.524
C	.515	.565	13.081	14.351
D	1.600	1.656	40.64	42.06
E	.110	—	2.794	—
F	.031	.017	.330	.432
G	.057	.059	1.447	1.449
H	7.980	8.115	202.70	206.11
J	—	.300	—	7.620
K	.137	.153	3.479	3.886
L	.065	.070	1.651	1.778
M	.245	.260	6.223	6.604
N	.120	.140	3.048	3.556
P	1.090	1.125	27.69	28.55
R	.135	.145	3.429	3.683
S	.067	.083	1.701	2.108
T	.340	—	8.636	—
U	.186	.189	4.724	4.801

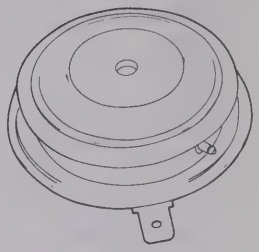
FOR MOUNTING HARDWARE SEE SELECTOR GUIDE PAG

HIGH SPEED
Silicon Controlled Rectifier

C385

600 Volts **400A RMS**

The General Electric Type C385 Silicon Controlled Rectifier is a reverse blocking triode thyristor designed primarily for power switching from 60–1000 Hz. This rugged SCR has been field proven for more than 6 years in applications like choppers, PWM motor controls, uninterruptible power supplies, and inverters.



For efficient operation in high speed applications, the C385 SCR provides a superior mix of capabilities:

- Forward and reverse blocking voltage to 600 volts
- 20 μsec turn-off-time maximum with shorter turn-off times available from factory upon special request
- High di/dt and dv/dt at rated frequency
- Low switching losses
- Reversibility eliminating need for reverse polarity units
- Increased current ratings when double side cooling is employed

MAXIMUM ALLOWABLE RATINGS

Types	Repetitive Peak Off-State Voltage, V_{DRM}(1)(2) $T_C = -40°C$ to $+125°C$	Repetitive Peak Reverse Voltage, V_{RRM}(1)(2) $T_C = -40°C$ to $+125°C$	Non-repetitive Peak Reverse Voltage, V_{RRM}(1)(3) $T_C = -40°C$ to $+125°C$
C385A	100 Volts	100 Volts	200 Volts
C385B	200	200	300
C385C	300	300	400
C385D	400	400	500
C385E	500	500	600
C385M	600	600	720

(1) Values apply for gate terminal open-circulated (negative gate bias is permissible).

(2) Ratings apply for zero or negative gate voltage. Maximum case to ambient thermal resistance for which maximum V_{DRM} and maximum V_{RRM} ratings apply equals 1.1°C/watt.

(3) Half sine wave voltage pulse, 10 millisecond maximum duration.

Peak Positive Anode Voltage	None*
Average On-State Current, $I_{T(AV)}$	(see Charts)
Peak One Cycle Surge (non-rep) On-State Current, I_{TSM}	3500 Amperes
I^2t (for fusing) for times ≧ 1.5 milliseconds	35,000 Ampere^2 seconds
I^2t (for fusing) for times ≧ 8.3 milliseconds	50,000 Ampere^2 seconds
Critical Rate-of-Rise of On-State Current, di/dt, During Turn-On Interval, Repetitive	100 Amperes per microsecond**
Peak Gate Power Dissipation, P_{GM} (Pulse Width = 10 μsec)	400 Watts
Average Gate Power Dissipation, $P_{G(AV)}$	2 Watts
Peak Negative Gate Voltage, V_{GM}	20 Volts
Storage Temperature, T_{STG}	−40°C to +100°C
Operating Temperature, T_J	−40°C to +125°C
External Mounting Force Required	800 lbs. ± 10%

*This SCR may be, non-repetitively, turned-on in the forward direction by exceeding the breakover voltage (V_{DRM}) with either a rapidly or slowly rising waveform. At breakover, di/dt must be limited to 20 amps/μsec and peak current to 1000 amperes.

**Required trigger source—20 volts, 20 ohms; maximum switching voltage—V_{DRM}; short-circuit gate supply current risetime—0.25 μsec. (This short-circuit current may be measured with a TEKTRONICS current probe.) RC Snubber circuit used across SCR—(see Figure 5).

di/dt rating is established in accordance with JEDEC Suggested Standard No. 7, Section 5.1.2.4. Immediately after each current pulse, off-state (blocking) voltage capability may be temporarily lost for durations less than the period of the applied pulse repetition rate. The pulse repetition rate for this test is 400 Hz. The duration of the JEDEC di/dt test condition is 5.0 seconds (minimum).

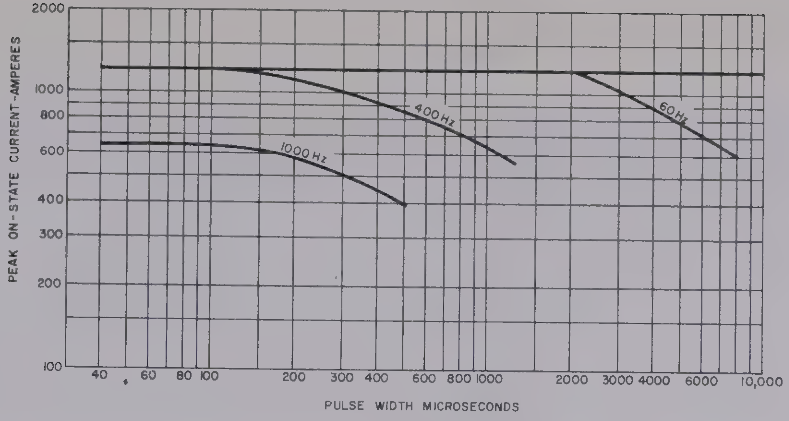
di/dt up to 100 amps/μsec at specified gate drive and switching voltage is part of the rectangular current wave ratings (see rating curves of Figures 13 through 30). This is a repetitive, long-term rating confirmed by life testing.

CHARACTERISTICS

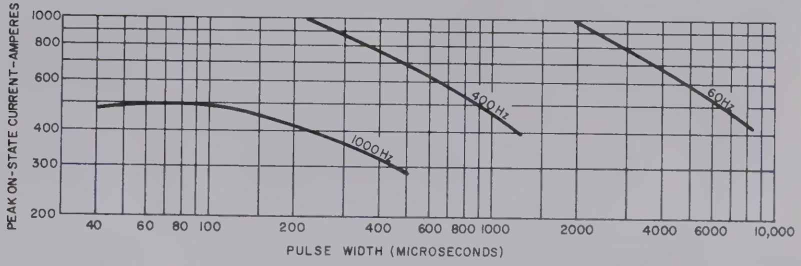
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Peak Reverse and Off-State Current	I_{DRM} and I_{RRM}				mA	$T_C = +25°C$
C385A		—	3	10		$V_{DRM} = V_{RRM} =$ 100 Volts peak
C385B		—	3	10		200 Volts peak
C385C		—	3	10		300 Volts peak
C385D		—	3	10		400 Volts peak
C385E		—	3	10		500 Volts peak
C385M		—	3	10		600 Volts peak
Peak Reverse and Off-State Current	I_{DRM} and I_{RRM}				mA	$T_C = 125°C$
C385A		—	15	20		$V_{DRM} = V_{RRM} =$ 100 Volts peak
C385B		—	15	20		200 Volts peak
C385C		—	15	20		300 Volts peak
C385D		—	15	20		400 Volts peak
C385E		—	15	20		500 Volts peak
C385M		—	15	20		600 Volts peak
Effective Thermal Resistance	θ_{J-C}	—	—	0.15	°C/watt	Junction to case—one side cooled
		—	—	0.095		Junction to case—two sides cooled
Critical Exponential Rate of Rise of Forward Blocking Voltage (Higher values may cause device switching)	dv/dt	200	500	—	V/μsec	V_{DRM}, $T_C = +125°C$, Gate open.
Holding Current	I_H	—	75	500	mAdc	$T_C = +25°C$, Anode supply = 24Vdc. Initial forward current = 2.5 amps.
Pulse Gate Trigger Current and Voltage	$i_{GT\ (pulse)}$	—	1	2	Amps.	$T_C = +25°C$, $t_p = 10\mu sec$.
	$V_{GT\ (pulse)}$	—	8	10	Volts	0.25 μsec rise time.
DC Gate Trigger Current	I_{GT}	—	125	300	mAdc	$T_C = +25°C$, $V_D = 6Vdc$, $R_L = 3$ ohms.
		—	175	500	mAdc	$T_C = -40°C$, $V_D = 6Vdc$, $R_L = 3$ ohms.
		—	100	250	mAdc	$T_C = +125°C$, $V_D = 6Vdc$, $R_L = 3$ ohms.
DC Gate Trigger Voltage	V_{GT}	—	—	3.0	Vdc	$T_C = -40°C$ to $+125°C$, $V_D = 6Vdc$, $R_L = 3$ ohms.
		0.15	—	—	Vdc	$T_C = +125°C$, V_{DRM}, $R_L = 1000$ ohms.
Peak On-State Voltage	V_{TM}	—	2.3	2.85	Volts	$T_C = +25°C$, $I_{TM} = 1500A$ peak. Duty cycle $\leqq$ .01%.
Delay Time	t_d	—	1	2	μsec	$T_C = +25°C$, $I_T = 50Adc$, V_{DRM}, Gate supply: 10 volt open circuit, 20 ohm, 0.1 μsec max. rise time.
Conventional Circuit Commutated Turn-Off-Time (with Reverse Voltage)	t_q	—	15	20	μsec	(1) $T_C = +125°C$, (2) $I_T = 250A$, (3) $V_R = 50$ volts min., (4) V_{DRM} (reapplied), (5) Rate of rise of reapplied forward blocking voltage = 20 V / μsec (linear). (6) Commutation di/dt = 12.5 Amps/μsec. (7) Duty cycle $\leqq$ .01%. (8) Gate bias during turn-off interval = 0 volts, 100 ohms.
Conventional Circuit Commutated Turn-Off-Time (with Feedback Diode)	$t_{q\ (diode)}$	—	20	30	μsec	(1) $T_C = +125°C$, (2) $I_T = 250A$, (3) $V_R = 1$ volt (Forward drop of GE A96 rectifier diode at $I_T = 250A$), (4) V_{DRM}, (5) Rate of rise of reapplied forward blocking voltage = 20 V/μsec (linear). (6) Commutation di/dt = 12.5 Amps/μsec. (7) Duty cycle $\leq$ .01%. (8) Gate bias during turn-off interval = 0 volts, 100 ohms.
Pulse Circuit Commutated Turn-Off-Time (with Reverse Voltage)	$t_{q\ (pulse)}$	—	15	20	μsec	(1) $T_C = +125°C$, V_{DRM} (reapplied), (2) Rate of rise of reapplied forward blocking voltage = 20 V/μsec (linear), (3) Rep. rate = 400 Hz., (4) Gate supply = 20 volts, 20 ohms, 0.25 μsec max. rise time, (5) $I_T = 500$ A peak, $t_p = 3$ μsec (half since wave), (6) $V_R = 50$ volts min.
Pulse Circuit Commutated Turn-Off-Time (with Feedback Diode)	$t_{q\ (pulse)\ (diode)}$	—	20	30	μsec	(1) $T_C = +125°C$, V_{DRM} (reapplied), (2) Rate of rise of reapplied forward blocking voltage = 20 V/μsec (linear), (3) Rep. rate = 400 Hz., (4) Gate supply = 20 volts, 20 ohms, 0.25 μsec max. rise time, (5) $I_T = 500$ A peak, $t_p = 3$ μsec (half since wave), (6) $V_R = 1.5$ volt (Forward drop of GE A96 rectifier diode at $I_T = 500A$).

SINE WAVE DATA

SINGLE-SIDE COOLING

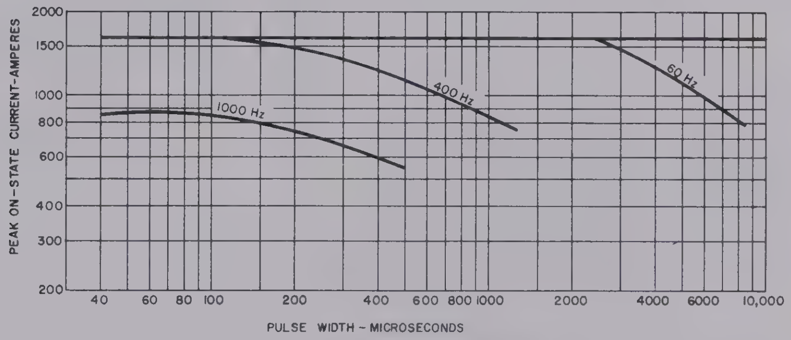


1. **Maximum allowable peak on-state current vs. pulse width (T_C = 65°C)**

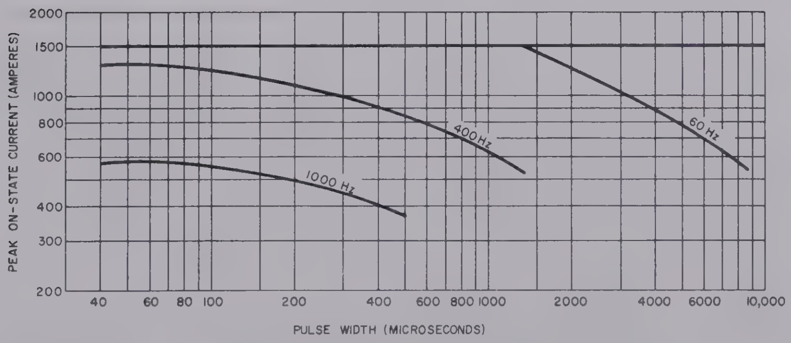


2. **Maximum allowable peak on-state current vs. pulse width (T_C = 90°C)**

DOUBLE-SIDE COOLING



3. **Maximum allowable peak on-state current vs. pulse width (T_C = 65°C)**

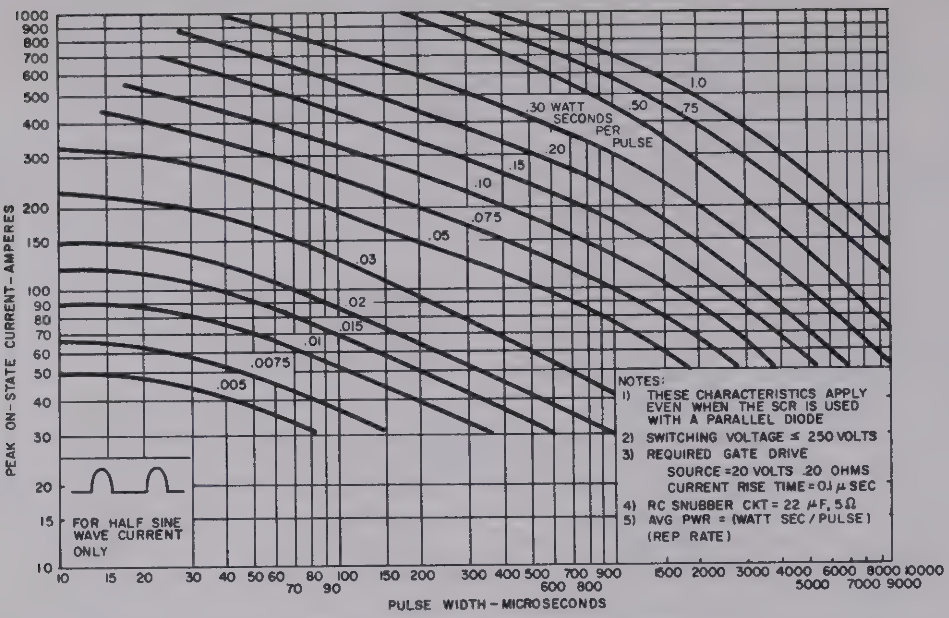


4. **Maximum allowable peak on-state current vs. pulse width (T_C = 90°C)**

NOTES:

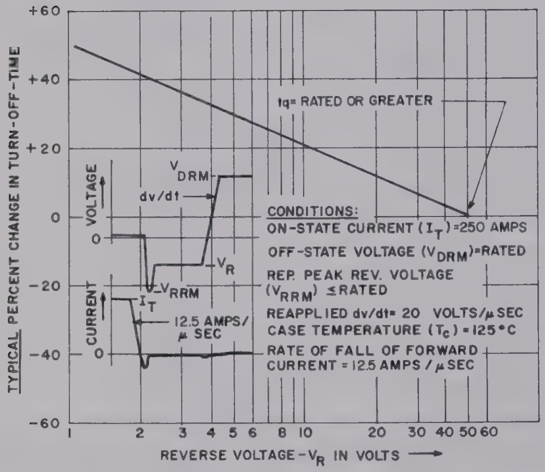
(1) Switching voltage–250 volts (2) Min. circuit turn-off-time ≥ 20 μsec. (3) Max. circuit dv/dt ≤ 200 V/μsec. (4) Required gate drive source = 20 volts, 20 ohms current rise time .1 μsec. (5) RC Snubber–.22 μf, 5 ohm.

SINE WAVE DATA

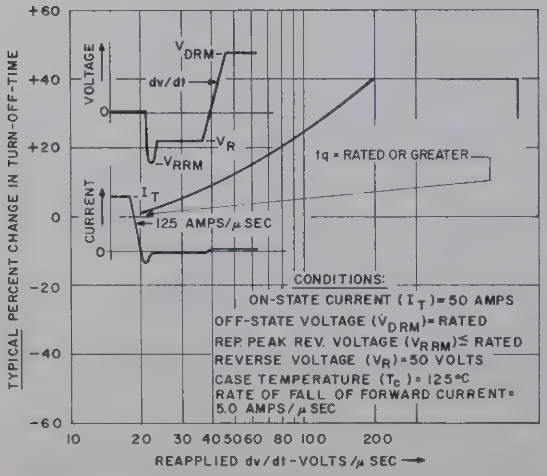


5. Energy per pulse for sinusoidal pulses

TURN-OFF-TIME DATA



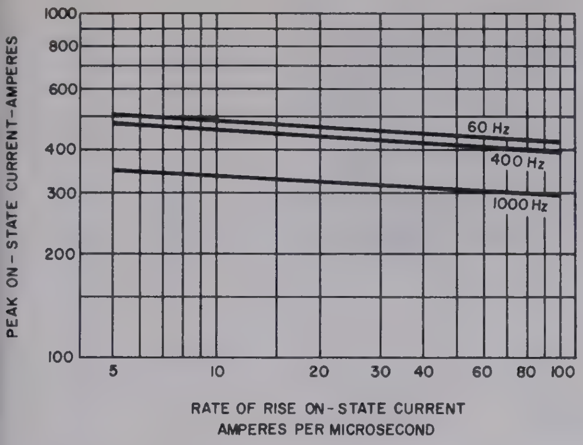
6. This curve shows a typical variation of SCR conventional circuit commutated turn-off-time with applied reverse voltage (V_R) during the turn-off interval. Testing at V_R = "1 volt" is done with a GE A96 fast recovery diode in inverse parallel with the C385. For SCR's with specified maximum turn-off-time with an inverse parallel diode—consult the factory.



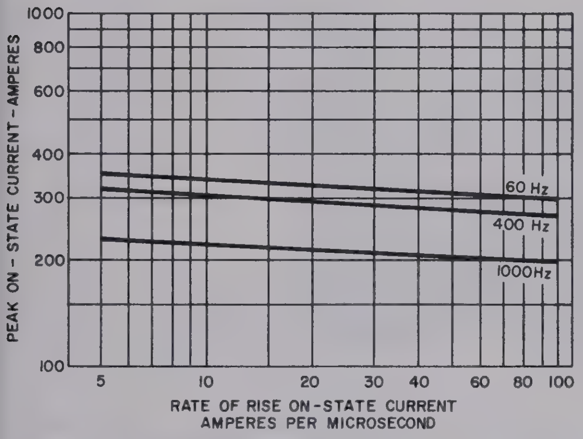
7. This curve shows a typical variation of SCR conventional circuit commutated turn-off-time with reapplied dv/dt. Specified turn-off-time is with reapplied dv/dt of 20 volts/μsec. Note turn-off-time increase at higher dv/dt. When requesting selected turn-off-time also specify maximum reapplied dv/dt.

RECTANGULAR WAVE DATA SWITCHING VOLTAGE - 500 VOLTS DOUBLE-SIDE COOLING

DUTY CYCLE – 50%

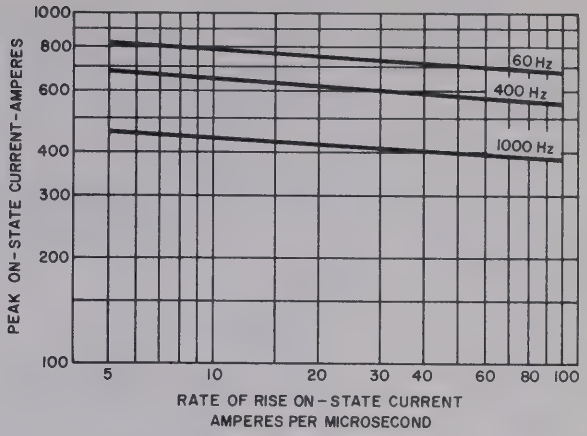


8. Maximum allowable peak on-state current vs. di/dt (T_C = 65°C)

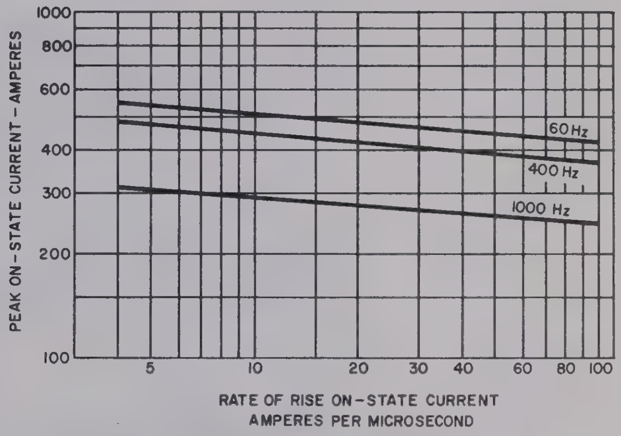


9. Maximum allowable peak on-state current vs. di/dt (T_C = 90°C)

DUTY CYCLE – 25%

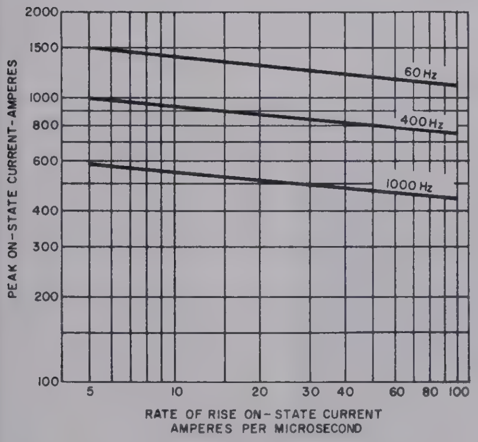


10. Maximum allowable peak on-state current vs. di/dt (T_C = 65°C)

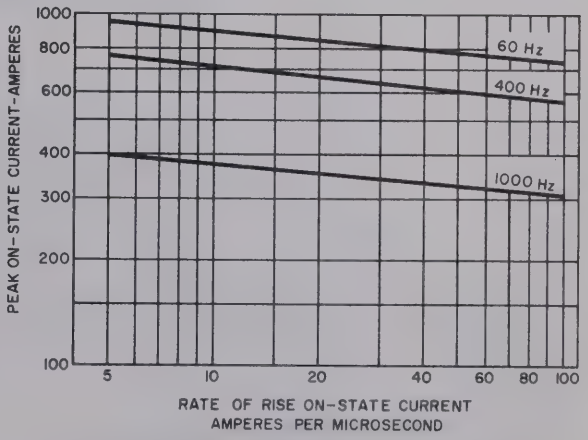


11. Maximum allowable peak on-state current vs. di/dt (T_C = 90°C)

DUTY CYCLE – 10%



12. Maximum allowable peak on-state current vs. di/dt (T_C = 65°C)



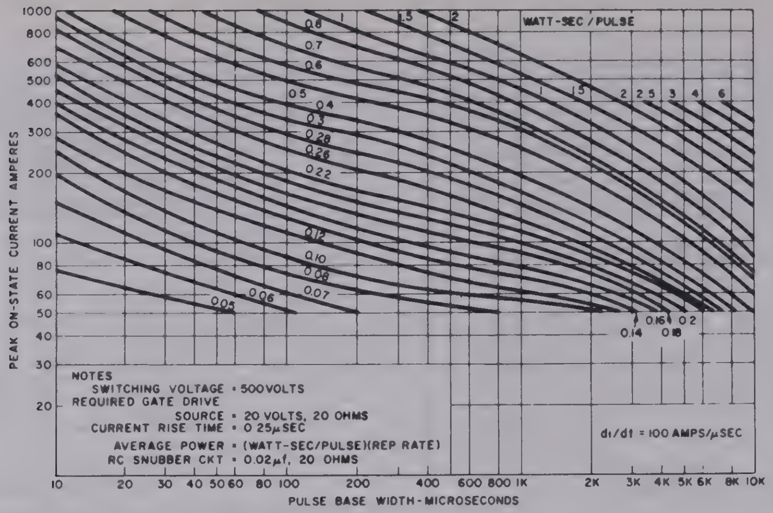
13. Maximum allowable peak on-state current vs. di/dt (T_C = 90°C)

NOTES:

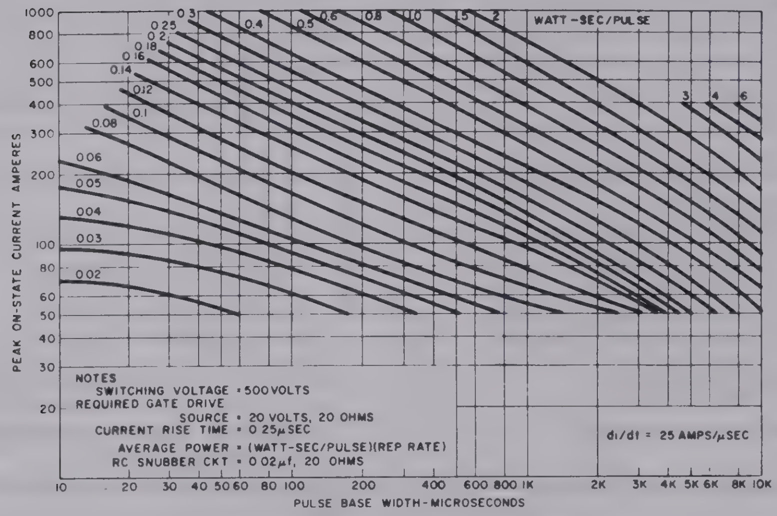
(1) Off-state voltage–500 volts (2) RC Snubber–.02 µf, 20 ohms (3) Turn-off-time–≥ 20 µsec. (4) Max. dv/dt ≤ 200 V/µsec
(5) Required gate drive–20 volts, 20 ohms, .1 µsec. rise time.

RECTANGULAR WAVE DATA WATT-SECOND PER PULSE SWITCHING VOLTAGE

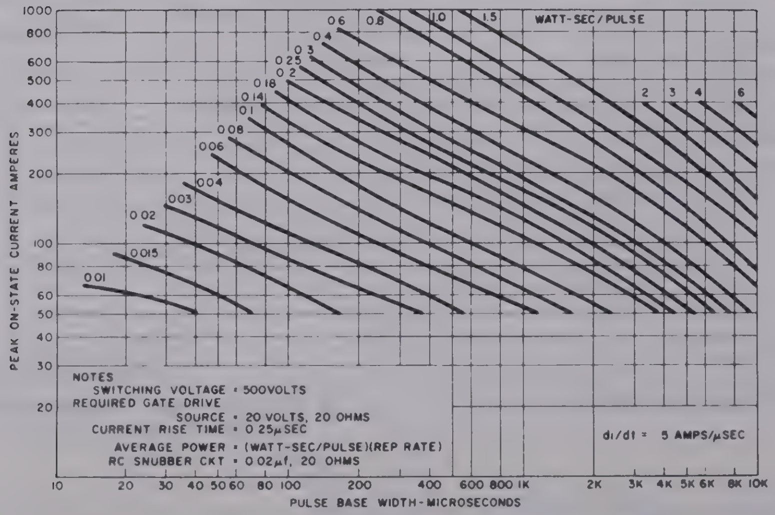
500 VOLTS



14. Energy per pulse vs. peak current and pulse width (di/dt = 100 A/μsec.)

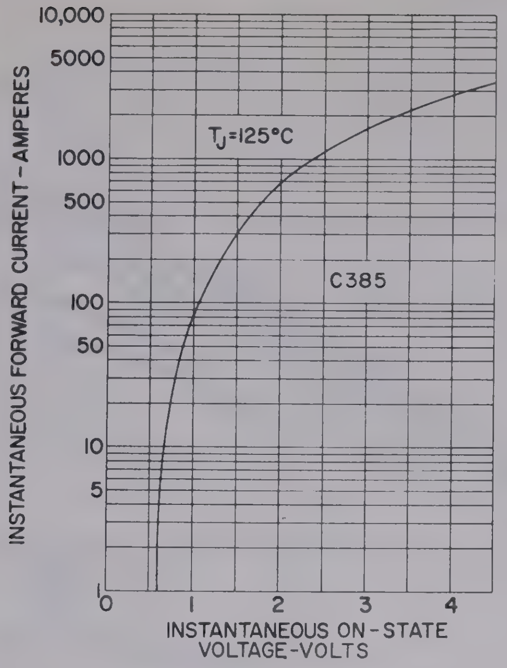


15. Energy per pulse vs. peak current and pulse width (di/dt = 25 A/μsec.)

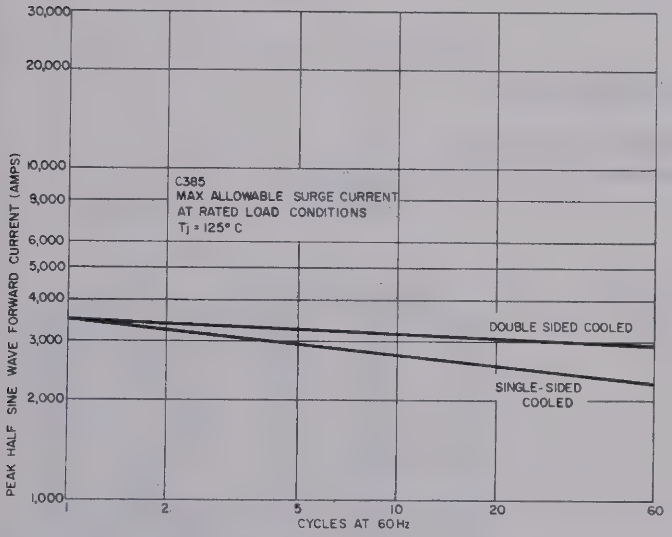


16. Energy per pulse vs. peak current and pulse width (di/dt = 5 A/μsec.)

LOW FREQUENCY DATA

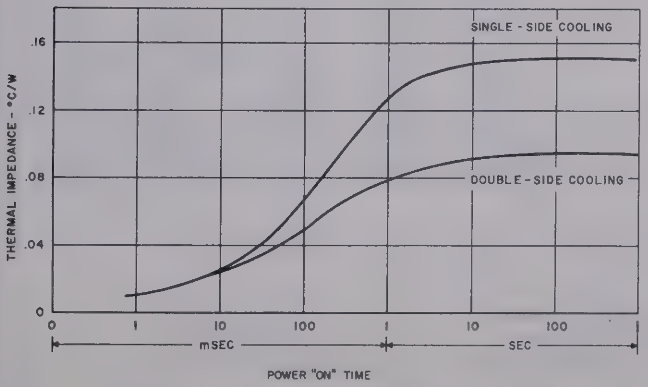


17. Forward conduction characteristic, on-state

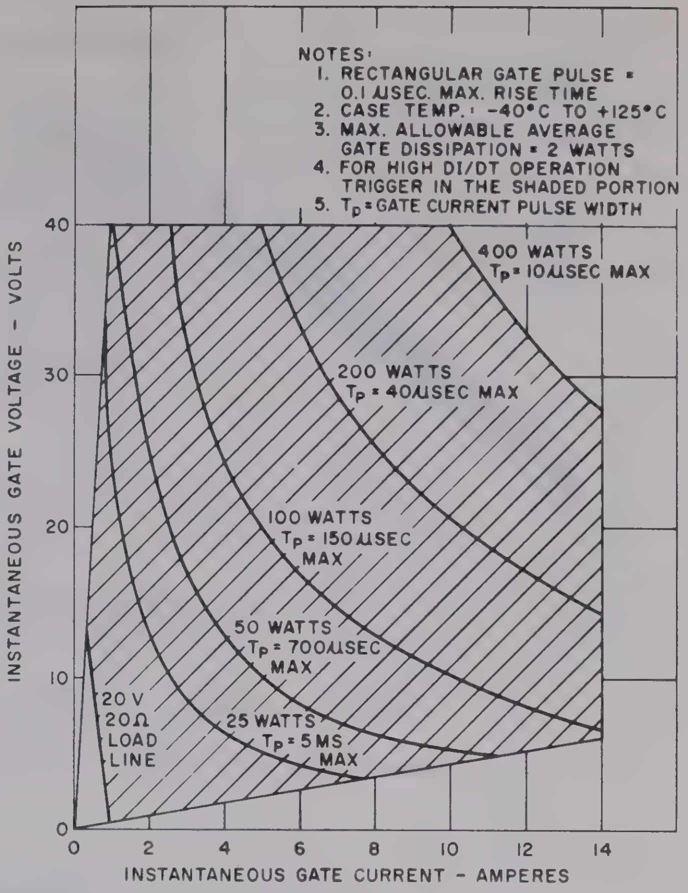


C385
MAX ALLOWABLE SURGE CURRENT
AT RATED LOAD CONDITIONS
T_j = 125° C

19. Maximum allowable surge current following rated load conditions

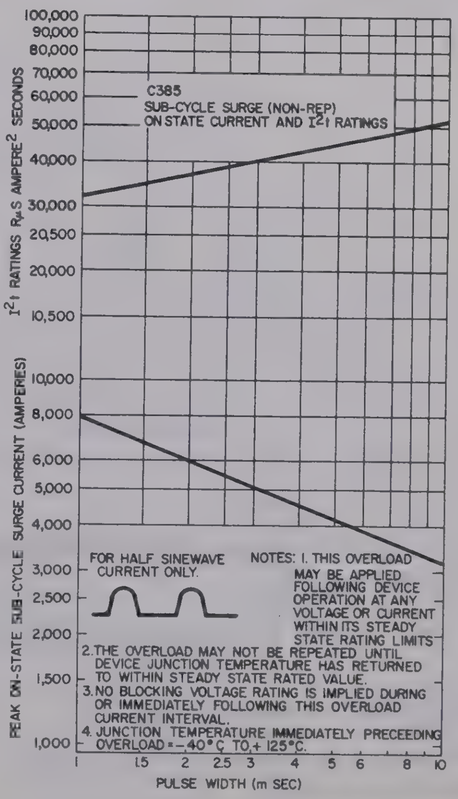


21. Transient thermal impedance, junction to case



NOTES:
1. RECTANGULAR GATE PULSE = 0.1 μSEC. MAX. RISE TIME
2. CASE TEMP.: -40°C TO +125°C
3. MAX. ALLOWABLE AVERAGE GATE DISSIPATION = 2 WATTS
4. FOR HIGH DI/DT OPERATION TRIGGER IN THE SHADED PORTION
5. T_P = GATE CURRENT PULSE WIDTH

18. Maximum allowable peak gate power vs. gate pulse width

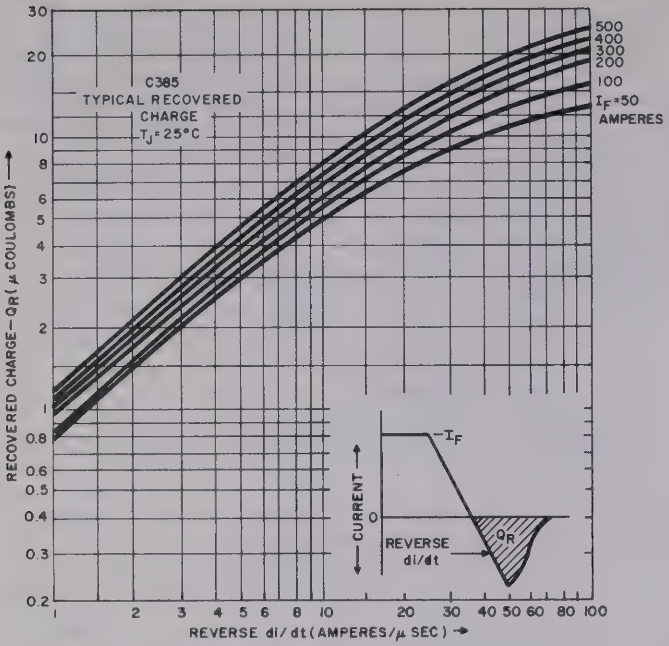


C385
SUB-CYCLE SURGE (NON-REP)
ON STATE CURRENT AND I^2t RATINGS

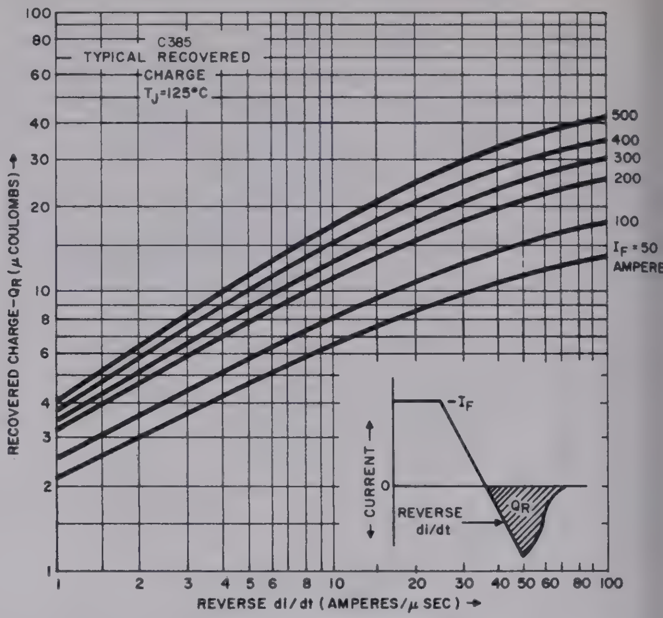
NOTES:
1. THIS OVERLOAD MAY BE APPLIED FOLLOWING DEVICE OPERATION AT ANY VOLTAGE OR CURRENT WITHIN ITS STEADY STATE RATING LIMITS
2. THE OVERLOAD MAY NOT BE REPEATED UNTIL DEVICE JUNCTION TEMPERATURE HAS RETURNED TO WITHIN STEADY STATE RATED VALUE.
3. NO BLOCKING VOLTAGE RATING IS IMPLIED DURING OR IMMEDIATELY FOLLOWING THIS OVERLOAD CURRENT INTERVAL.
4. JUNCTION TEMPERATURE IMMEDIATELY PRECEEDING OVERLOAD = -40°C TO +125°C.

20. Sub-cycle surge and I^2t rating following rated load conditions (sinusoidal waveform)

C385 RECOVERED CHARGE DATA



22. Typical recovered charge at 25°C

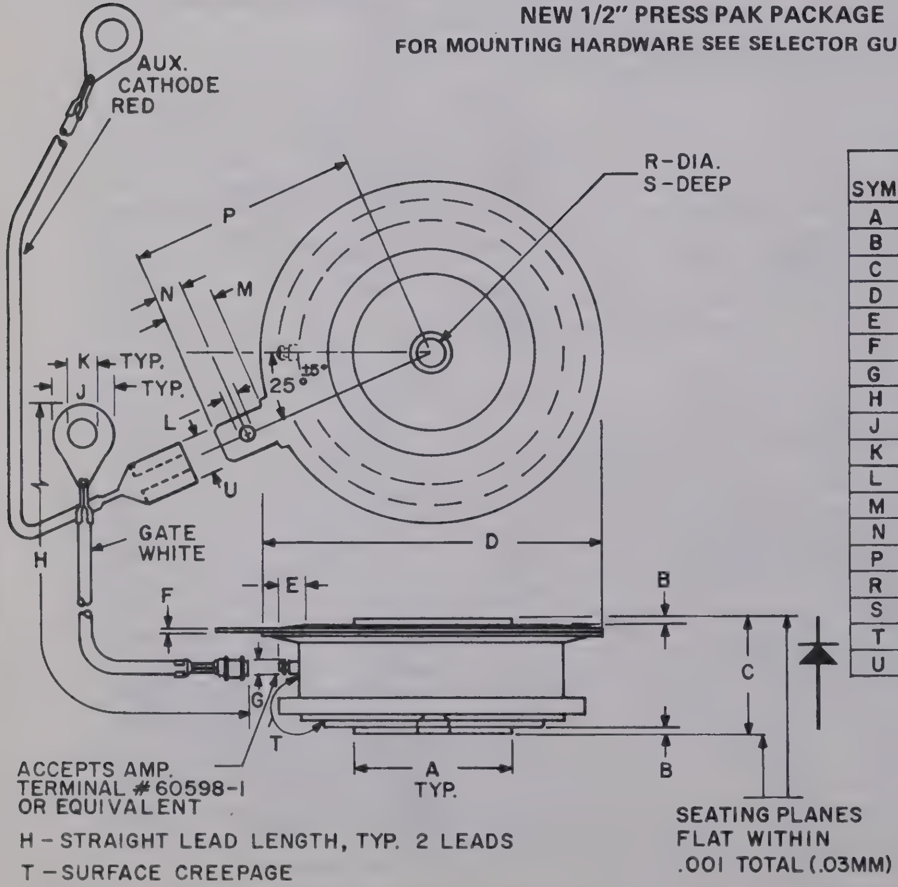


23. Typical recovered charge at 125°C

OUTLINE DRAWINGS

NEW 1/2" PRESS PAK PACKAGE

FOR MOUNTING HARDWARE SEE SELECTOR GUIDE PAGE 171


AUX.
CATHODE
RED
R-DIA.
S-DEEP
P
N
M
K
TYP.
J
TYP.
25°
15°
L
U
GATE
WHITE
H
D
E
F
B
C
G
T
A
TYP.
B
ACCEPTS AMP.
TERMINAL # 60598-1
OR EQUIVALENT
SEATING PLANES
FLAT WITHIN
.001 TOTAL (.03MM)

H – STRAIGHT LEAD LENGTH, TYP. 2 LEADS

T – SURFACE CREEPAGE

TABLE OF DIMENSIONS

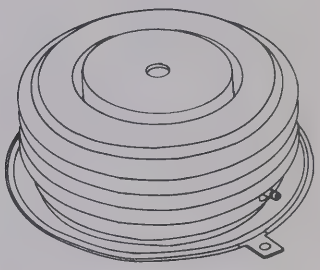
Conversion Table

SYM	DECIMAL INCHES		METRIC MM	
	MIN	MAX.	MIN.	MAX.
A	.744	.752	18.897	19.101
B	.030	.060	.762	1.524
C	.515	.565	13.081	14.351
D	1.600	1.656	40.64	42.06
E	.110	—	2.794	—
F	.031	.017	.330	.432
G	.057	.059	1.447	1.449
H	7.980	8.115	202.70	206.11
J	—	.300	—	7.620
K	.137	.153	3.479	3.886
L	.065	.070	1.651	1.778
M	.245	.260	6.223	6.604
N	.120	.140	3.048	3.556
P	1.090	1.125	27.69	28.55
R	.135	.145	3.429	3.683
S	.067	.083	1.701	2.108
T	.340	—	8.636	—
U	.186	.189	4.724	4.801

SCR

C387/C388

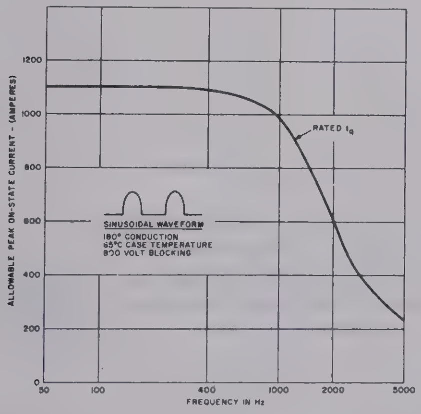
†I RMS (Max) for half sine wave current @ T_C = 65°C, 60 Hz is 550 amperes.
I RMS (Max) for rectangular wave current @ T_C = 65°C, 60 Hz and 50% Duty Cycle at low di/dt (5A/μsec) is 425 amperes.

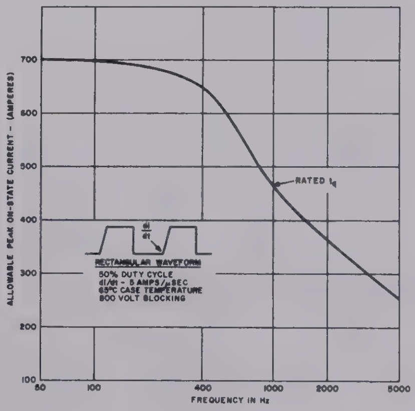


The General Electric Type C387/C388 silicon controlled rectifiers are new, pressure-mounted high current devices employing the Amplifying Gate. The C387/C388 are designed for power switching at frequencies up to 3k Hz (sinusoidal).

For efficient operation in high speed applications, the C387/C388 features a superior mix of capabilities:

- Forward and reverse blocking capabilities to 1200 volts
- Very low switching losses at high frequencies
- 40 μsec. maximum turnoff time at severe operating conditions (C387)
- 30 μsec. maximum turnoff at severe operating conditions (C388)
- di/dt rating of 800 A/μsec.
- Soft firing gate
- 1” creepage-path, glazed-ceramic package





Equipment designers can use the C387/C388 SCR in demanding applications, such as:

- **Choppers**
- **Inverters**
- **Regulated power supplies**
- **Sonar transmitters**
- **Induction heaters**
- **Radio transmitters**
- **Cycloconverters**
- **DC to DC converters**
- **High frequency lighting**

FOR SINE WAVE OPERATION

Like the Type C140/141, C158/159, and C358 SCR’s, the C387/C388 SCR is rated for:

- **Peak current**

  vs.
- **Pulse width**
- **Frequency**
- **Case temperature**

FOR RECTANGULAR WAVE OPERATION

GE now introduces a new, high-frequency rating for the C387/C388 SCR, which is:

- **Peak current**

  vs.
- **di/dt of leading edge**
- **Frequency**
- **Duty cycle**
- **Case temperature**

MAXIMUM ALLOWABLE RATINGS

Types	Repetitive Peak Off-State Voltage, V_{DRM}	Repetitive Peak Reverse Voltage, V_{RRM}(1)	Non-repetitive Peak Reverse Voltage, V_{RSM}(1)
	$T_C = -40°C$ to $+125°C$(2)	$T_C = -40°C$ to $+125°C$(2)	$T_C = -40°C$ to $+125°C$(2)
C387/C388E	500 Volts	500 Volts	600 Volts
C387/C388M	600	600	720
C387/C388S	700	700	840
C387/C388N	800	800	960
C387/C388T	900	900	1080
C387/C388P	1000	1000	1200
C387/C388PA	1100	1100	1300
C387/C388PB	1200	1200	1400

(1) Half sine wave voltage pulse, 10 millisecond maximum duration.

(2) Ratings apply for zero or negative gate voltage. Maximum case to ambient thermal resistance for which maximum V_{DRM} and maximum V_{RRM} ratings apply equals 0.2°C/watt.

Peak Positive Anode Voltage	None†
Average On-State Current, $I_{T(AV)}$	(See Charts)
Peak One Cycle Surge (non-rep) On-State Current, I_{TSM}	5500 Amperes
I^2t (for fusing) for times $\geqq$ 1.5 milliseconds	50,000 Ampere^{2}seconds
I^2t (for fusing) for times $\geqq$ 8.3 milliseconds	120,000 Ampere^{2}seconds
Critical Rate-of-Rise of On-State Current, di/dt During Turn-On Interval	800 Amperes per microsecond††
Peak Gate Power Dissipation, P_{GM}. . . (Pulse Width = 10μsec)	400 Watts
Average Gate Power Dissipation, $P_{G(AV)}$	2 Watts
Peak Negative Gate Voltage, V_{GM}	20 Volts
Storage Temperature, T_{STG}	−40°C to +125°C
Operating Temperature, T_J	−40°C to +125°C
Mounting Force	2000 lb. ±200 lb.

†This SCR may be, non-repetitively, turned-on in the forward direction by exceeding the breakover voltage (V_{DRM}) with either a rapidly or slowly rising waveform. At breakover, di/dt must be limited to 20 amps/μsec and peak current to 1000 amperes.

††Required trigger source—20 volts, 65 ohms; maximum switching voltage — 1200 volts; short-circuit gate supply current risetime — 1.0 μsec. (This short-circuit current may be measured with a TEKTRONICS current probe.); RC Snubber circuit used across SCR.

di/dt rating is established in accordance with JEDEC Suggested Standard No. 7, Section 5.1.2.4. Immediately after each current pulse, off-state (blocking) voltage capability may be temporarily lost for durations less than the period of the applied pulse repetition rate. The pulse repetition rate for this test is 400 Hz: The duration of the JEDEC di/dt test condition is 5.0 seconds (minimum).

di/dt up to 100 amps/μsec, at specified gate drive and switching voltage is part of the rectangular current wave ratings (see rating curves of Figures 9 through 15). This is a repetitive, long-term rating confirmed by life test.

CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}				mA	$T_C = +25°C$
C387/C388E		–	5	20		$V_{DRM} = V_{RRM} =$ 500 Volts peak
C387/C388M		–	5	20		600 Volts peak
C387/C388S		–	5	20		700 Volts peak
C387/C388N		–	5	20		800 Volts peak
C387/C388T		–	5	20		900 Volts peak
C387/C388P		–	5	20		1000 Volts peak
C387/C388PA		–	5	20		1100 Volts peak
C387/C388PB		–	5	20		1200 Volts peak
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–			mA	$T_C = 125°C$
C387/C388E		–	20	45		$V_{DRM} = V_{RRM} =$ 500 Volts peak
C387/C388M		–	20	45		600 Volts peak
C387/C388S		–	20	45		700 Volts peak
C387/C388N		–	20	45		800 Volts peak
C387/C388T		–	20	45		900 Volts peak
C387/C388P		–	20	45		1000 Volts peak
C387/C388PA		–	20	45		1100 Volts peak
C387/C388PB		–	20	45		1200 Volts peak

CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
Effective Thermal Resistance	$R\theta_{JC}$	–	.05	.06	°C/watt	Junction to case (DC) Double Side Cooled
Critical Exponential Rate of Rise of Forward Blocking Voltage (Higher values may cause device switching)	dv/dt	200 ★	500	–	V/μsec	V_{DRM}, T_C = +125°C, Gate open.
Holding Current	I_H	–	20	500	mAdc	T_C = +25°C, Anode supply = 24 Vdc. Initial forward current = 2 amps.
Pulse Gate Trigger Current and Voltage	$i_{GT(pulse}$ $V_{GT(pulse)}$	– –	 8	200 10	mAdc Volts	T_C = +25°C, t_p = 10 μsec. 0.25 μsec rise time
DC Gate Trigger Current	I_{GT}	– – –	50 75 15	150 300 125	mAdc mAdc mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 3 ohms. T_C = –40°C, V_D = 6 Vdc, R_L = 3 ohms. T_C = +125°C, V_D = 6 Vdc, R_L = 3 ohms.
DC Gate Trigger Voltage	V_{GT}	– – 0.15	3 1.25 –	5 3.0 –	Vdc Vdc Vdc	T_C = –40°C to 0°C, V_D = 6 Vdc, R_L = 3 ohms. T_C = 0°C to +125°C, V_D = 6 Vdc, R_L = 3 ohms. T_C = 125°C, V_{DRM}, R_L = 1000 ohms.
Peak On-State Voltage	V_{TM}	–	3.3	4.2	Volts	T_C = +25°C, I_{TM} = 3000 peak. Duty cycle ≦ .01%.
Turn-On Time (Delay Time + Rise Time)	t_{GT}	–	2	–	μsec	T_C = +25°C, I_T = 50 Adc, V_{DRM}. Gate supply: 10 volt open circuit, 20 ohm, 1.0 μsec max. rise time.†††
Delay Time	td	–	0.5	2.0	μsec	T_C = +25°C, I_T = 50 Adc, V_{DRM}, Gate supply: 10 volt open circuit, 20 ohm, 0.1 μsec max. rise time. ††,†††
Conventional Circuit Commutated Turn-Off-Time (with Reverse Voltage)	tq	–	-	-		(1) T_C = +125°C, (2) I_T = 500A, (3) V_R = 50 volts min., (4) V_{DRM} (reapplied), (5) Rate of rise of reapplied forward blocking voltage = 20 V/μsec (linear). (6) Commutation di/dt = 25 Amps/μsec. (7) Repetition rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts, 100 ohms.
	C388	–	15	20	μsec	
	C387	–	20	30	μsec	
	C388	–	20	30	μsec	(1) T_C = +125°C, (2) I_T = 500A, (3) V_R = 50 volts min., (4) V_{DRM} (reapplied), (5) Rate of rise of reapplied forward blocking voltage = 200 V/μsec (linear). (6) Commutation di/dt = 25 Amps/μsec. (7) Repetition rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts, 100 ohms.
	C387	–	25	40	μsec	
Conventional Circuit Commutated Turn-Off-Time (with Feedback Diode)	tq(diode)					(1) T_C = +125°C, (2) I_T = 500A, (3) V_R = 1 volt (Forward drop of GE A396 rectifier diode at I_T = 150A) (4) V_{DRM}, (5) Rate of rise of reapplied forward blocking voltage = 200 V/μsec (linear). (6) Commutation di/dt = 25 Amps/μsec. (7) Repetition rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts, 100 ohms.
	C388	–	30	–†	μsec	
	C387	–	40	–†	μsec	
Pulse Circuit Commutated Turn-off-Time (with Reverse Voltage)	tq(pulse)					(1) T_C = +125°C, V_{DRM} (reapplied), (2) Rate of rise of reapplied forward blocking voltage = 200 V/μsec (linear), (3) Rep. rate = 400 Hz., (4) Gate supply = 20 volts, 80 ohms, 1.0 μsec max. rise time. (5) I_T = 500A peak, t_p = 3 μsec (half sine wave), (6) V_R = 50 volts min.
	C388		20	30	μsec	
	C387		25	40	μsec	
Pulse Circuit Commutated Turn-Off-Time (with Feedback Diode)	tq(pulse) (diode)					(1) T_C = +125°C, V_{DRM} (reapplied), (2) Rate of rise of reapplied forward blocking voltage = 200 V/μsec (linear), (3) Rep. rate = 400 Hz., (4) Gate supply = 20 volts, 80 ohms, 1.0 μsec max. rise time, (5) I_T = 500A peak, t_p = 3 μsec (half sine wave), (6) V_R = 1 volt (Forward drop of GE A396 rectifier diode at I_T = 150A).
	C388	–	30	–†	μsec	
	C387		40	–†	μsec	

†Consult Factory for specified maximum Turn-Off Time.

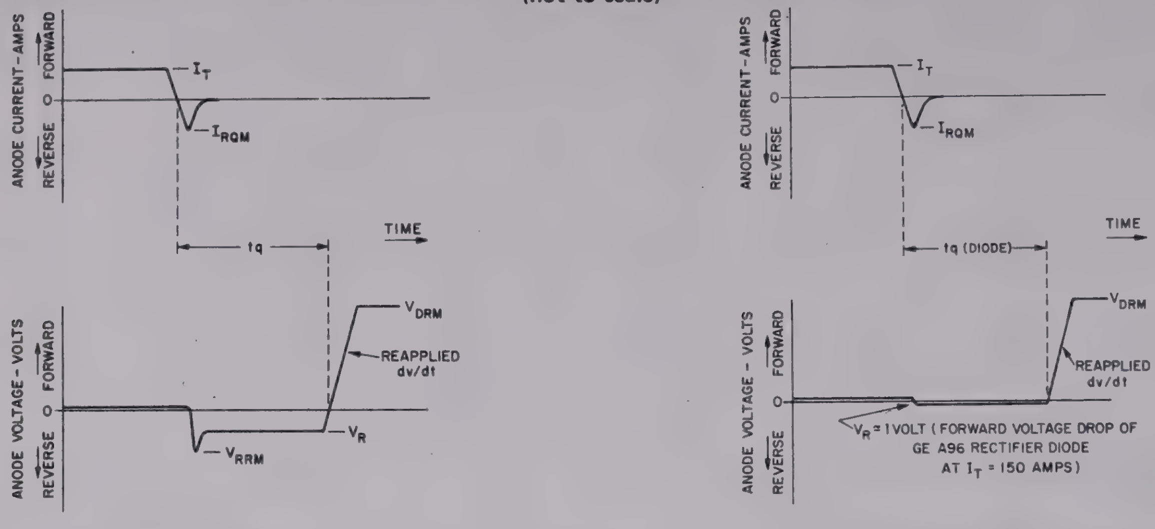
††Delay Time may increase significantly as the gate drive approaches the I_{GT} of the Device Under Test (D.U.T.).

†††Current risetime as measured with a current probe, or voltage rise time across a non-inductive resistor.

★Consult factory for higher dv/dt selections of 300, 400, or 500 volts/μsec.

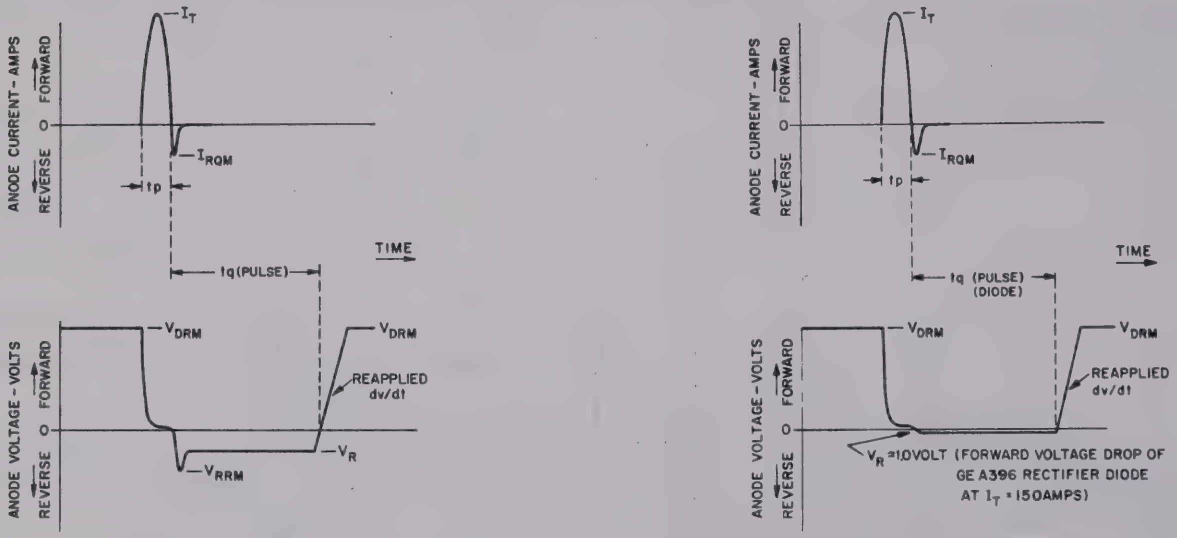
WAVEFORM DEFINITION OF TURN-OFF-TIME

(not to scale)


ANODE CURRENT - AMPS
FORWARD
REVERSE
0
I_T
I_{RQM}
TIME
tq
ANODE VOLTAGE - VOLTS
FORWARD
REVERSE
0
V_{DRM}
REAPPLIED dv/dt
V_R
V_{RRM}
ANODE CURRENT - AMPS
FORWARD
REVERSE
0
I_T
I_{RQM}
TIME
tq (DIODE)
ANODE VOLTAGE - VOLTS
FORWARD
REVERSE
0
V_{DRM}
REAPPLIED dv/dt
$V_R \approx$ 1 VOLT (FORWARD VOLTAGE DROP OF GE A96 RECTIFIER DIODE AT I_T = 150 AMPS)

(a) With reverse voltage **(b) With feedback diode**

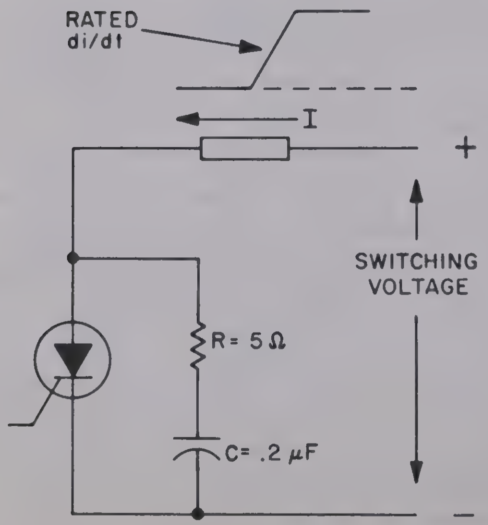
Conventional circuit commutated turn-off-time


ANODE CURRENT - AMPS
FORWARD
REVERSE
0
I_T
I_{RQM}
tp
TIME
tq(PULSE)
ANODE VOLTAGE - VOLTS
FORWARD
REVERSE
0
V_{DRM}
V_{DRM}
REAPPLIED dv/dt
V_R
V_{RRM}
ANODE CURRENT - AMPS
FORWARD
REVERSE
0
I_T
I_{RQM}
tp
TIME
tq (PULSE) (DIODE)
ANODE VOLTAGE - VOLTS
FORWARD
REVERSE
0
V_{DRM}
V_{DRM}
REAPPLIED dv/dt
$V_R \approx$1.0VOLT (FORWARD VOLTAGE DROP OF GE A396 RECTIFIER DIODE AT I_T = 150AMPS)

(a) With reverse voltage **(b) With feedback diode**

Pulse circuit commutated turn-off-time

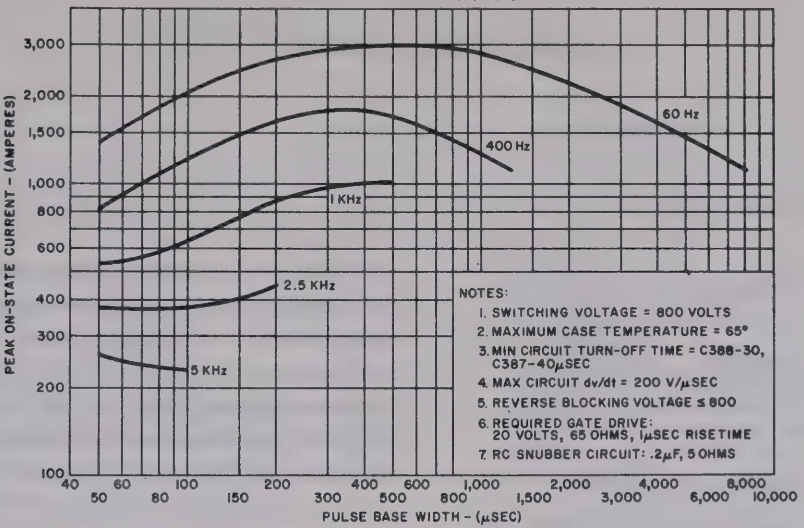
RATED di/dt AND THE RC SNUBBER CIRCUIT


RATED di/dt
I
+
SWITCHING VOLTAGE
R= 5 Ω
C= .2 μF
−

RC Snubber circuit

The rated di/dt for the C387/C388 SCR's are in addition to the discharge of the RC Snubber circuit shown connected in parallel with the SCR's. For all high-frequency ratings, the SCR shunted by the snubber has been considered as the device under test.

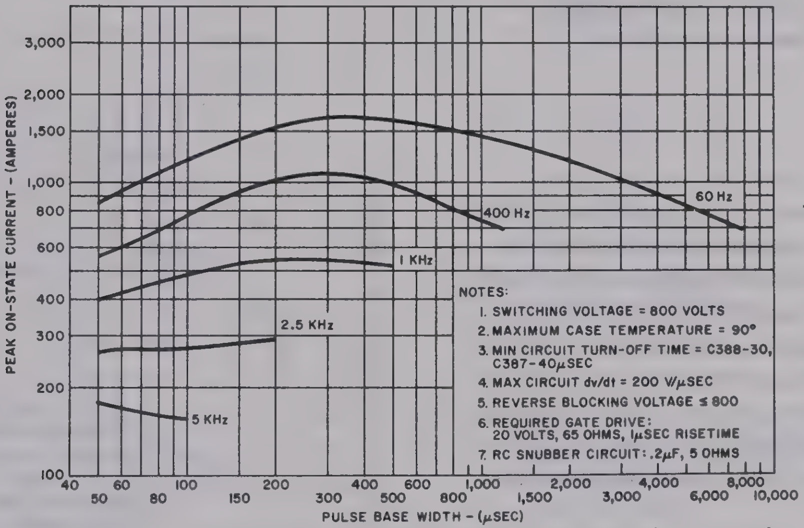
SINE WAVE DATA



NOTES:

1. SWITCHING VOLTAGE = 800 VOLTS
2. MAXIMUM CASE TEMPERATURE = 65°
3. MIN CIRCUIT TURN-OFF TIME = C388-30, C387-40μSEC
4. MAX CIRCUIT dv/dt = 200 V/μSEC
5. REVERSE BLOCKING VOLTAGE ≤ 800
6. REQUIRED GATE DRIVE: 20 VOLTS, 65 OHMS, 1μSEC RISETIME
7. RC SNUBBER CIRCUIT: .2μF, 5 OHMS

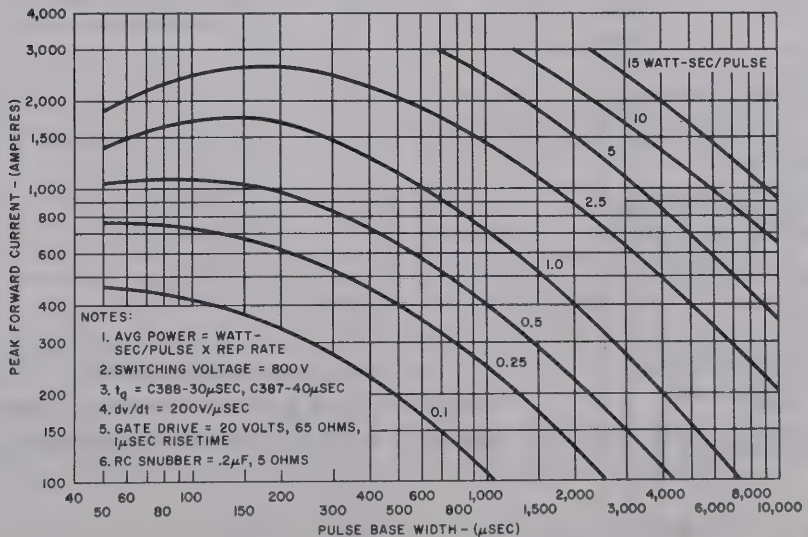
3. Maximum allowable peak on-state current vs. pulse width ($T_C = 65°C$)



NOTES:

1. SWITCHING VOLTAGE = 800 VOLTS
2. MAXIMUM CASE TEMPERATURE = 90°
3. MIN CIRCUIT TURN-OFF TIME = C388-30, C387-40μSEC
4. MAX CIRCUIT dv/dt = 200 V/μSEC
5. REVERSE BLOCKING VOLTAGE ≤ 800
6. REQUIRED GATE DRIVE: 20 VOLTS, 65 OHMS, 1μSEC RISETIME
7. RC SNUBBER CIRCUIT: .2μF, 5 OHMS

4. Maximum allowable peak on-state current vs. pulse width ($T_C = 90°C$)



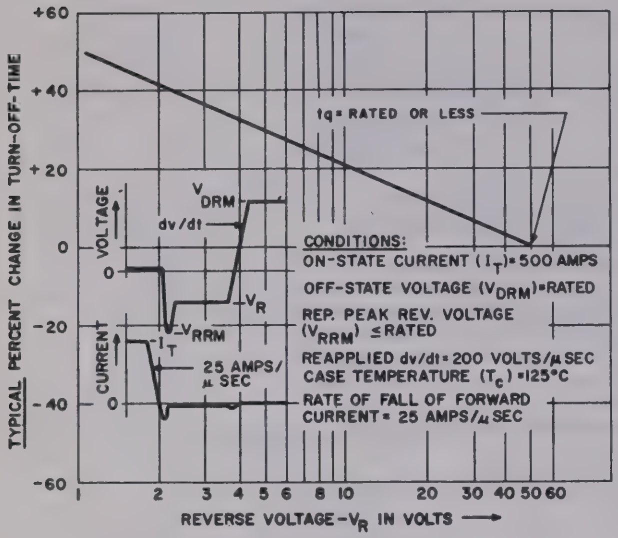
NOTES:

1. AVG POWER = WATT-SEC/PULSE X REP RATE
2. SWITCHING VOLTAGE = 800 V
3. t_q = C388-30μSEC, C387-40μSEC
4. dv/dt = 200V/μSEC
5. GATE DRIVE = 20 VOLTS, 65 OHMS, 1μSEC RISETIME
6. RC SNUBBER = .2μF, 5 OHMS

5. Energy per pulse for sinusoidal pulses

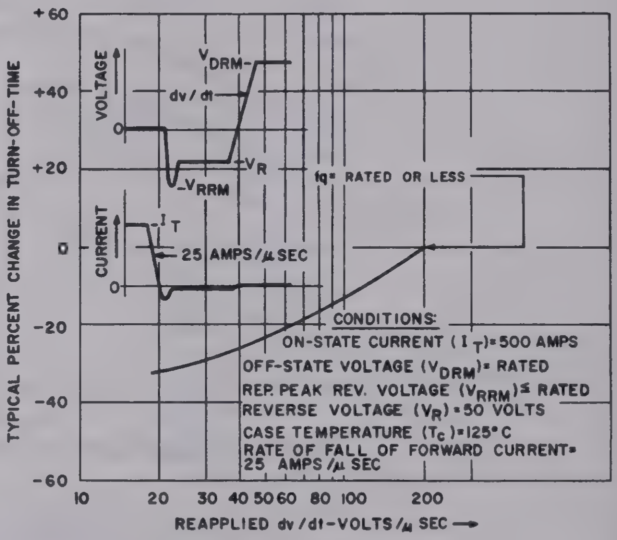
Charts 3 and 4 give the maximum value of peak on-state current at which the specified turn-off-time and dv/dt still apply.

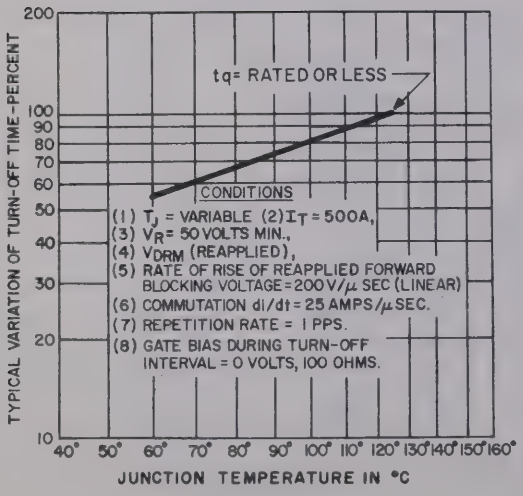
TURN-OFF-TIME DATA



6. This curve shows a typical variation of SCR turn-off-time with applied reverse voltage (V_R) during the turn-off interval. Testing at V_R = "1 volt" is done with a GE A396 fast recovery diode in inverse parallel with the C387 or C388. For SCR's with specified maximum turn-off-time with an inverse parallel diode — consult the factory.

7. This curve shows a typical variation of SCR turn-off-time with reapplied dv/dt. Specified turn-off-time (40 µsec) is with reapplied dv/dt of 200 volts/µsec. Note turn-off-time enhancement at lower dv/dt. When requesting selected turn-off-time (less than 40 µsec) also specify maximum reapplied dv/dt. For the 30 µsec, 200 volt/µsec reapplied dv/dt rated C388 a similar enhancement of turn-off-time would occur at lower reapplied dv/dt.

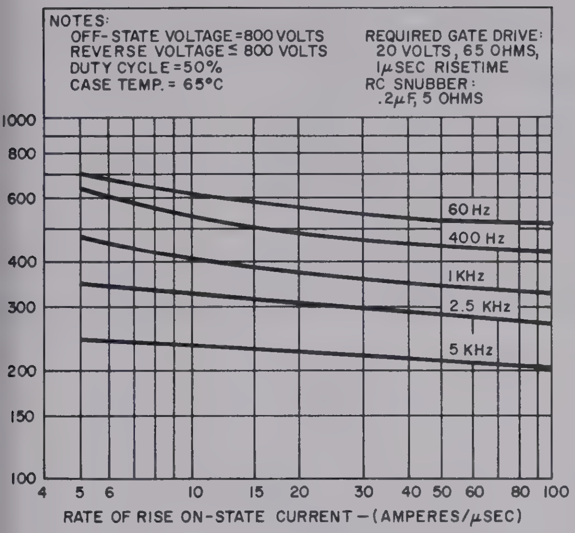




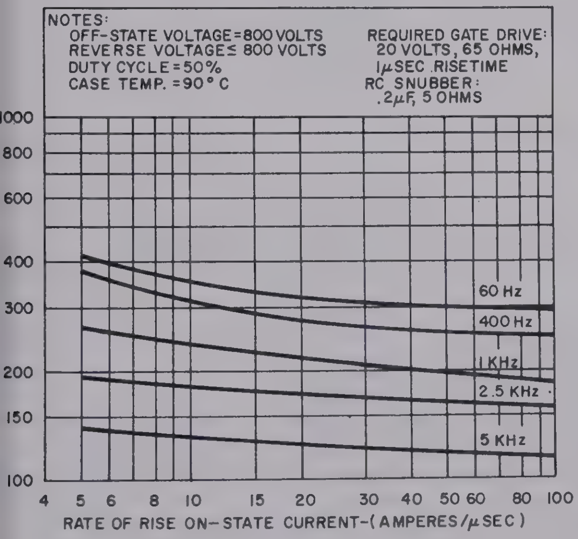
8. This curve shows typical variation of SCR turn-off-time with junction temperature. Specified turn-off is based on a 125°C junction temperature.

RECTANGULAR WAVE DATA

DUTY CYCLE – 50%

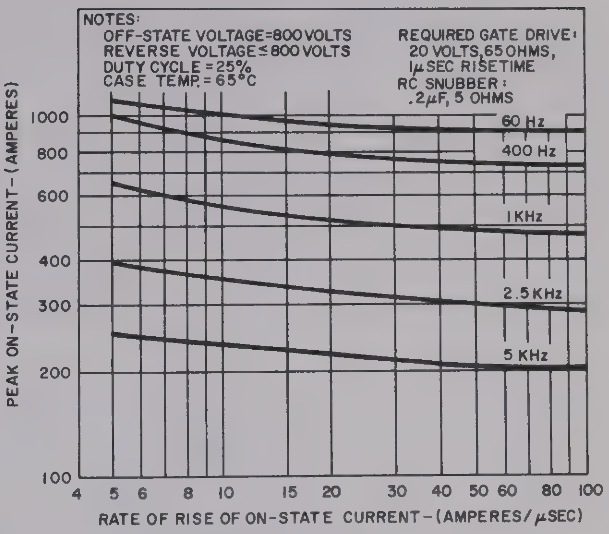

NOTES:
OFF-STATE VOLTAGE = 800 VOLTS
REVERSE VOLTAGE ≤ 800 VOLTS
DUTY CYCLE = 50%
CASE TEMP. = 65°C
REQUIRED GATE DRIVE:
20 VOLTS, 65 OHMS,
1μSEC RISETIME
RC SNUBBER:
.2μF, 5 OHMS

9. Maximum allowable peak on-state current vs. di/dt ($T_C = 65°C$)

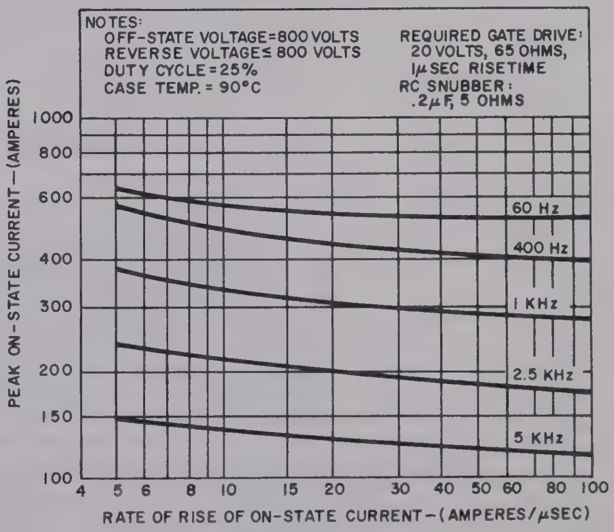

NOTES:
OFF-STATE VOLTAGE = 800 VOLTS
REVERSE VOLTAGE ≤ 800 VOLTS
DUTY CYCLE = 50%
CASE TEMP. = 90°C
REQUIRED GATE DRIVE:
20 VOLTS, 65 OHMS,
1μSEC RISETIME
RC SNUBBER:
.2μF, 5 OHMS

10. Maximum allowable peak on-state current vs. di/dt ($T_C = 90°C$)

DUTY CYCLE – 25%

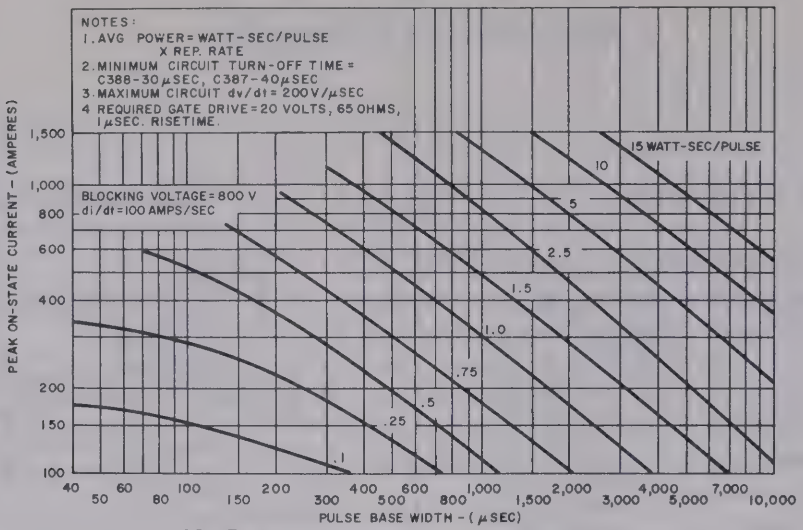

NOTES:
OFF-STATE VOLTAGE = 800 VOLTS
REVERSE VOLTAGE ≤ 800 VOLTS
DUTY CYCLE = 25%
CASE TEMP. = 65°C
REQUIRED GATE DRIVE:
20 VOLTS, 65 OHMS,
1μSEC RISETIME
RC SNUBBER:
.2μF, 5 OHMS

11. Maximum allowable peak on-state current vs. di/dt ($T_C = 65°C$)

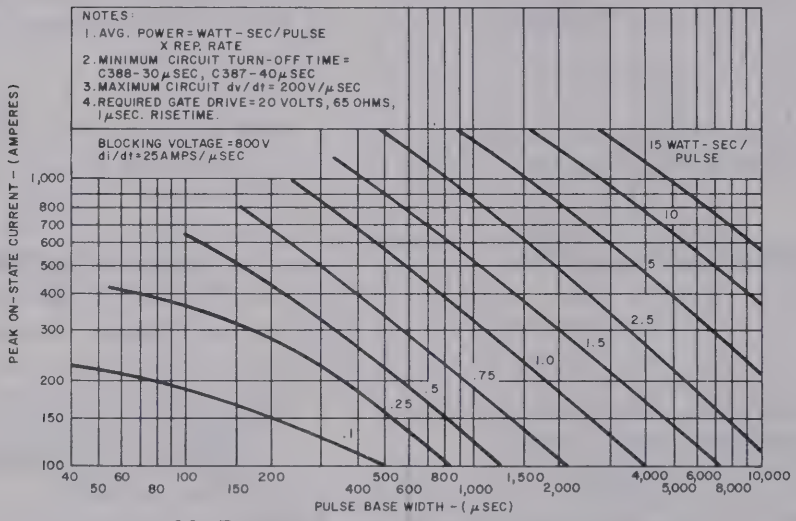

NOTES:
OFF-STATE VOLTAGE = 800 VOLTS
REVERSE VOLTAGE ≤ 800 VOLTS
DUTY CYCLE = 25%
CASE TEMP. = 90°C
REQUIRED GATE DRIVE:
20 VOLTS, 65 OHMS,
1μSEC RISETIME
RC SNUBBER:
.2μF, 5 OHMS

12. Maximum allowable peak on-state current vs. di/dt ($T_C = 90°C$)

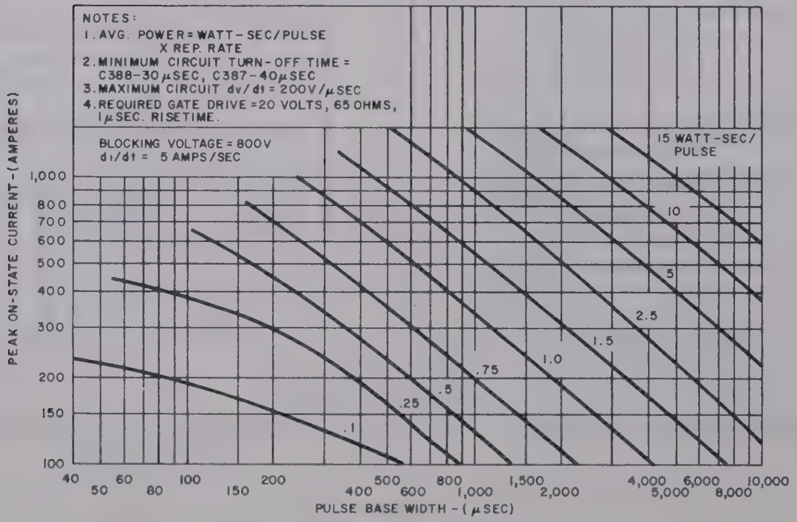
RECTANGULAR WAVE DATA
WATT-SECOND PER PULSE



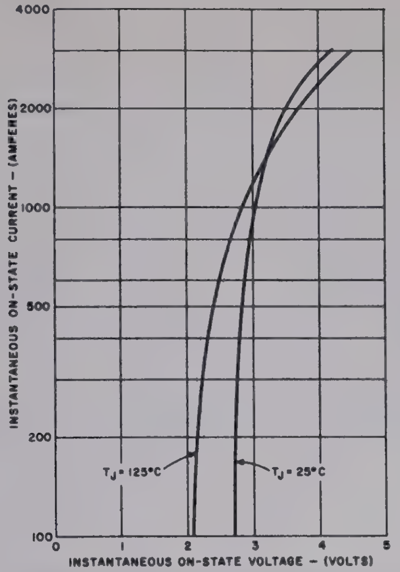
13. Energy per pulse vs. peak current and pulse width (di/dt = 100A/μsec)



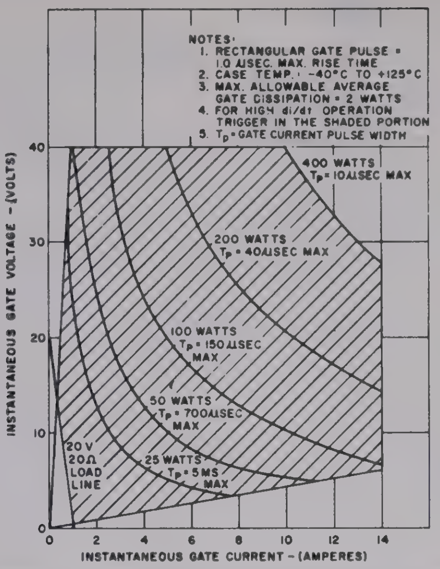
14. Energy per pulse vs. peak current and pulse width (di/dt = 25A/μsec)



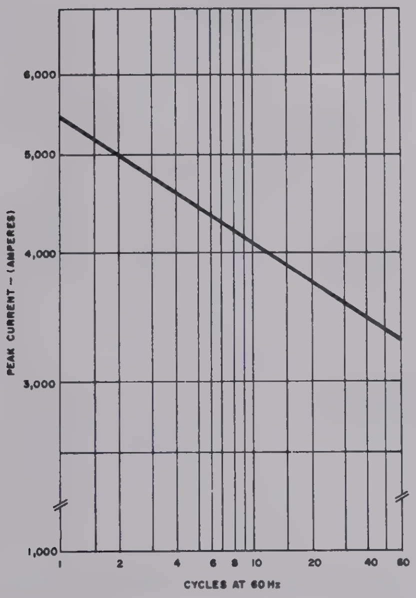
15. Energy per pulse vs. peak current and pulse width (di/dt = 5A/μsec)



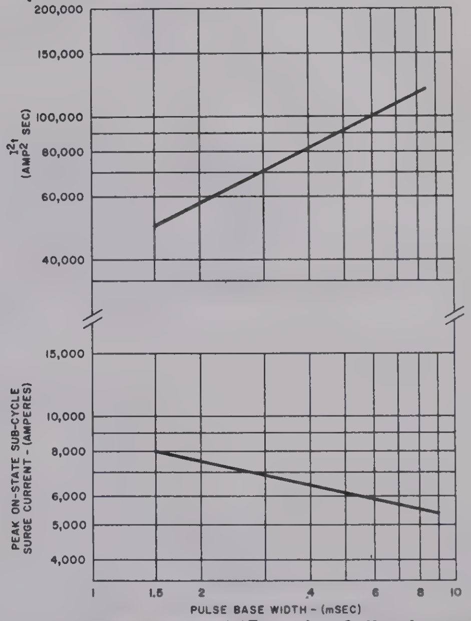
16. Forward conduction characteristic, on-state



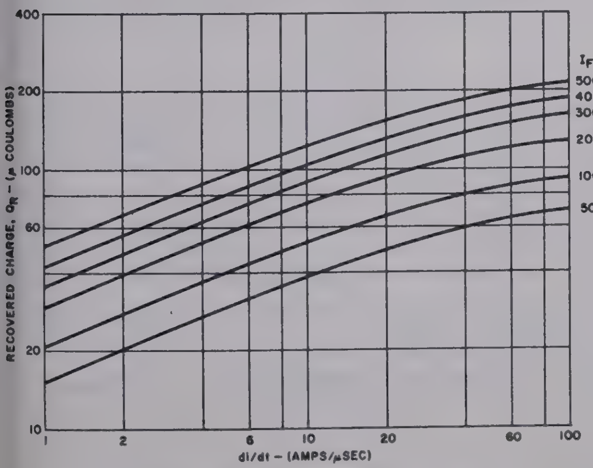
17. Maximum allowable peak gate power vs. gate pulse width



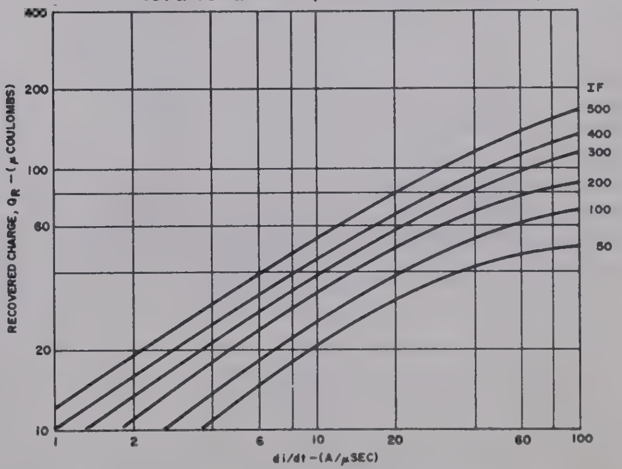
18. Maximum allowable surge current following rated load conditions (Sinusoidal Waveform)



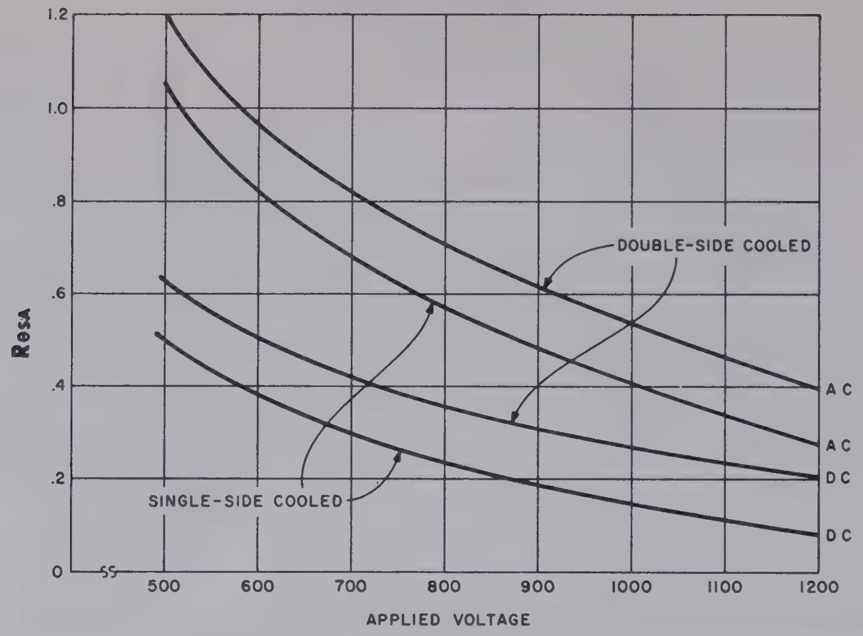
19. Sub-cycle surge and I^2t rating following rated load conditions (Sinusoidal Waveform)



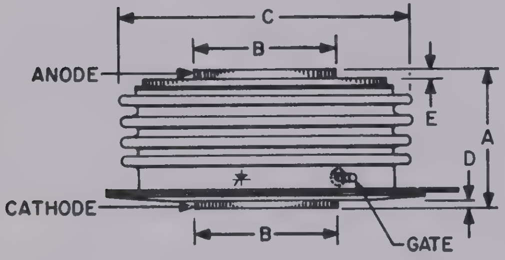
20. Typical Recovered Charge (125°C)



21. Typical Recovered Charge (25°C)



22. RθSA Selection for Non-Operating Thermal Stability @ 125° C, T_j



	DECIMAL (INCHES)		METRIC (MM)	
	MIN.	MAX.	MIN.	MAX.
A	1.025	1.065	26.04	27.05
B	1.043	1.057	26.49	26.85
C	—	2.100	—	53.44
D	.020	.105	.508	2.67
E	.030	.096	.762	2.44

23. Outline Drawing

FOR MOUNTING HARDWARE SEE SELECTOR GUIDE PAGE 171

Specification Sheets

140.12	1N3879 Series (6 amp) Fast Recovery Diode
140.22	1N3889 Series (12 amp) Fast Recovery Diode
140.23	A28 Series (12 amp) Very Fast Recovery Diode
140.47	1N3899 Series (20 amp) Fast Recovery Diode
140.48	1N3909 Series (30 amp) Fast Recovery Diode
145.55	A96 Series (250 amp) Fast Recovery Diode
160.35	C140 Series (35A) 50-400V High Speed SCR
160.39	C144 Series (35A) 500-800V High Speed SCR
170.35	C154-7 Series (110 amp) High Speed SCR
170.36	C158, 9 Series (110 amp) High Speed SCR
170.37	C385 Series (250 amp) High Speed SCR
170.38	C358 Series (225A) High Speed SCR
170.42	C395 Series (550A) up to 600V, High Speed SCR
170.44	C388, C387 Series (550A) High Speed SCR
170.45	C398, C397 Series (700A) High Speed SCR
170.53	C185 Series (235 amp) High Speed SCR
170.57	C354, 5 Series (115 amp) High Speed SCR
170.76	C506 Series (625 amp) High Speed SCR
170.80	C510 Series (625 amp) High Speed SCR

Application Notes

200.38	"Application of Fast Recovery Rectifiers"
200.41	"Simple Circuits For Triggering SCR's Into Fast-Rising Load Currents"
200.42	"Commutation Behavior of Diffused High Current Rectifier Diodes"
200.49	"A Low Cost Ultrasonic Frequency Inverter Using A Single SCR"

Technical Paper Reprints

660.13	"The Rating and Application of SCR's Designed for Switching at High Frequencies"
660.14	"Basic Magnetic Functions in Converters and Inverters Including New Soft Commutations"
660.15	"SCR Inverter Commutated By An Auxiliary Impulse"
660.16	"An SCR Inverter With Good Regulation and Sine Wave Output"

Seminar Notes

671.4	"The Widening World of The Fast Recovery Rectifier Diode"
671.15	"The Amplifying Gate SCR"

***For copies of any published information, please order by decimal publication number from: General Electric Company, Distribution Services, 1 River Road, Schenectady, N. Y. 12305.**

HIGH SPEED

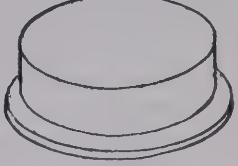
Silicon Controlled Rectifier

Up to 600 Volts, High Power, (550-700) Amps RMS

C392/C393
C394/C395

AMPLIFYING GATE

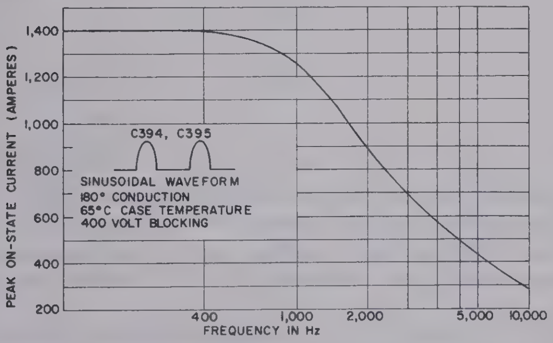
†I RMS(Max) for half sine wave current @ T_c = 65°C, 60 Hz is 550–700 amperes.

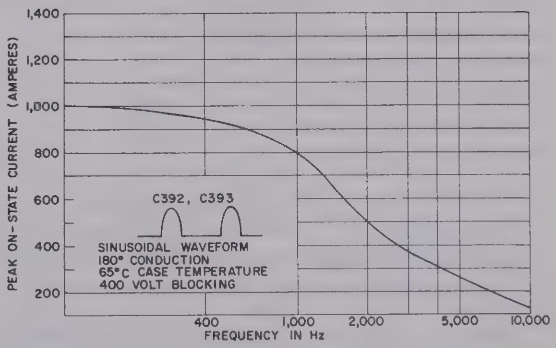


The General Electric Types C392, C393, C394, C395 silicon controlled rectifiers are new, pressure-mounted high current devices employing the Amplifying Gate. These devices are designed for power switching at frequencies up to 10kHz (sinusoidal).

For efficient operation in high speed applications, these devices feature a superior mix of capabilities:

- Forward and reverse blocking capabilities to 600 volts
- Low switching losses at high frequencies
- 14μsec. maximum turnoff time at severe operating conditions (C392)
- 10μsec. turnoff at less severe operating conditions (C392)
- di/dt rating of 800A/μsec.
- Soft firing gate
- 1" creepage-path, glazed-ceramic package





Equipment designers can use the C392, C393, C394, C395 SCR's in demanding applications, such as:

- **Choppers**
- **Inverters**
- **Regulated power supplies**
- **Cycloconverters**
- **DC to DC converters**
- **High frequency lighting**

FOR SINE WAVE OPERATION

Like the Type C140/141, C158/159, and C358 SCR's, the C392, C393, C394, C395 SCR's are rated for:

- **Peak current**

vs.

- **Pulse width**
- **Frequency**
- **Case temperature**

FOR RECTANGULAR WAVE OPERATION

GE now introduces a new, high-frequency rating for the C392, C393, C394, C395 SCR's, which are:

- **Peak current**

vs.

- **di/dt of leading edge**
- **Frequency**
- **Duty cycle**
- **Case temperature**

MAXIMUM ALLOWABLE RATINGS

Types	Repetitive Peak Off-State Voltage, V_{DRM}	Repetitive Peak Reverse Voltage, V_{RRM}①	Non-repetitive Peak Reverse Voltage, V_{RSM}①
	T_C = −40°C to +125°C②	T_C = −40°C to +125°C②	T_C = −40°C to +125°C②
C392, C393, C394, C395A	100 Volts	100 Volts	150 Volts
C392, C393, C394, C395B	200	200	300
C392, C393, C394, C395C	300	300	400
C392, C393, C394, C395D	400	400	500
C392, C393, C394, C395E	500	500	600
C392, C393, C394, C395M	600	600	720

①Half sine wave voltage pulse, 10 millisecond maximum duration.

②Ratings apply for zero or negative gate voltage. Maximum case to ambient thermal resistance for which maximum V_{DRM} and maximum V_{RRM} ratings apply equals 0.2°C/watt.

Peak Positive Anode Voltage . . . . None
Average On-State Current, $I_{T(AV)}$ . . . . (See Charts
Peak One Cycle Surge (non-rep) On-State Current, I_{TSM} . . . . C392, C393 – 5500 Ampere
C394, C395 – 8000 Ampere
I^2t (for fusing) for times ⩾ 1.5 milliseconds . . . . C392, C393 – 120,000 Ampere² second
C394, C395 – 50,000 Ampere² second
I^2t (for fusing) for times ⩾ 8.3 milliseconds . . . . C392, C393 – 250,000 Ampere² second
C394, C395 – 100,000 Ampere² second
Critical Rate-of-Rise of On-State Current, di/dt,
During Turn-On Interval . . . . 800 Amperes per microsecon
Peak Gate Power Dissipation, P_{GM} . . . (Pulse Width = 10μsec) . . . . 400 Watt
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . .2 Watt
Peak Negative Gate Voltage, V_{GM} . . . . 20 Volt
Storage Temperature, T_{STG} . . . . −40°C to +125°C
Operating Temperature, T_J . . . . −40°C to +125°C
Mounting Force . . . . .2000 lb. ±200 lb

†This SCR may be, non-repetitively, turned-on in the forward direction by exceeding the breakover voltage (V_{DRM}) with either a rapidly slowly rising waveform. At breakover, di/dt must be limited to 20 amps/μsec and peak current to 1000 amperes.

††Required trigger source—20 volts, 20 ohms; maximum switching voltage – 1200 volts; short-circuit gate supply current risetime – 0.5 μ (This short-circuit current may be measured with a TEKTRONICS current probe.): di/dt includes 5 Ω, .25 μF RC Snubber circuit used ac SCR.

di/dt rating is established in accordance with JEDEC Suggested Standard No. 7, Section 5.1.2.4. Immediately after each current pulse, off-s (blocking) voltage capability may be temporarily lost for durations less than the period of the applied pulse repetition rate. The pulse repetit rate for this test is 400 Hz: The duration of the JEDEC di/dt test condition is 5.0 seconds (minimum). For repetitive di/dt rating to 500A/μ see Curve 27.

CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}				mA	T_C = +25°C
C392, C393, C394, C395A		–	10	30		$V_{DRM} = V_{RRM}$ = 100 Volts peak
C392, C393, C394, C395B		–	10	30		200 Volts peak
C392, C393, C394, C395C		–	10	30		300 Volts peak
C392, C393, C394, C395D		–	10	30		400 Volts peak
C392, C393, C394, C395E		–	10	30		500 Volts peak
C392, C393, C394, C395M		–	10	30		600 Volts peak
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}				mA	T_C = 125°C
C392, C393, C394, C395A		–	40	90		$V_{DRM} = V_{RRM}$ = 100 Volts peak
C392, C393, C394, C395B		–	40	90		200 Volts peak
C392, C393, C394, C395C		–	40	90		300 Volts peak
C392, C393, C394, C395D		–	40	90		400 Volts peak
C392, C393, C394, C395E		–	40	90		500 Volts peak
C392, C393, C394, C395M		–	40	90		600 Volts peak

CHARACTERISTICS

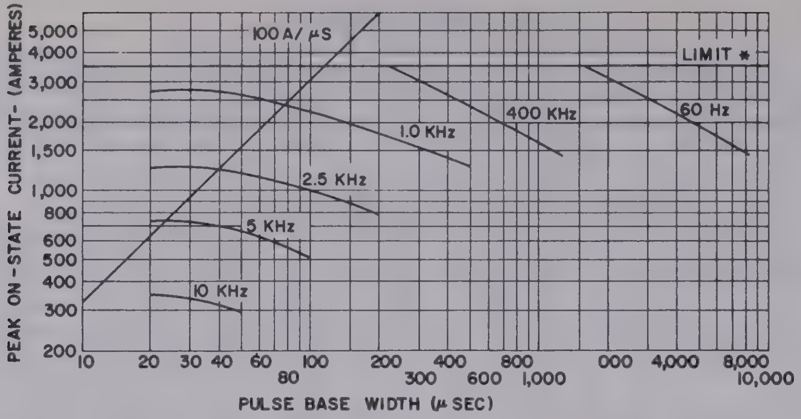
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
Effective Thermal Resistance	$R\theta_{JC}$	–	.05	.06	°C/watt	Junction to case (DC) Double Side Cooled
Critical Exponential Rate of Rise of Forward Blocking Voltage (Higher values may cause device switching)	dv/dt	200 ★	500	–	V/μsec	V_{DRM}, $T_C = +125°C$, Gate open.
Holding Current	I_H	–	40	1000	mAdc	$T_C = +25°C$, Anode supply = 24Vdc. Initial forward current = 10 amps.
DC Gate Trigger Current See Fig. 27	I_{GT}	– – –	70 100 25	200 400 150	mAdc mAdc mAdc	$T_C = +25°C$, $V_D = 10$ Vdc, $R_L = 1$ ohm. $T_C = -40°C$, $V_D = 10$ Vdc, $R_L = 1$ ohm. $T_C = +125°C$, $V_D = 10$ Vdc, $R_L = 1$ ohm.
DC Gate Trigger Voltage	V_{GT}	– – 0.15	3 1.50 –	5 3.0 –	Vdc Vdc Vdc	$T_C = -40°C$ to 0°C, $V_D = 10$ Vdc, $R_L = 1$ ohm. $T_C = 0°C$ to +125°C, $V_D = 10$ Vdc, $R_L = 1$ ohm. $T_C = +125°C$, V_{DRM}, $R_L = 60$ ohms.
Peak On-State Voltage	V_{TM} C392, C393 C394, C395	– – –	– 3.3 2.3	– 4.2 2.5	Volts	$T_C = +25°C$, $I_{TM} = 3000$ peak. Duty cycle ⩽ .01%. Pulse width = 3.0μs.
Turn-On Time (Delay Time + Rise Time)	t_{GT}	–	2	–	μsec	$T_C = +25°C$, $I_T = 50$ Adc, V_{DRM}. Gate Supply: 20 volt open circuit, 20 ohm, 0.1 μsec max. rise time.†††
Delay Time	t_d	–	0.5	2.0	μsec	$T_C = +25°C$, $I_T = 50$ Adc, V_{DRM}, Gate supply: 20 volt open circuit, 20 ohm, 0.1 μsec max. rise time. ††, †††
Conventional Circuit Commutated Turn-Off-Time (with Reverse Voltage)	t_q C392 C394 C393 C395	 – – – –	 8 12 12 15	 10 15 15 20	 μsec μsec μsec μsec	(1) $T_C = +125°C$, (2) $I_T = 500A$, (3) $V_R = 50$ volts min., (4) V_{DRM} (reapplied), (5) Rate of rise of reapplied forward blocking voltage = 20 V/μsec (linear). (6) Commutation di/dt = 25 Amps/μsec. (7) Repetition rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts, 100 ohms.
	C392 C394 C393 C395	– – – –	12 17 17 20	14 20 20 25	μsec μsec μsec μsec	(1) $T_C = +125°C$, (2) $I_T = 500A$, (3) $V_R = 50$ volts min., (4) V_{DRM} (reapplied), (5) Rate of rise of reapplied forward blocking voltage = 200 V/μsec (linear). (6) Commutation di/dt = 25 Amps/μsec. (7) Repetition rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts, 100 ohms.
Conventional Circuit Commutated Turn-Off-Time (with Feedback Diode)	t_q (diode) C392 C394 C393 C395	 – – – –	 18 25 25 30	 –† –† –† –†	 μsec μsec μsec μsec	(1) $T_C = +125°C$, (2) $I_T = 500A$, (3) $V_R = 1$ volt (Forward drop of GE A396 rectifier diode at $I_T = 150A$) (4) V_{DRM}, (5) Rate of rise of reapplied forward blocking voltage = 200 V/μsec (linear). (6) Commutation di/dt = 25 Amps/μsec. (7) Repetition rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts, 100 ohms.
Pulse Circuit Commutated Turn-Off-Time (with Reverse Voltage)	t_q (pulse) C392 C394 C393 C395	 – – – –	 12 17 17 20	 14 20 20 25	 μsec μsec μsec μsec	(1) $T_C = +125°C$, V_{DRM} (reapplied), (2) Rate of rise of reapplied forward blocking voltage = 200 V/μsec (linear), (3) Rep. rate - 400 Hz., (4) Gate supply = 20 volts, 20 ohms, .5 μsec max. rise time. (5) $I_T = 400A$ peak, $t_p = 3$ μsec (half sine wave), (6) $V_R = 50$ volts min.
Pulse Circuit Commutated Turn-Off-Time (with Feedback Diode)	t_q (pulse) (diode) C392 C394 C393 C395	 – – – –	 18 25 25 30	 –† –† –† –†	 μsec μsec μsec μsec	(1) $T_C = +125°C$, V_{DRM} (reapplied), (2) Rate of rise of reapplied forward blocking voltage = 200 V/μsec (linear), (3) Rep. rate = 400 Hz., (4) Gate supply = 20 volts, 20 ohms, .5 μsec max. rise time. (5) $I_T = 400A$ peak, $t_p = 3$ μsec (half sine wave), (6) $V_R = 1$ volt (Forward drop of GE A396 rectifier diode at $I_T = 150A$).

†Consult Factory for specified maximum Turn-Off Time.

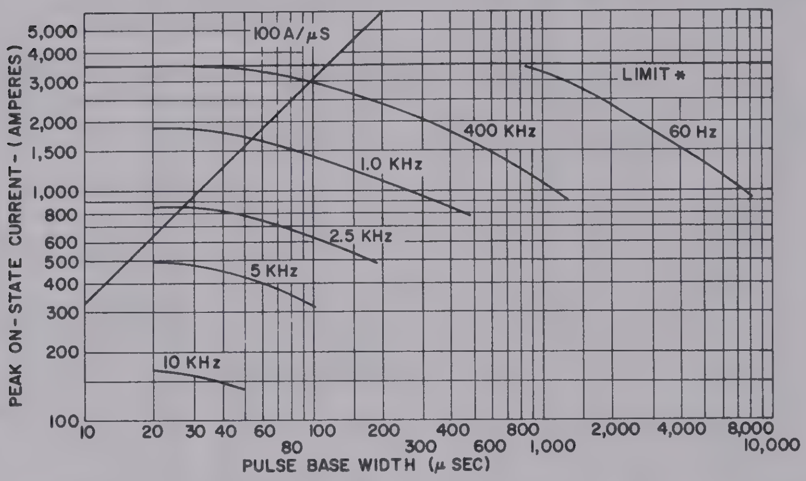
††Delay Time may increase significantly as the gate drive approaches the I_{GT} of the Device Under Test (D.U.T.).

†††Current risetime as measured with a current probe, or voltage rise time across a non-inductive resistor.

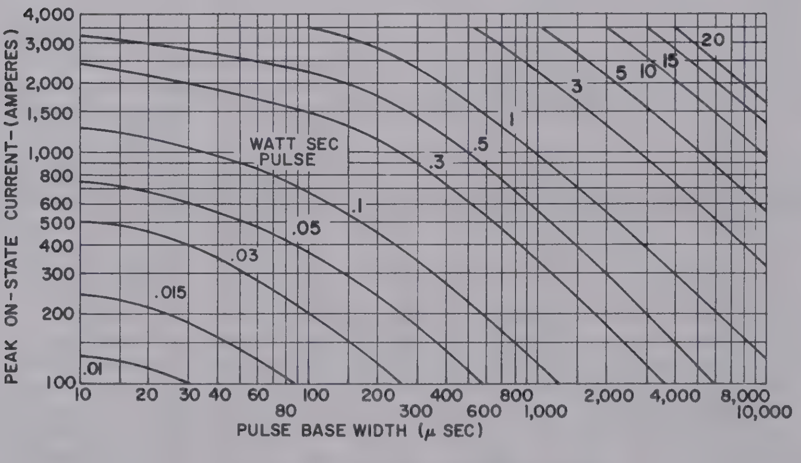
★ Consult Factory for higher dv/dt selections of 300, 400, or 500 volts/μsec.



3. Maximum allowable peak on-state current vs. pulse width (T_C = 65°C)



4. Maximum allowable peak on-state current vs. pulse width (T_C = 90°C)



5. Energy per pulse for sinusoidal pulses

Charts 3 and 4 give the maximum value of peak on-state current at which the specified turn-off-time and dv/dt still apply.

NOTES: Charts 3, 4, 5

1. Switching voltage = 400 volts
2. Minimum ckt. turn-off-time = 15 μsec
3. Maximum ckt. dv/dt = 200 volts/μsec
4. Reverse voltage applied = 50 V ≤ V_R ≤ 400 V
5. Required gate drive:
   20 volts, 65 ohms, 1 μsec risetime for less than 100 amps/μsec
   20 volts, 20 ohms, .5 μsec risetime for greater than 100 amps/μse
6. RC Snubber ckt. = .2 μF, 5Ω
7. Double Side Cooled

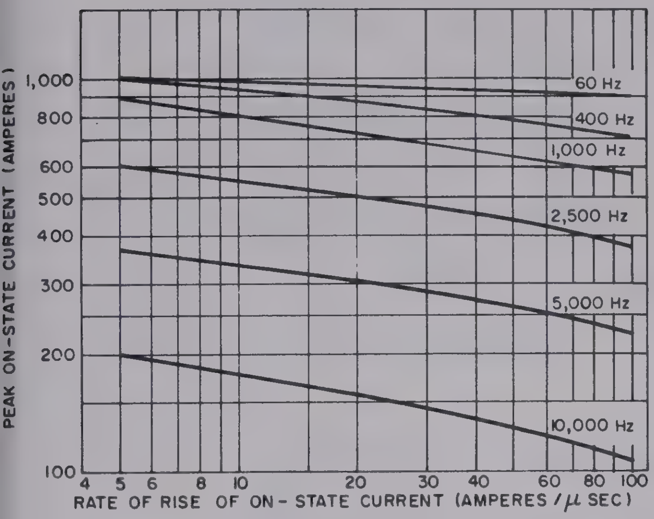
If the circuit dl/dt remains below 100 amps/μs, and normally constructed snubbers using the components specified are employed, ther the "soft" gate drive shown under "conditions" for each current rating curve is sufficient.

If the circuit dl/dt exceeds 100 amps/μs shown by the boundary lines, (on the sine wave curves) then the stiff gate source (20 V – 20Ω) t_r = .5 μs, specified in Chart #27 must be used. In addition the total device dl/dt must be checked to insure that it is not above the 50 amps/μs which is the long term repetitive limit noted in Chart #27 for stiff gate source.

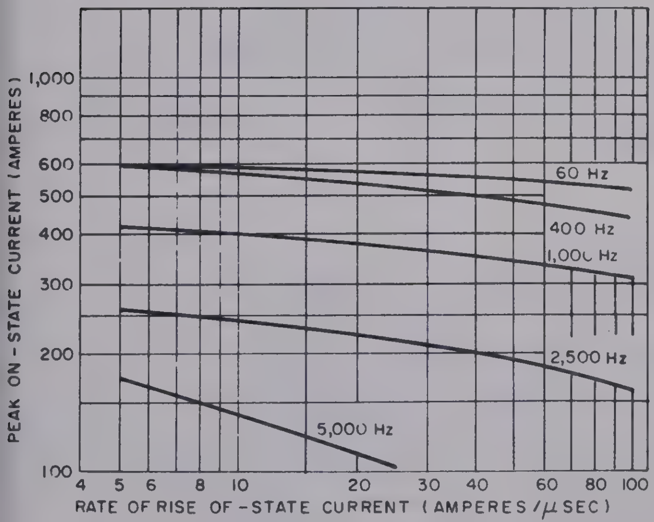
C394,C395

RECTANGULAR WAVE DATA

50% DUTY CYCLE

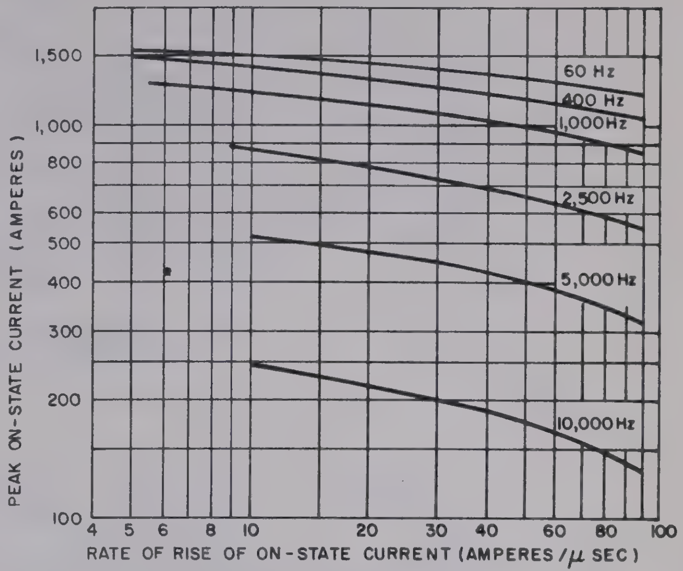


6. Maximum allowable peak on-state current vs. di/dt (T_C = 65°C)

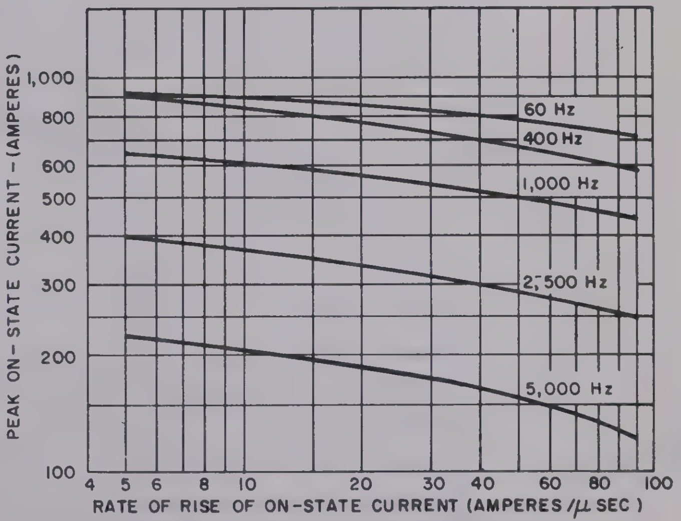


7. Maximum allowable peak on-state current vs. di/dt (T_C = 90°C)

25% DUTY CYCLE



8. Maximum allowable peak on-state current vs. di/dt (T_C = 65°C)

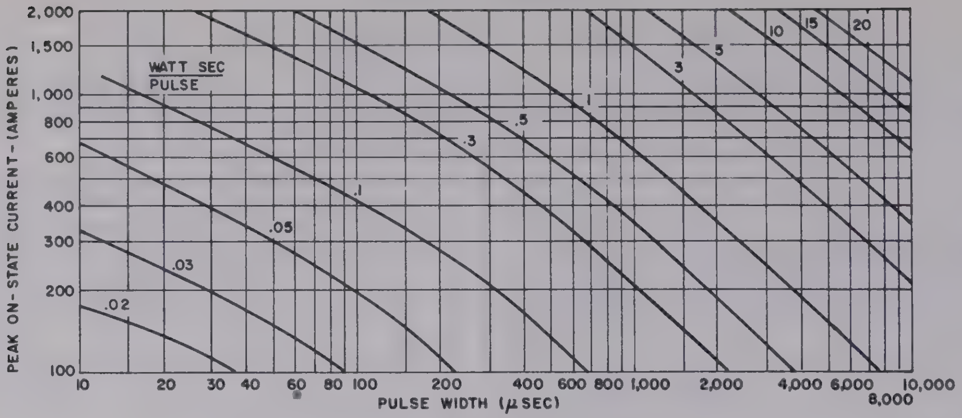


9. Maximum allowable peak on-state current vs. di/dt (T_C = 90°C)

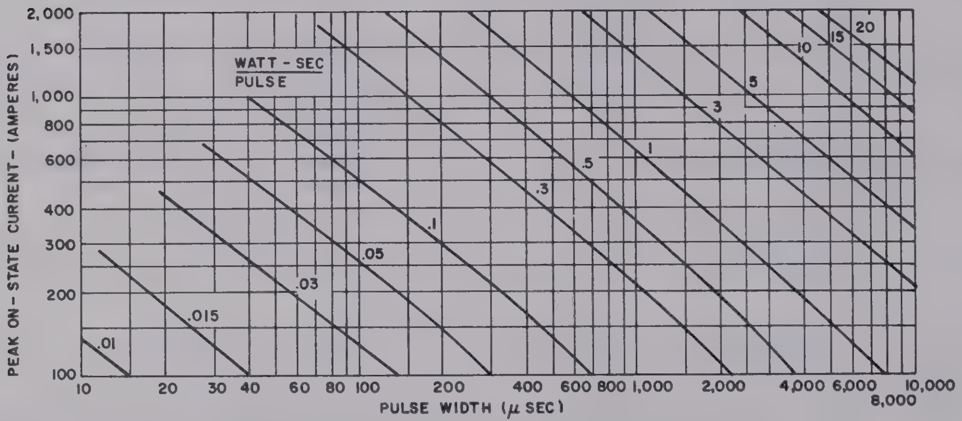
NOTES:
1. RC Snubber ckt. = .25μF, 5Ω 2. Off-state voltage = 400 volts 3. Reverse voltage = 50 V ⩽ V_R ⩽ 400 V 4. Turn-off-time = 15 μsec
5. dv/dt (maximum) = 200 volts/μsec 6. Required gate drive: 20 volts, 65 ohms, 1 μsec risetime 7. Double Side Cooled

C394,C395

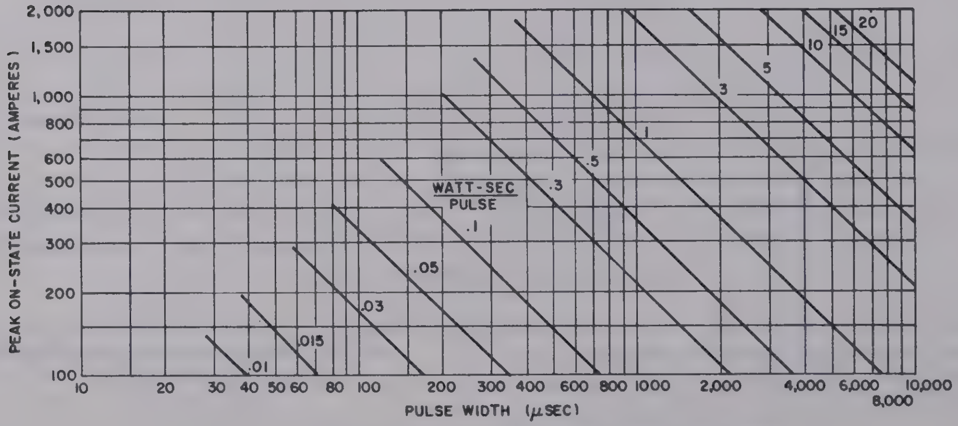
WATT-SECOND PER PULSE



10. Energy per pulse vs. peak current and pulse width (di/dt = 100A/μsec)



11. Energy per pulse vs. peak current and pulse width (di/dt = 25A/μsec)

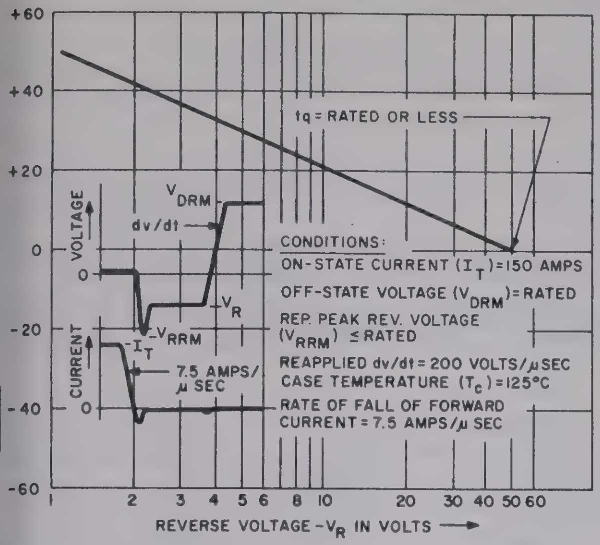


12. Energy per pulse vs. peak current and pulse width (di/dt = 5A/μsec)

NOTES:

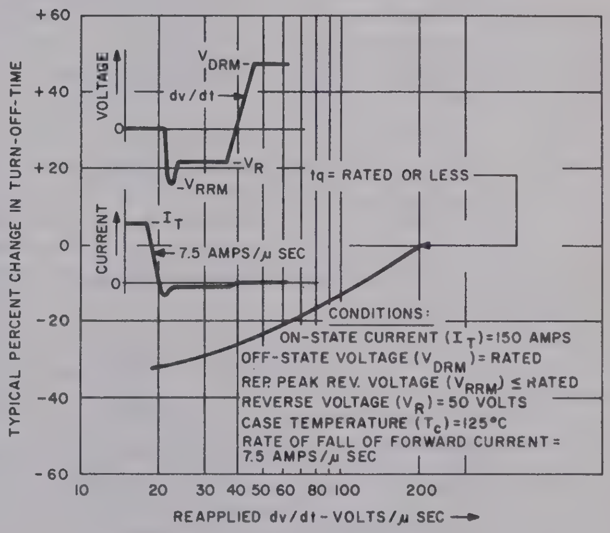
1. RC Snubber ckt. = .25μF, 5Ω
2. Off-state voltage = 400 volts
3. Reverse voltage = 50 V ⩽ V_R ⩽ 400 V
4. Turn-off-time = 15
5. dv/dt (maximum) = 200 volts/μsec
6. Required gate drive: 20 volts, 65 ohms, 1 μsec risetime
7. Double Side Cooled

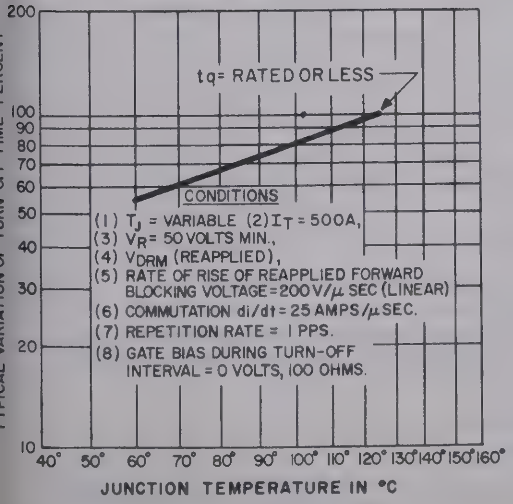
TURN-OFF-TIME DATA



This curve shows a typical variation of SCR turn-off-time with applied reverse voltage (V_R) during the turn-off interval. Testing at V_R = "1 volt" is done with a GE A396 fast recovery diode in inverse parallel with the C394, C395. For SCR's with specified maximum turn-off-time with an inverse parallel diode—consult the factory.

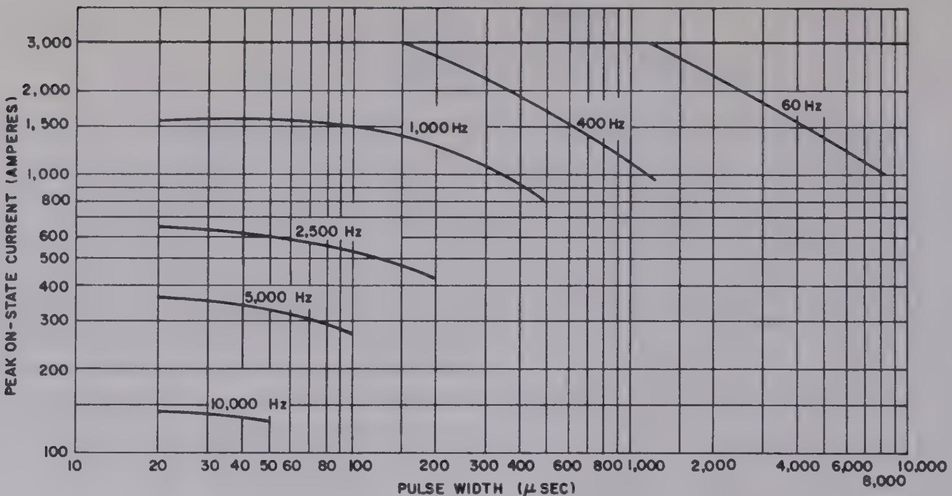
This curve shows a typical variation of SCR turn-off-time with reapplied dv/dt. Specified turn-off-time (20 μsec) is with reapplied dv/dt of 200 volts/μsec. Note turn-off-time enhancement at lower dv/dt. When requesting selected turn-off-time (less than 20 μsec) also specify maximum reapplied dv/dt. Similar enhancement occurs with the C392 spec of 14 μsec at 200 volts/μsec with lower reapplied dv/dt.



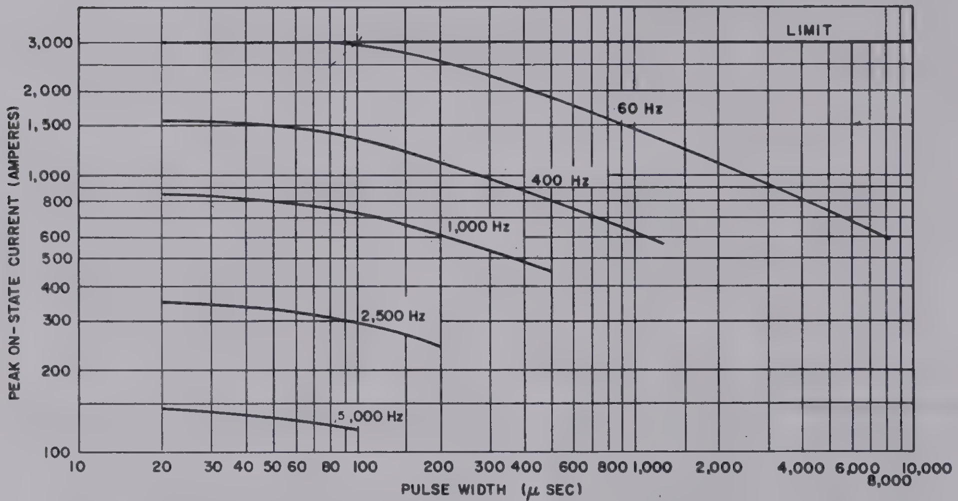


This curve shows typical variation of SCR turn-off-time with junction temperature (T_J). Specified turnoff is based upon 125°C junction temperature.

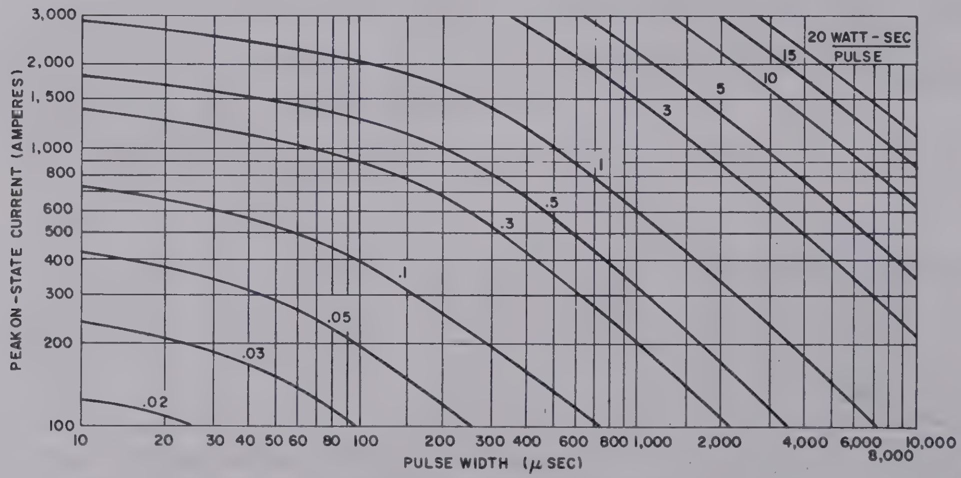
C392,C393 SINE WAVE DATA



13. Maximum allowable peak on-state current vs. pulse width ($T_C = 65°C$)



14. Maximum allowable peak on-state current vs. pulse width ($T_C = 90°C$)



15. Energy per pulse for sinusoidal pulses

Charts 3 and 4 give the maximum value of peak on-state current at which the specified turn-off-time and dv/dt still apply.

NOTES: Charts 3, 4, 5

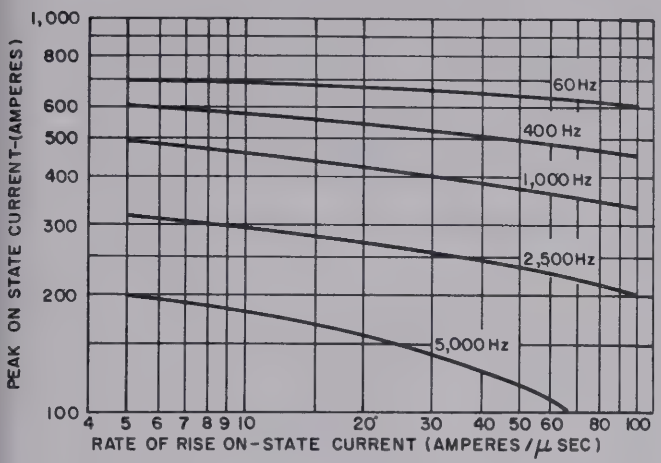
1. Switching voltage = 400 volts
2. Minimum ckt. turn-off-time = 15 μsec
3. Maximum ckt. dv/dt = 200 volts/μsec
4. Reverse voltage applied = 50 V ⩽ V_R ⩽ 400 V
5. Required gate drive:
   20 volts, 65 ohms, 1 μsec risetime for less than 100 amps/μsec
   20 volts, 20 ohms, .5 μsec risetime for greater than 100 amps/μsec
6. RC Snubber ckt. = .2 μF, 5Ω
7. Double Side Cooled

If the circuit dI/dt remains below 100 amps/μs, and normally constructed snubbers using the components specified are employed, then the "soft" gate drive shown under "conditions" for each current rating curve is sufficient.

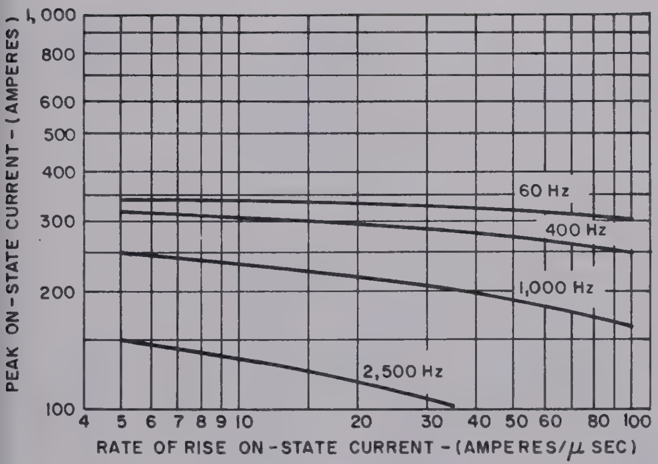
If the circuit dI/dt exceeds 100 amps/μs shown by the boundary lines, (on the sine wave curves) then the stiff gate source (20 V – 20Ω), t_r = .5 μs, specified in Chart #27 must be used. In addition the total device dI/dt must be checked to insure that it is not above the 500 amps/μs which is the long term repetitive limit noted in Chart #27 for stiff gate source.

C392,C393
RECTANGULAR WAVE DATA

50% DUTY CYCLE

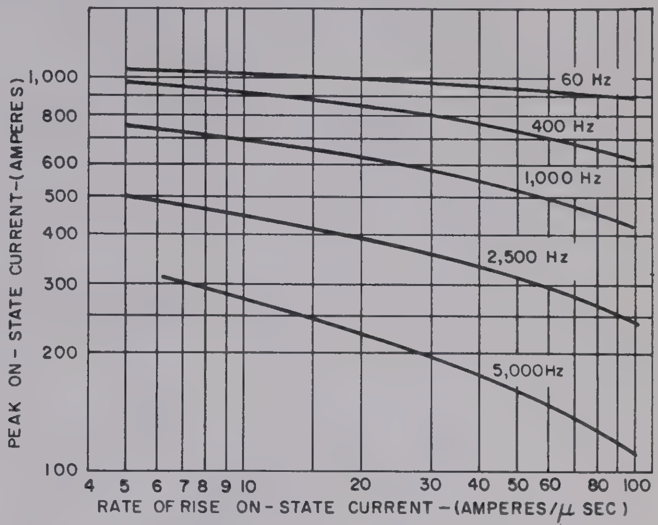


16. Maximum allowable peak on-state current vs. di/dt (T_C = 65°C)

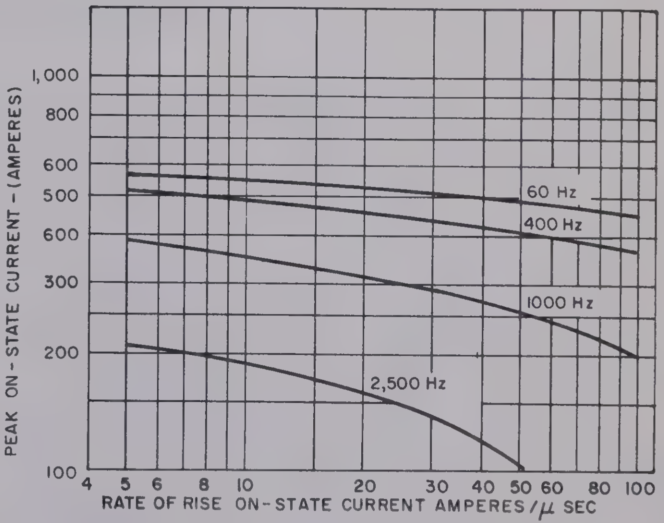


17. Maximum allowable peak on-state current vs. di/dt (T_C = 90°C)

25% DUTY CYCLE



18. Maximum allowable peak on-state current vs. di/dt (T_C = 65°C)

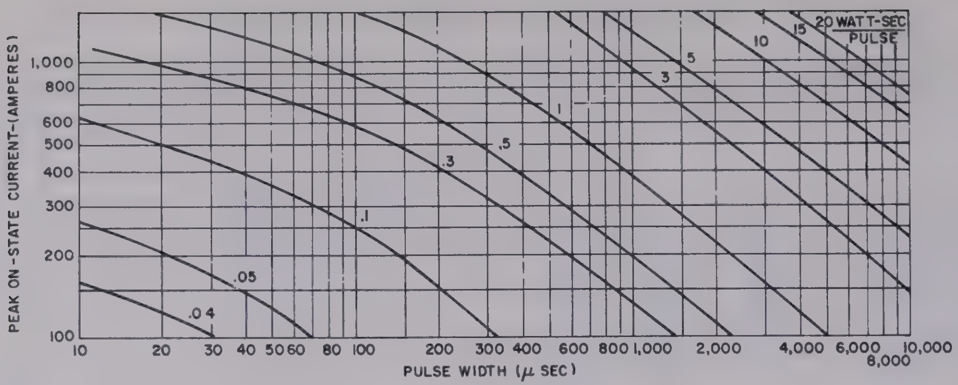


19. Maximum allowable peak on-state current vs. di/dt (T_C = 90°C)

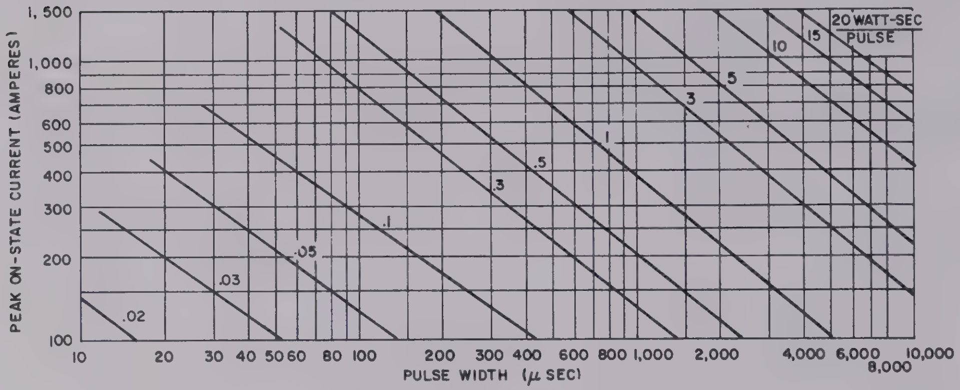
NOTES:
1. RC Snubber ckt. = .25μF, 5Ω 2. Off-state voltage = 400 volts 3. Reverse voltage = 50 V $\leq V_R \leq$ 400 V 4. Turn-off-time = 15 μsec
5. dv/dt (maximum) = 200 volts/μsec 6. Required gate drive: 20 volts, 65 ohms, 1 μsec risetime 7. Double Side Cooled

C392,C393

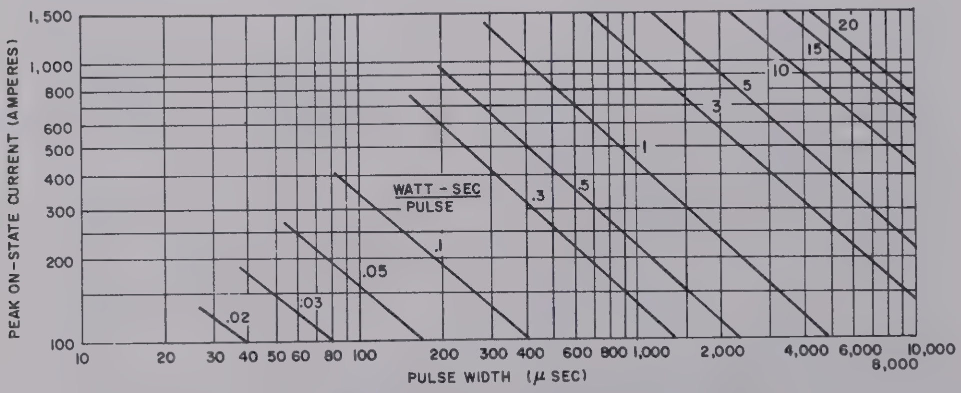
WATT-SECOND PER PULSE



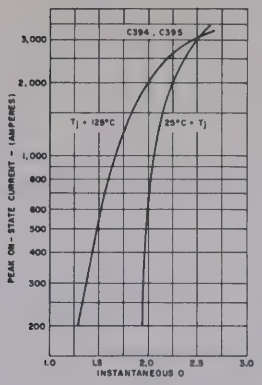
20. Energy per pulse vs. peak current and pulse width (di/dt = 100A/μsec)



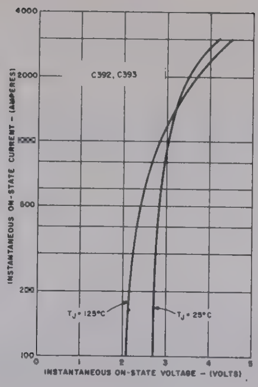
21. Energy per pulse vs. peak current and pulse width (di/dt = 25A/μsec)



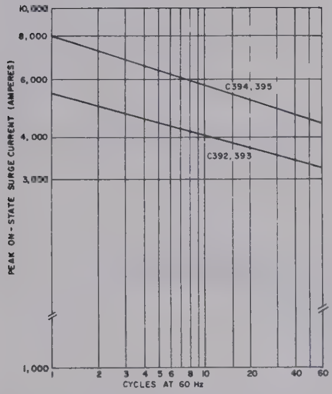
22. Energy per pulse vs. peak current and pulse width (di/dt = 5A/μsec)



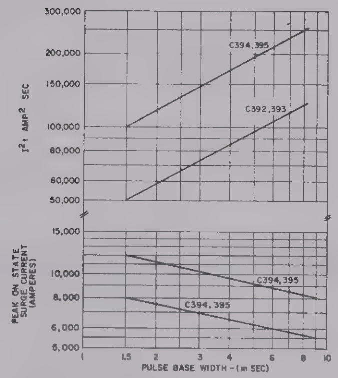
23. Forward conduction characteristic, on-state



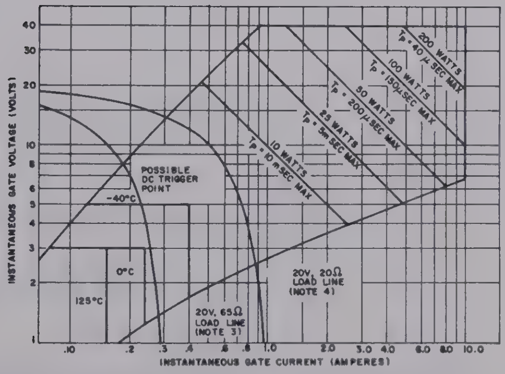
24. Forward conduction characteristic, on-state



25. Maximum allowable surge current following rated load conditions



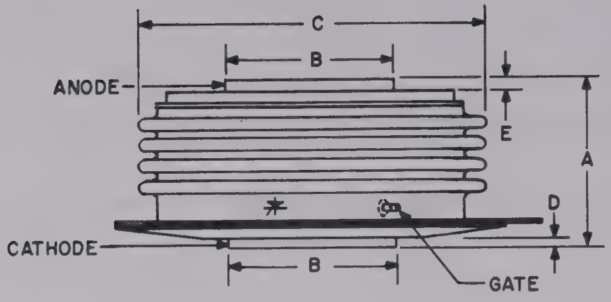
26. Sub-cycle surge and I^2t rating following rated load conditions



27. Maximum allowable peak gate power vs. gate pulse width

NOTES:

1. Maximum allowable average gate dissipation = 2 watts
2. The locus of possible dc trigger points lie outside the boundaries shown at various case temperatures
3. T_p = Rectangular gate current pulse width (5 µs min duration; 1.0 µs max rise time for 20 V, 65Ω source)
4. 20V – 20Ω is the minimum gate source load line when rate of circuit current rise > 100 amp/µs or anode rate of current rise > 200 amps/µs (T_p = 5 µs min, 0.5 µs max rise time) Maximum long term repetitive anode dl/dt = 500 amps/µs with 20 V – 20Ω gate source.



	DECIMAL (INCHES)		METRIC (MM)	
	MIN.	MAX.	MIN.	MAX.
A	1.025	1.065	26.04	27.05
B	1.043	1.057	26.49	26.85
C	—	2.100	—	53.44
D	.020	.105	.508	2.67
E	.030	.096	.762	2.44

OUTLINE DRAWING

OTHER INVERTER DEVICE AND APPLICATION INFORMATION AVAILABLE FROM GENERAL ELECTRIC*

Publication Number	Title
	Specification Sheets
140.12	1N3879 Series (6 amp) Fast Recovery Diode
140.22	1N3889 Series (12 amp) Fast Recovery Diode
140.23	A28 Series (12 amp) Very Fast Recovery Diode
140.47	1N3899 Series (20 amp) Fast Recovery Diode
140.48	1N3909 Series (30 amp) Fast Recovery Diode
145.55	A96 Series (250 amp) Fast Recovery Diode
160.35	C140 Series (35A) 50-400V High Speed SCR
160.39	C144 Series (35A) 500-800V High Speed SCR
170.35	C154-7 Series (110 amp) High Speed SCR
170.36	C158, 9 Series (110 amp) High Speed SCR
170.37	C385 Series (250 amp) High Speed SCR
170.38	C358 Series (225A) High Speed SCR
170.42	C395 Series (550A) up to 600V, High Speed SCR
170.44	C388, C387 Series (550A) High Speed SCR
170.45	C398, C397 Series (700A) High Speed SCR
170.53	C185 Series (235 amp) High Speed SCR
170.57	C354, 5 Series (115 amp) High Speed SCR
170.76	C506 Series (625 amp) High Speed SCR
170.80	C510 Series (625 amp) High Speed SCR

Publication Number	Title
	Application Notes
200.38	"Application of Fast Recovery Rectifiers"
200.41	"Simple Circuits For Triggering SCR's Into Fast-Rising Load Currents"
200.42	"Commutation Behavior of Diffused High Current Rectifier Diodes"
200.49	"A Low Cost Ultrasonic Frequency Inverter Using A Single SCR"
	Technical Paper Reprints
660.13	"The Rating and Application of SCR's Designed for Switching at High Frequencies"
660.14	"Basic Magnetic Functions in Converters and Inverters Including New Soft Commutations"
660.15	"SCR Inverter Commutated By An Auxiliary Impulse"
660.16	"An SCR Inverter With Good Regulation and Sine Wave Output"
	Seminar Notes
671.4	"The Widening World of The Fast Recovery Rectifier Diode"
671.15	"The Amplifying Gate SCR"

*For copies of any published information, please order by decimal publication number from: General Electric Company, Distribution Services, 1 River Road, Schenectady, N. Y. 12305.

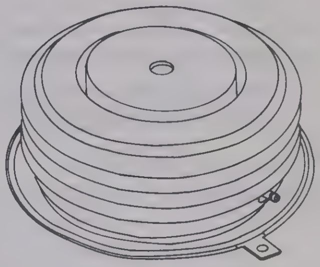
SCR

C397/C398

Up to 1200 Volts, High Power, 700 Amps RMS†

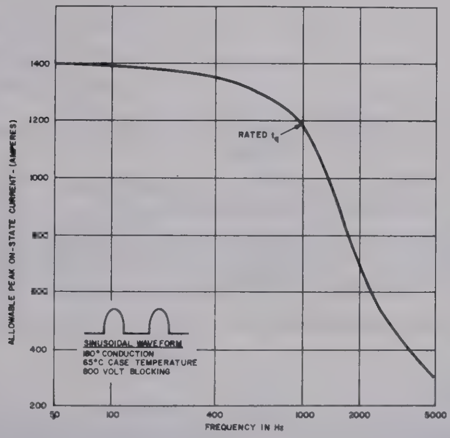
†I RMS(Max) for half sine wave current @ Tc = 65°C, 60 Hz is 700 amperes.
I RMS (Max) for rectangular wave current @ Tc = 65°C, 60 Hz and 50% Duty Cycle at low di/dt (5A/μsec) is 600 amperes.

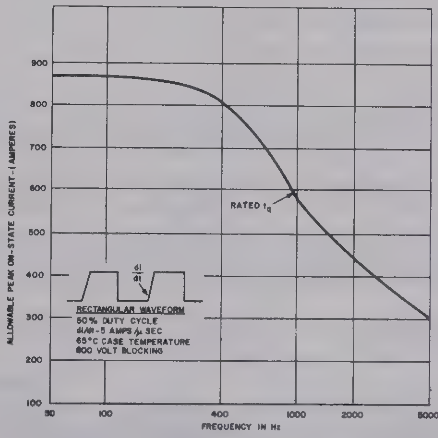
The General Electric Types C397/C398 silicon controlled rectifiers are new, pressure-mounted igh current devices employing the Amplifying Gate. The C397/C398 are designed for power witching at frequencies up to 3kHz (sinusoidal).



or efficient operation in high speed applications, the C397/C398 feature a superior mix of apabilities:

- Forward and reverse blocking capabilities to 1200 volts
- Low switching losses at high frequencies
- 40μsec. maximum turnoff time at severe operating conditions (C398)
- 30μsec. turnoff at less severe operating conditions (C398)
- di/dt rating of 800A/μsec.
- Soft firing gate
- 1" creepage-path, glazed-ceramic package





quipment designers can use the C397/C398 SCR's in demanding applications, such as:

Choppers
Inverters
Regulated power supplies

- **Sonar transmitters**
- **Induction heaters**
- **Radio transmitters**

- **Cycloconverters**
- **DC to DC converters**
- **High frequency lighting**

FOR SINE WAVE OPERATION

Like the Type C140/141, C158/159, and C358 SCR's, the C397/C398 SCR's are rated for:

- **Peak current**

  vs.

- **Pulse width**
- **Frequency**
- **Case temperature**

FOR RECTANGULAR WAVE OPERATION

GE now introduces a new, high-frequency rating for the C397/C398 SCR's, which are:

- **Peak current**

  vs.

- **di/dt of leading edge**
- **Frequency**
- **Duty cycle**
- **Case temperature**

MAXIMUM ALLOWABLE RATINGS

Types	Repetitive Peak Off-State Voltage, V_{DRM}	Repetitive Peak Reverse Voltage, V_{RRM}(1)	Non-repetitive Peak Reverse Voltage, V_{RSM}(1)
	$T_C = -40°C$ to $+125°C$(2)	$T_C = -40°C$ to $+125°C$(2)	$T_C = -40°C$ to $+125°C$(2)
C397/C398E	500 Volts	500 Volts	600 Volts
C397/C398M	600	600	720
C397/C398S	700	700	840
C397/C398N	800	800	960
C397/C398T	900	900	1080
C397/C398P	1000	1000	1200
C397/C398PA	1100	1100	1300
C397/C398PB	1200	1200	1400

(1) Half sine wave voltage pulse, 10 millisecond maximum duration.

(2) Ratings apply for zero or negative gate voltage. Maximum case to ambient thermal resistance for which maximum V_{DRM} and maximum V_{RRM} ratings apply equals 0.2°C/watt.

Peak Positive Anode Voltage . . . . None†

Average On-State Current, $I_{T(AV)}$ . . . . (See Charts)

Peak One Cycle Surge (non-rep) On-State Current, I_{TSM} . . . . 7500 Amperes

I^2t (for fusing) for times ≧ 1.5 milliseconds . . . . 95,000 Ampere^{2}seconds

I^2t (for fusing) for times ≧ 8.3 milliseconds . . . . 230,000 Ampere^{2}seconds

Critical Rate-of-Rise of On-State Current, di/dt,
During Turn-On Interval . . . . 800 Amperes per microsecond††

Peak Gate Power Dissipation, P_{GM} . . . (Pulse Width = 10μsec) . . . . 400 Watts

Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 2 Watts

Peak Negative Gate Voltage, V_{GM} . . . . 20 Volts

Storage Temperature, T_{STG} . . . . –40°C to +125°C

Operating Temperature, T_J . . . . –40°C to +125°C

Mounting Force . . . . 2000 lb. ±200 lb.

†This SCR may be, non-repetitively, turned-on in the forward direction by exceeding the breakover voltage (V_{DRM}) with either a rapidly or slowly rising waveform. At breakover, di/dt must be limited to 20 amps/μsec and peak current to 1000 amperes.

††Required trigger source—20 volts, 65 ohms; maximum switching voltage – 1200 volts; short-circuit gate supply current risetime – 1.0 μsec. (This short-circuit current may be measured with a TEKTRONICS current probe.); RC Snubber circuit used across SCR.

di/dt rating is established in accordance with JEDEC Suggested Standard No. 7, Section 5.1.2.4. Immediately after each current pulse, off-state (blocking) voltage capability may be temporarily lost for durations less than the period of the applied pulse repetition rate. The pulse repetition rate for this test is 400 Hz: The duration of the JEDEC di/dt test condition is 5.0 seconds (minimum).

di/dt up to 100 amps/μsec, at specified gate drive and switching voltage is part of the rectangular current wave ratings (see rating curves of Figures 9 through 15). This is a repetitive, long-term rating confirmed by life test.

CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}				mA	T_C = +25°C
C397/C398E		–	5	20		$V_{DRM} = V_{RRM}$ = 500 Volts peak
C397/C398M		–	5	20		600 Volts peak
C397/C398S		–	5	20		700 Volts peak
C397/C398N		–	5	20		800 Volts peak
C397/C398T		–	5	20		900 Volts peak
C397/C398P		–	5	20		1000 Volts peak
C397/C398PA		–	5	20		1100 Volts peak
C397/C398PB		–	5	20		1200 Volts peak
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}				mA	T_C = 125°C
C397/C398E		–	20	45		$V_{DRM} = V_{RRM}$ = 500 Volts peak
C397/C398M		–	20	45		600 Volts peak
C397/C398S		–	20	45		700 Volts peak
C397/C398N		–	20	45		800 Volts peak
C397/C398T		–	20	45		900 Volts peak
C397/C398P		–	20	45		1000 Volts peak
C397/C398PA		–	20	45		1100 Volts peak
C397/C398PB		–	20	45		1200 Volts peak

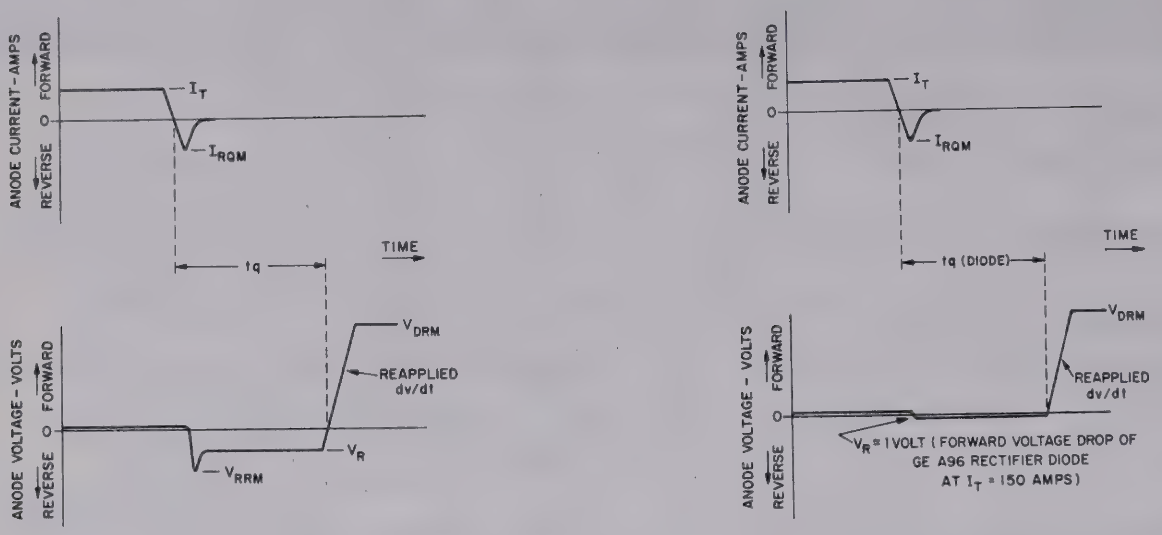
CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
Effective Thermal Resistance	$R\theta_{JC}$	–	.05	.06	°C/watt	Junction to case (DC) Double Side Cooled
Critical Exponential Rate of Rise of Forward Blocking Voltage (Higher values may cause device switching)	dv/dt	200 ★	500	–	V/μsec	V_{DRM}, T_C = +125°C, Gate open.
Holding Current	I_H	–	20	500	mAdc	T_C = +25°C, Anode supply = 24Vdc. Initial forward current = 2 amps.
Pulse Gate Trigger Current and Voltage	$I_{GT(pulse)}$	–		200	mAdc	T_C = +25°C, t_p = 10 μsec.
	$V_{GT(pulse)}$	–	8	10	Volts	0.25 μsec rise time.
DC Gate Trigger Current	I_{GT}	–	50	150	mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 3 ohms.
		–	75	300	mAdc	T_C = –40°C, V_D = 6 Vdc, R_L = 3 ohms.
		–	15	125	mAdc	T_C = +125°C, V_D = 6 Vdc, R_L = 3 ohms.
DC Gate Trigger Voltage	V_{GT}	–	3	5	Vdc	T_C = –40°C to 0°C, V_D = 6 Vdc, R_L = 3 ohms.
		–	1.25	3.0	Vdc	T_C = 0°C to +125°C, V_D = 6 Vdc, R_L = 3 ohms.
		0.15	–	–	Vdc	T_C = 125°C, V_{DRM}, R_L = 1000 ohms.
Peak On-State Voltage	V_{TM}	–	2.7	2.95	Volts	T_C = +25°C, I_{TM} = 3000 peak. Duty cycle ≦ .01%.
Turn-On Time (Delay Time + Rise Time)	t_{GT}	–	2	–	μsec	T_C = +25°C, I_T = 50 Adc, V_{DRM}. Gate supply: 10 volt open circuit, 20 ohm, 1.0 μsec max. rise time.†††
Delay Time	td	–	0.5	2.0	μsec	T_C = +25°C, I_T = 50 Adc, V_{DRM}, Gate supply: 10 volt open circuit, 20 ohm, 0.1 μsec max. rise time. ††, †††
Conventional Circuit Commutated Turn-Off-Time (with Reverse Voltage)	tq					(1) T_C = +125°C, (2) I_T = 500A, (3) V_R = 50 volts min., (4) V_{DRM} (reapplied), (5) Rate of rise of reapplied forward blocking voltage = 20 V/μsec (linear). (6) Commutation di/dt = 25 Amps/μsec. (7) Repetition rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts, 100 ohms.
	C398	–	20	30	μsec	
	C397	–	35	45	μsec	
	C398	–	30	40	μsec	(1) T_C = +125°C, (2) I_T = 500A, (3) V_R = 50 volts min., (4) V_{DRM} (reapplied), (5) Rate of rise of reapplied forward blocking voltage = 200 V/μsec (linear). (6) Commutation di/dt = 25 Amps/μsec. (7) Repetition rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts, 100 ohms.
	C397	–	45	60	μsec	
Conventional Circuit Commutated Turn-off-Time (with Feedback Diode)	tq(diode)					(1) T_C = +125°C, (2) I_T = 500A, (3) V_R = 1 volt (Forward drop of GE A396 rectifier diode at I_T = 150A) (4) V_{DRM}, (5) Rate of rise of reapplied forward blocking voltage = 200 V/μsec (linear). (6) Commutation di/dt = 25 Amps/μsec. (7) Repetition rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts, 100 ohms.
	C398	–	40	–†	μsec	
	C397	–	60	–†	μsec	
Pulse Circuit Commutated Turn-Off-Time (with Reverse Voltage)	tq(pulse)					(1) T_C = +125°C, V_{DRM} (reapplied), (2) Rate of rise of reapplied forward blocking voltage = 200 V/μsec (linear), (3) Rep. rate = 400 Hz., (4) Gate supply = 20 volts, 80 ohms, 1.0 μsec max. rise time. (5) I_T = 500A peak, t_p = 3 μsec (half sine wave), (6) V_R = 50 volts min.
	C398	–	25	40	μsec	
	C397	–	40	60	μsec	
Pulse Circuit Commutated Turn-Off-Time (with Feedback Diode)	tq(pulse) (diode)					(1) T_C = +125°C, V_{DRM} (reapplied), (2) Rate of rise of reapplied forward blocking voltage = 200 V/μsec (linear), (3) Rep. rate = 400 Hz., (4) Gate supply = 20 volts, 80 ohms, 1.0 μsec max. rise time. (5) I_T = 500A peak, t_p = 3 μsec (half sine wave), (6) V_R = 1 volt (Forward drop of GE A396 rectifier diode at I_T = 150A).
	C398	–	40	–†	μsec	
	C397	–	60	–†	μsec	

†Consult Factory for specified maximum Turn-Off Time.
††Delay Time may increase significantly as the gate drive approaches the I_{GT} of the Device Under Test (D.U.T.).
†††Current risetime as measured with a current probe, or voltage rise time across a non-inductive resistor.
★ Consult Factory for higher dv/dt selections of 300, 400, or 500 volts/msec.

WAVEFORM DEFINITION OF TURN-OFF-TIME

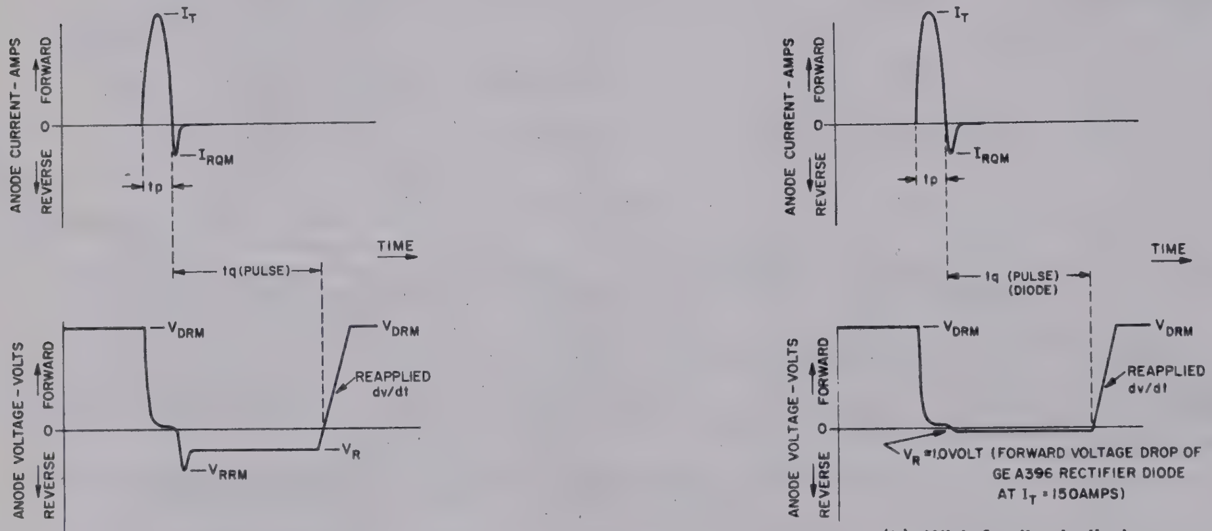
(not to scale)



(a) With reverse voltage

(b) With feedback diode

Conventional circuit commutated turn-off-time

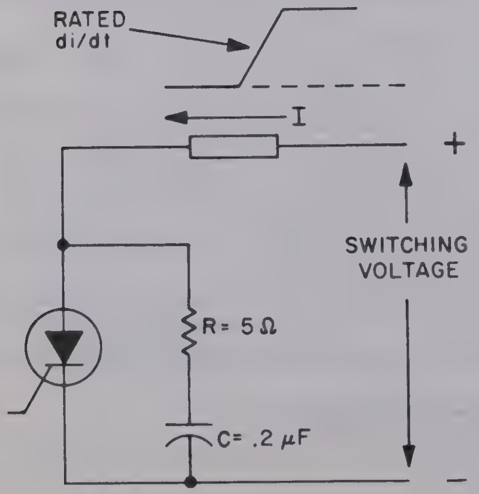


(a) With reverse voltage

(b) With feedback diode

Pulse circuit commutated turn-off-time

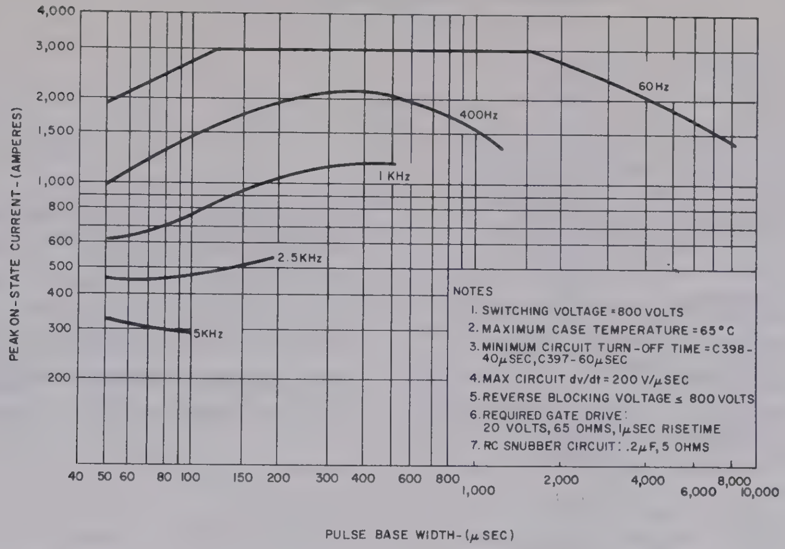
RATED di/dt AND THE RC SNUBBER CIRCUIT



RC Snubber circuit

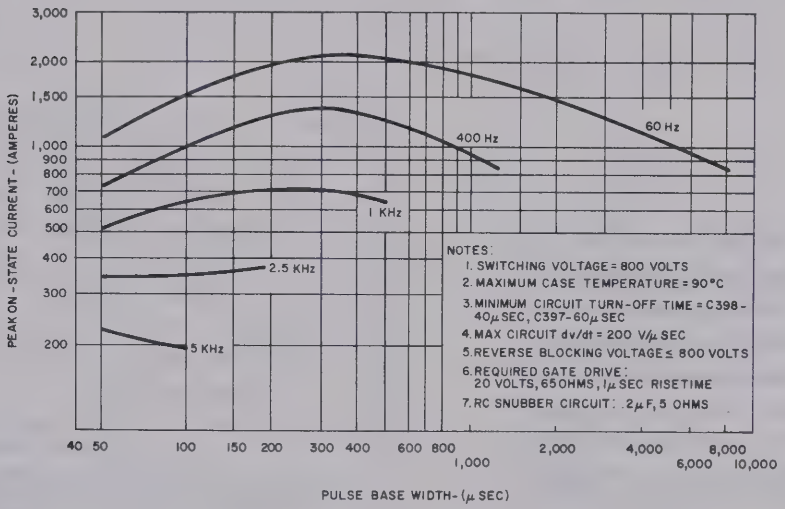
The rated di/dt for the C397/C398 SCR's are in addition to the discharge of the RC Snubber circuit shown connected in parallel with the SCR's. For all high-frequency ratings, the SCR shunted by the snubber has been considered as the device under test.

SINE WAVE DATA



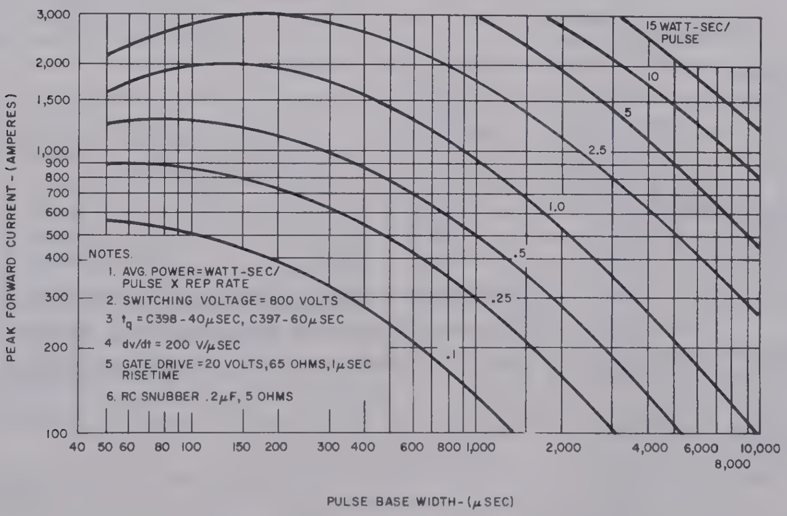
NOTES
1. SWITCHING VOLTAGE = 800 VOLTS
2. MAXIMUM CASE TEMPERATURE = 65°C
3. MINIMUM CIRCUIT TURN-OFF TIME = C398-40μSEC, C397-60μSEC
4. MAX CIRCUIT dv/dt = 200 V/μSEC
5. REVERSE BLOCKING VOLTAGE ≤ 800 VOLTS
6. REQUIRED GATE DRIVE: 20 VOLTS, 65 OHMS, 1μSEC RISETIME
7. RC SNUBBER CIRCUIT: .2μF, 5 OHMS

3. Maximum allowable peak on-state current vs. pulse width ($T_C = 65°C$)



NOTES:
1. SWITCHING VOLTAGE = 800 VOLTS
2. MAXIMUM CASE TEMPERATURE = 90°C
3. MINIMUM CIRCUIT TURN-OFF TIME = C398-40μSEC, C397-60μSEC
4. MAX CIRCUIT dv/dt = 200 V/μ SEC
5. REVERSE BLOCKING VOLTAGE ≤ 800 VOLTS
6. REQUIRED GATE DRIVE: 20 VOLTS, 65OHMS, 1μ SEC RISETIME
7. RC SNUBBER CIRCUIT: .2μF, 5 OHMS

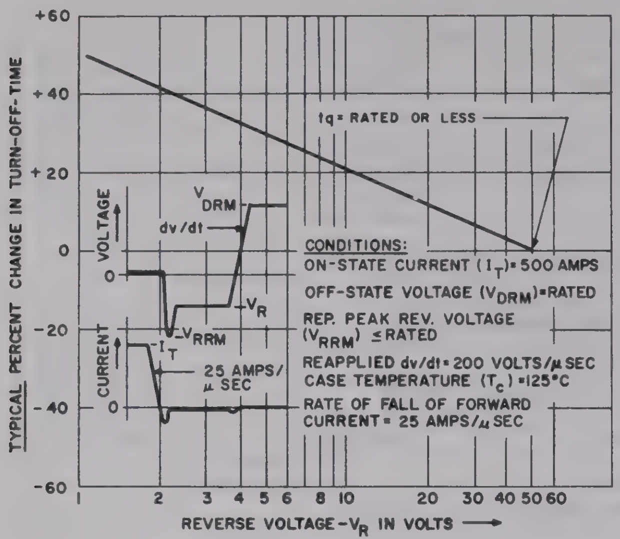
4. Maximum allowable peak on-state current vs. pulse width ($T_C = 90°C$)



NOTES.
1. AVG. POWER = WATT-SEC/PULSE X REP RATE
2. SWITCHING VOLTAGE = 800 VOLTS
3. t_q = C398-40μSEC, C397-60μSEC
4. dv/dt = 200 V/μSEC
5. GATE DRIVE = 20 VOLTS, 65 OHMS, 1μSEC RISETIME
6. RC SNUBBER .2μF, 5 OHMS

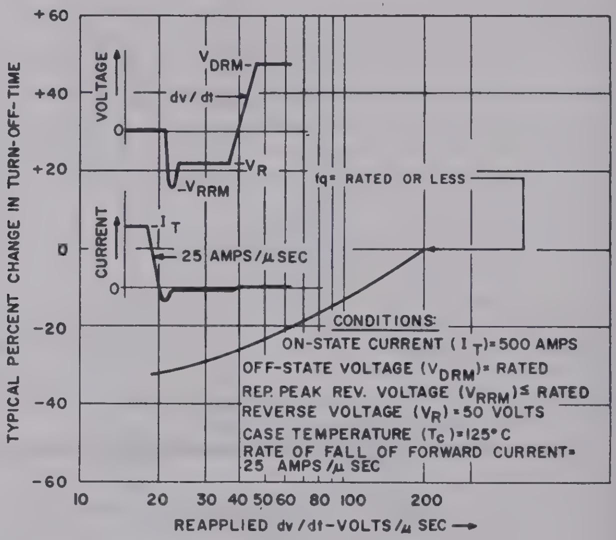
5. Energy per pulse for sinusoidal pulses

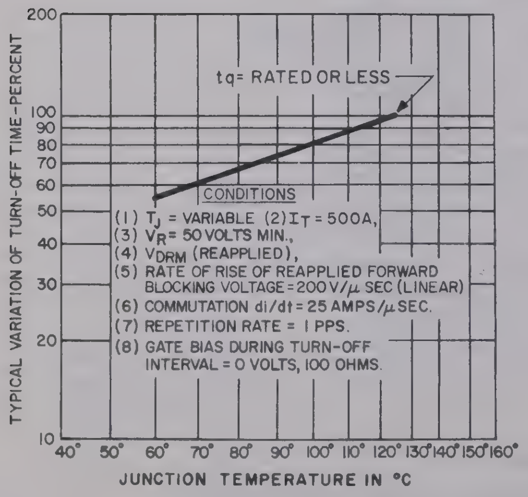
Charts 3 and 4 give the maximum value of peak on-state current at which the specified turn-off-time and dv/dt still apply.



6. This curve shows a typical variation of SCR turn-off-time with applied reverse voltage (V_R) during the turn-off interval. Testing at V_R = "1 volt" is done with a GE A396 fast recovery diode in inverse parallel with the C397, C398. For SCR's with specified maximum turn-off-time with an inverse parallel diode — consult the factory.

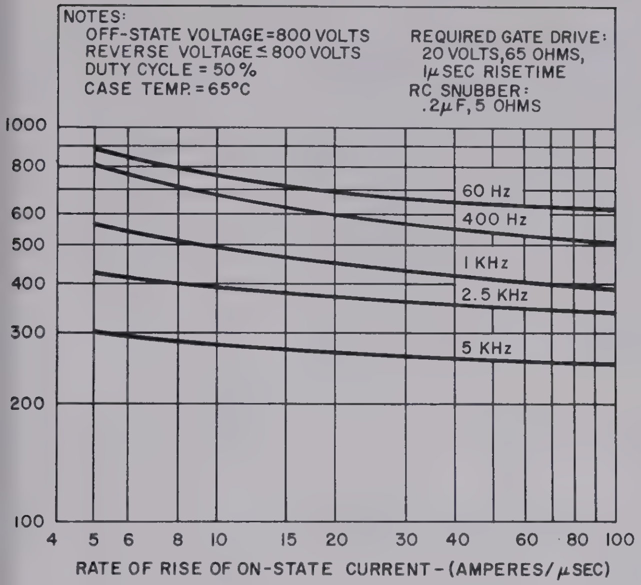
7. This curve shows a typical variation of SCR turn-off-time with reapplied dv/dt. Specified turn-off-time (40 µsec) is with reapplied dv/dt of 200 volts/µsec. Note turn-off-time enhancement at lower dv/dt. When requesting selected turn-off-time (less than 40 µsec) also specify maximum reapplied dv/dt. Similar enhancement occurs with the C397 spec of 60 µsec at 200 volts/µsec with lower reapplied dv/dt.



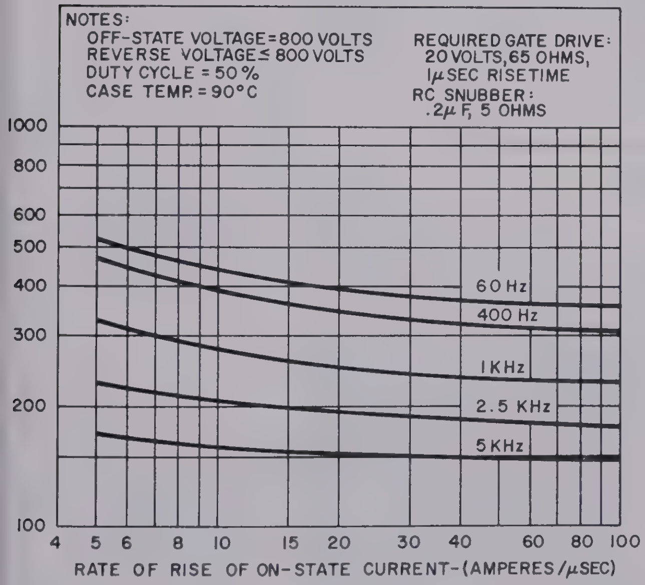


8. This curve shows typical variation of SCR turn-off-time with junction temperature (T_J). Specified turnoff is based upon 125°C junction temperature.

DUTY CYCLE – 50%

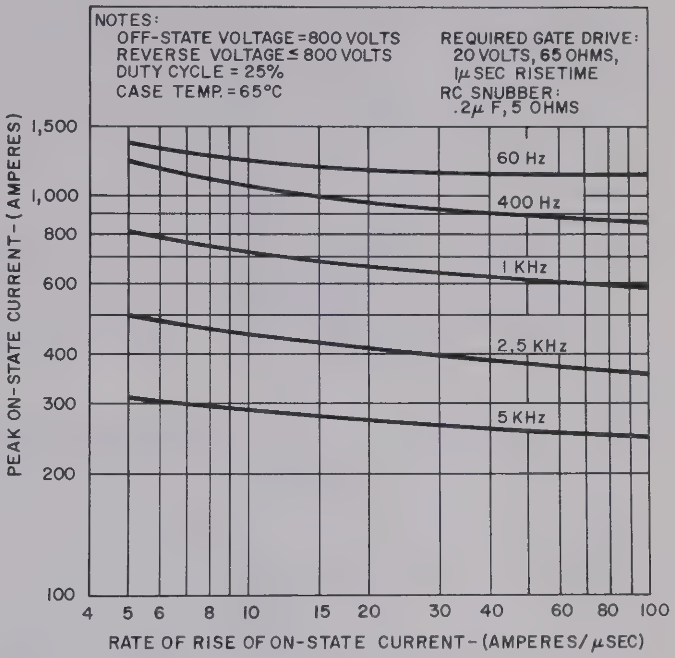


9. Maximum allowable peak on-state current vs. di/dt (T_C = 65°C)

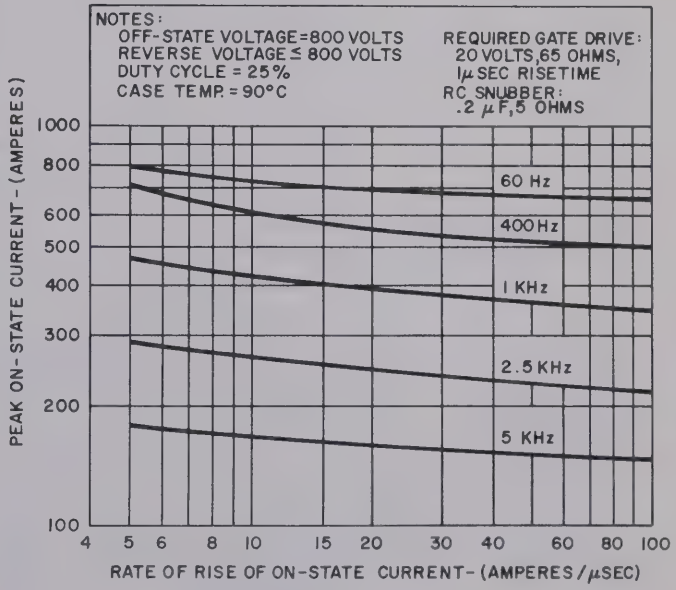


10. Maximum allowable peak on-state current vs. di/dt (T_C = 90°C)

DUTY CYCLE – 25%



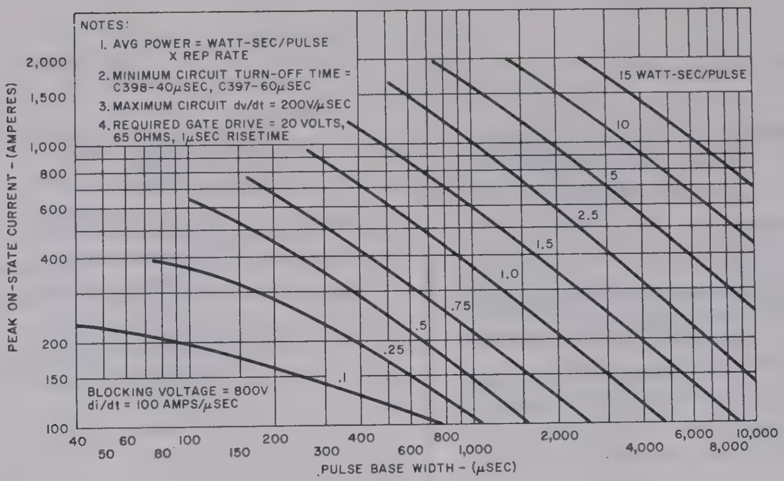
11. Maximum allowable peak on-state current vs. di/dt (T_C = 65°C)



12. Maximum allowable peak on-state current vs. di/dt (T_C = 90°C)

RECTANGULAR WAVE DATA

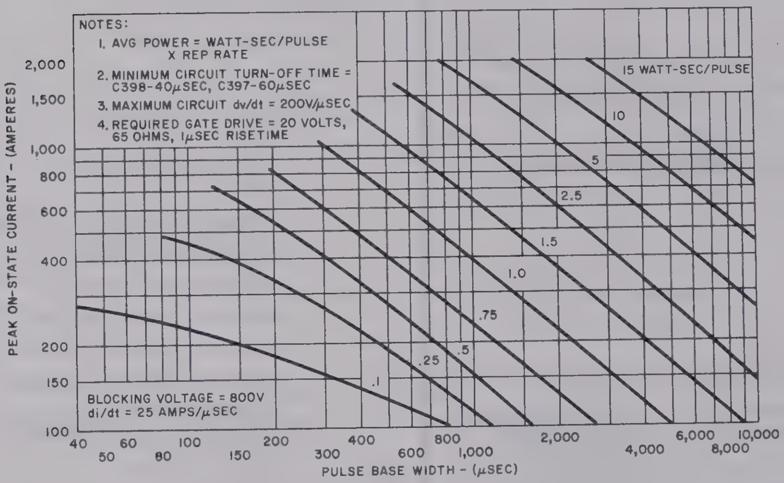
WATT-SECOND PER PULSE



NOTES:
1. AVG POWER = WATT-SEC/PULSE X REP RATE
2. MINIMUM CIRCUIT TURN-OFF TIME = C398-40μSEC, C397-60μSEC
3. MAXIMUM CIRCUIT dv/dt = 200V/μSEC
4. REQUIRED GATE DRIVE = 20 VOLTS, 65 OHMS, 1μSEC RISETIME

BLOCKING VOLTAGE = 800V
di/dt = 100 AMPS/μSEC

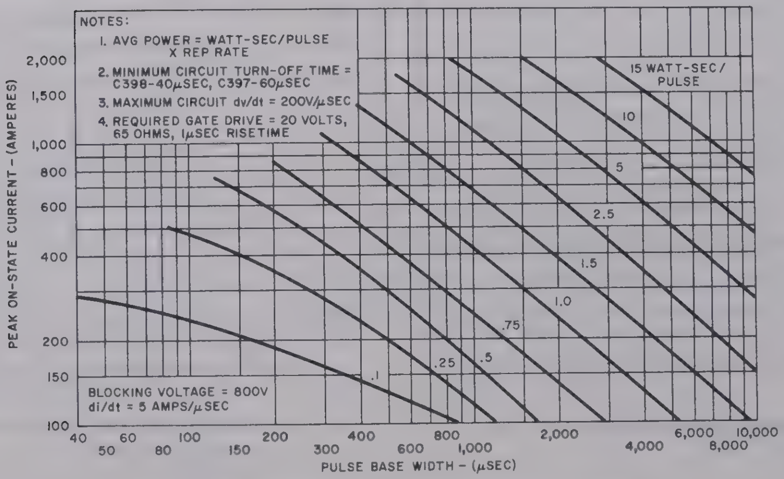
13. Energy per pulse vs. peak current and pulse width (di/dt = 100A/μsec)



NOTES:
1. AVG POWER = WATT-SEC/PULSE X REP RATE
2. MINIMUM CIRCUIT TURN-OFF TIME = C398-40μSEC, C397-60μSEC
3. MAXIMUM CIRCUIT dv/dt = 200V/μSEC
4. REQUIRED GATE DRIVE = 20 VOLTS, 65 OHMS, 1μSEC RISETIME

BLOCKING VOLTAGE = 800V
di/dt = 25 AMPS/μSEC

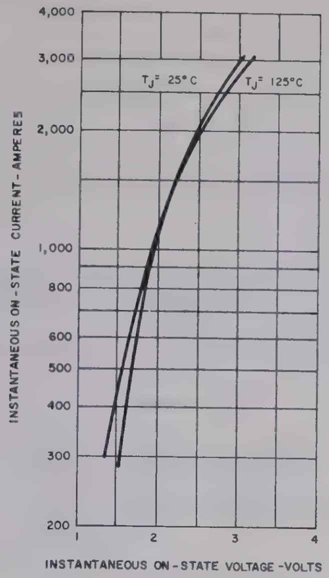
14. Energy per pulse vs. peak current and pulse width (di/dt = 25A/μsec)



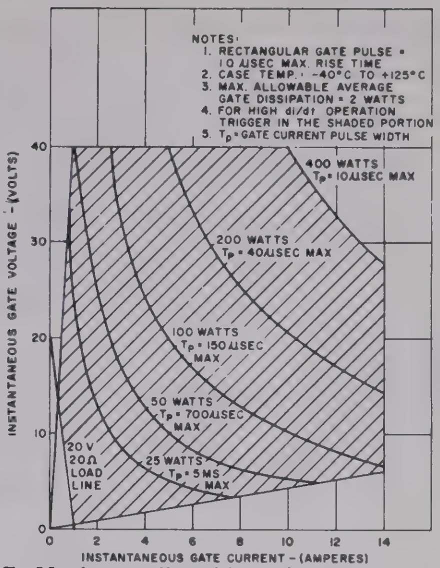
NOTES:
1. AVG POWER = WATT-SEC/PULSE X REP RATE
2. MINIMUM CIRCUIT TURN-OFF TIME = C398-40μSEC, C397-60μSEC
3. MAXIMUM CIRCUIT dv/dt = 200V/μSEC
4. REQUIRED GATE DRIVE = 20 VOLTS, 65 OHMS, 1μSEC RISETIME

BLOCKING VOLTAGE = 800V
di/dt = 5 AMPS/μSEC

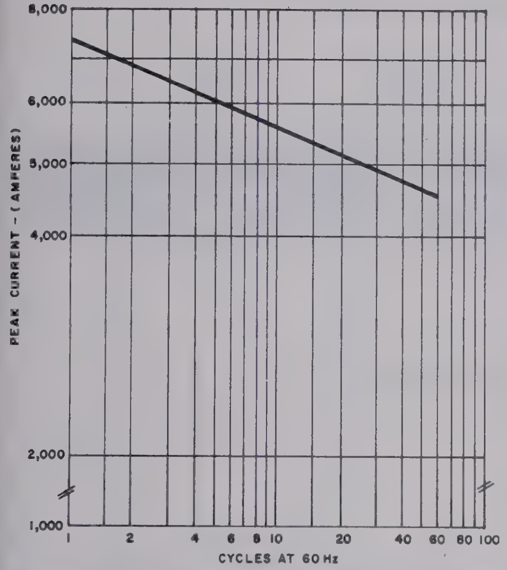
15. Energy per pulse vs. peak current and pulse width (di/dt = 5A/μsec)



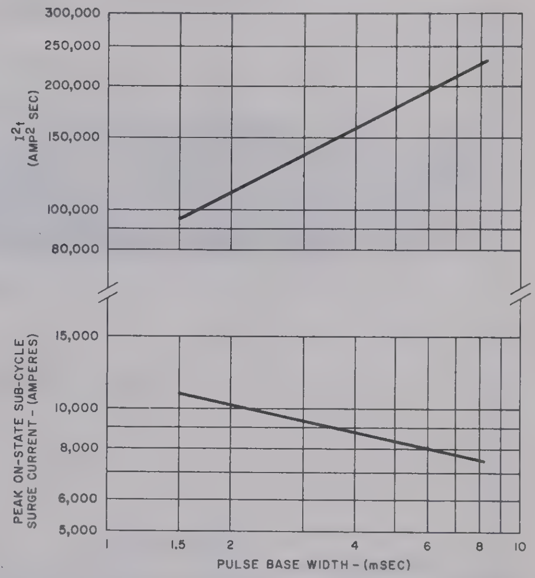
16. Forward conduction characteristic, on-state



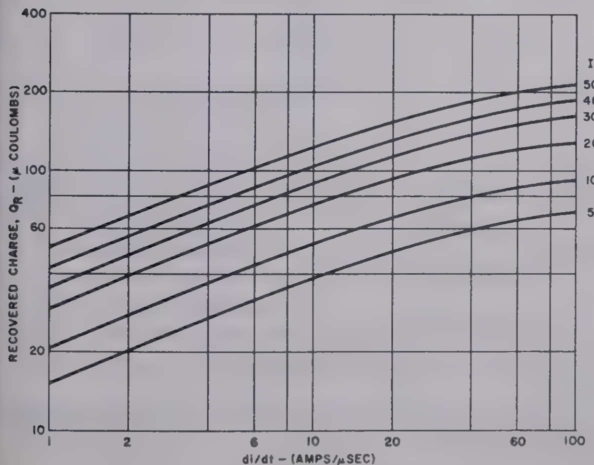
17. Maximum allowable peak gate power vs. gate pulse width



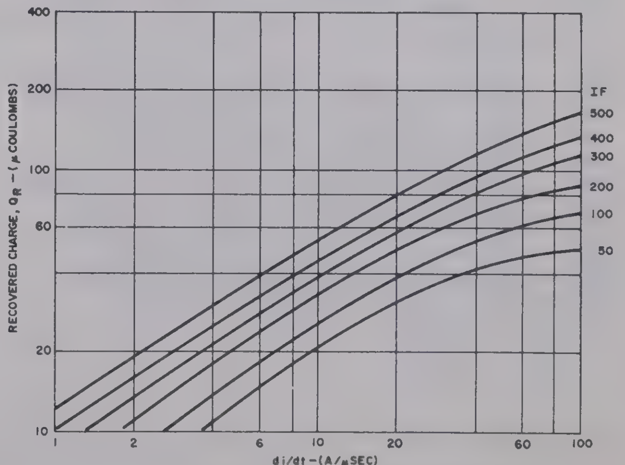
18. Maximum allowable surge current following rated load conditions (Sinusoidal Waveform)



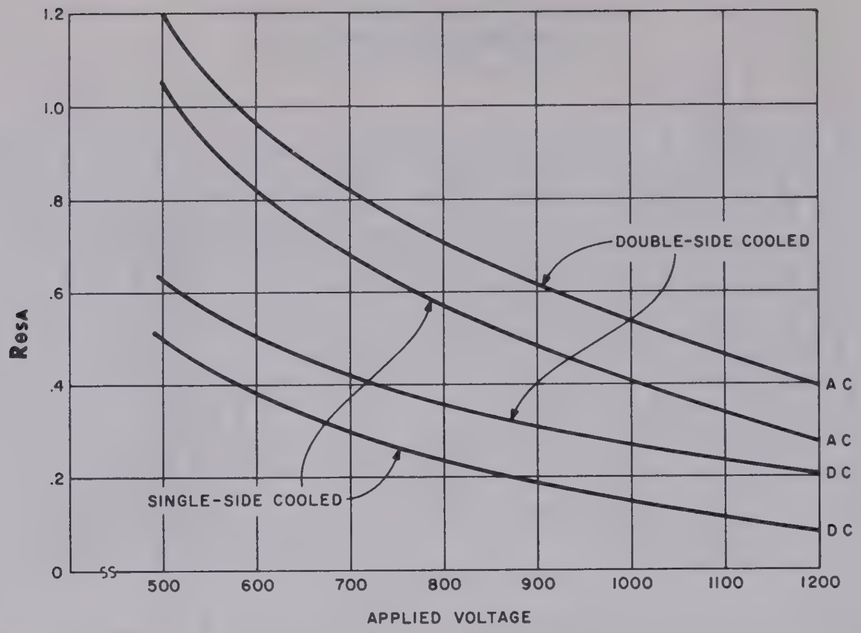
19. Sub-cycle surge and I^2t rating following rated load conditions (Sinusoidal Waveform)



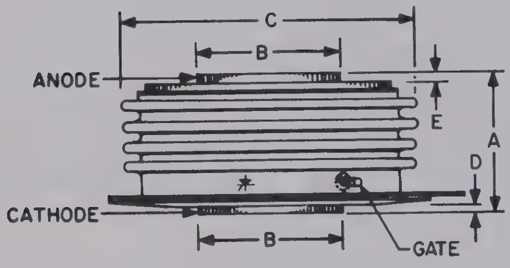
20. Typical Recovered Charge (125°C)



21. Typical Recovered Charge (25°C)



22. RθSA Selection For Non-Operating Thermal Stability @ 125°C, T_j



	DECIMAL (INCHES)		METRIC (MM)	
	MIN.	MAX.	MIN.	MAX.
A	1.025	1.065	26.04	27.05
B	1.043	1.057	26.49	26.85
C	—	2.100	—	53.44
D	.020	.105	.508	2.67
E	.030	.096	.762	2.44

23. Outline Drawing

FOR MOUNTING HARDWARE SEE SELECTOR GUIDE PAGE 171

Specification Sheets

140.12	1N3879 Series (6 amp) Fast Recovery Diode
140.22	1N3889 Series (12 amp) Fast Recovery Diode
140.23	A28 Series (12 amp) Very Fast Recovery Diode
140.47	1N3899 Series (20 amp) Fast Recovery Diode
140.48	1N3909 Series (30 amp) Fast Recovery Diode
145.55	A96 Series (250 amp) Fast Recovery Diode
160.35	C140 Series (35A) 50-400V High Speed SCR
160.39	C144 Series (35A) 500-800V High Speed SCR
170.35	C154-7 Series (110 amp) High Speed SCR
170.36	C158, 9 Series (110 amp) High Speed SCR
170.37	C385 Series (250 amp) High Speed SCR
170.38	C358 Series (225A) High Speed SCR
170.42	C395 Series (550A) up to 600V, High Speed SCR
170.44	C388, C387 Series (550A) High Speed SCR
170.45	C398, C397 Series (700A) High Speed SCR
170.53	C185 Series (235 amp) High Speed SCR
170.57	C354, 5 Series (115 amp) High Speed SCR
170.76	C506 Series (625 amp) High Speed SCR
170.80	C510 Series (625 amp) High Speed SCR

Application Notes

200.38	"Application of Fast Recovery Rectifiers"
200.41	"Simple Circuits For Triggering SCR's Into Fast-Rising Load Currents"
200.42	"Commutation Behavior of Diffused High Current Rectifier Diodes"
200.49	"A Low Cost Ultrasonic Frequency Inverter Using A Single SCR"

Technical Paper Reprints

660.13	"The Rating and Application of SCR's Designed for Switching at High Frequencies"
660.14	"Basic Magnetic Functions in Converters and Inverters Including New Soft Commutations"
660.15	"SCR Inverter Commutated By An Auxiliary Impulse"
660.16	"An SCR Inverter With Good Regulation and Sine Wave Output"

Seminar Notes

671.4	"The Widening World of The Fast Recovery Rectifier Diode"
671.15	"The Amplifying Gate SCR"

***For copies of any published information, please order by decimal publication number from: General Electric Company, Distribution Services, 1 River Road, Schenectady, N. Y. 12305.**

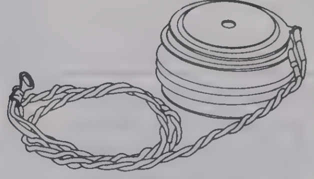
SCR

C501

The C501 Series of high power devices feature the proven, alloy-diffused construction in a new, larger pressure-mounted package.

Special features of these new devices are:

- Short delay time
- Pressure contacts
- Glazed ceramic package with 1″ creepage path
- Reversibility (eliminates need for special reverse polarity units)
- Hermetic seal
- Available in factory assembled heat exchangers or ready-to-mount



IMPORTANT: Mounting instructions on the last page of this specification must be followed.

MAXIMUM ALLOWABLE RATINGS

TYPE	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM}[1] $T_J = -40°C$ to $+125°C$	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM}[1] $T_J = -40°C$ to $+125°C$	TRANSIENT PEAK REVERSE VOLTAGE (Non-recurrent $<$ 5 Millisec.), V_{RSM} $T_J = -40°C$ to $+125°C$
C501S	700 Volts	700 Volts	800 Volts
C501N	800	800	900
C501T	900	900	1000
C501P	1000	1000	1100
C501PA	1100	1100	1200
C501PB	1200	1200	1300
C501PC	1300	1300	1400
C501PD	1400	1400	1500
C501PE	1500	1500	1600
C501PN	1600	1600	1700
C501PS	1700	1700	1800

Average Forward Current, On-State		Depends on conduction angle (See Charts 1 and 3)
Peak One-Cycle Surge ON-state Current, I_{TSM}		7000 amperes
Maximum Rate of Rise of Anode Current Turn-on Interval (See Chart 11) (Switching Rates $\leqq$ 400 Hz.)	Switch From <500V	75A/μsec
	Switch From <1000V	50A/μsec
	Switch From <1300V	30A/μsec
I^2t (for fusing) (for times $\geqq$ 1.5 milliseconds)		100,000 ampere² seconds
I^2t (for fusing) (at 8.3 milliseconds)		200,000 ampere² seconds
Peak Gate Power Dissipation, P_{GM}		25 Watts
Average Gate Power Dissipation, $P_{G(AV)}$		5 Watts
Peak Reverse Gate Voltage, V_{GRM}		5 Volts
Storage and Operating Temperature, T_{STG} & T_J		−40°C to +125°C
Mounting Force Required		2200 lbs. ±10% 910 kg. ±10%

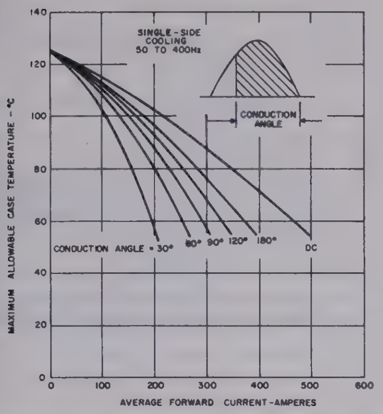
---

[1] Ratings apply for zero gate voltage. The C501 SCR will trigger ON with negative gate current. Maximum heatsink thermal resistance for which maximum PRV ratings apply equal 1.1°C/watt.

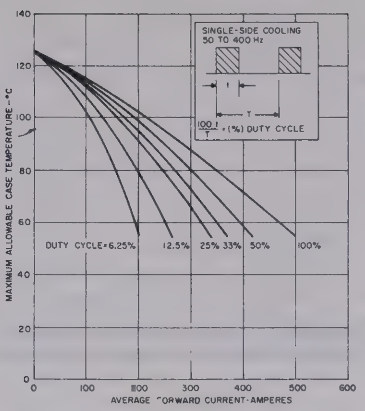
CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Peak Reverse and Forward Blocking Current	I_{DRM} and I_{RRM}	—	1.0	15	mA	$T_J = +25°C$, $V = V_{DRM} = V_{RRM}$
Peak Reverse and ON-state Blocking Current	I_{DRM} and I_{RRM}	—	15	35	mA	$T_J = +125°C$, $V = V_{DRM} = V_{RRM}$
Effective Thermal Resistance (DC)	$\theta_{J\text{-}S}$	—	—	0.108	°C/watt	Junction to Sink—One side cooled, anode to sink
		—	—	0.129		Junction to Sink—One side cooled, cathode to sink
		—	—	0.059		Junction to Sink—Two sides cooled
Critical Exponential Rate of Rise of Forward Blocking Voltage (Higher values may cause device switching)	dv/dt	100	—	—	V/μsec	$T_J = +125°C$, $V_{DRM} = .8$ Rated, Gate open.
Holding Current	I_H	—	100	250	mAdc	$T_C = +25°C$, Anode supply = 20Vdc. Initial forward current = 500 amps.
Latching Current	I_L	—	—	1	Adc	$T_C = +25°C$, Anode voltage = 24Vdc, Load resistance 12 ohms max.
Delay Time	t_d	—	.7	4	μsec	$T_C = +25°C$, Bias voltage = 140V, Gate supply: 20V, 10Ω, 500 mA, 0.5 μsec max. rise time.
Gate Pulse Width Necessary to Trigger		—	—	10	μsec	$T_C = +25°C$. Gate Supply: 10 volt open circuit, 5 ohm, 0.1 μsec rise time.
Gate Trigger Current	I_{GT}	—	—	150	mAdc	$T_C = +25°C$, $V_D = 10$Vdc, $R_L =$ 3 ohms
		—	—	225		$T_C = -40°C$, $V_D = 10$Vdc, $R_L =$ 3 ohms
		—	5	75		$T_C = +120°C$, $V_D = 10$Vdc, $R_L =$ 3 ohms
Gate Trigger Voltage	V_{GT}	—	—	6.5	Vdc	$T_C = -40°C$ to $+125°C$, $V_D = 10$ Vdc, $R_L = 3$ ohms
		0.15	—	—		$T_C = +125°C$, $V_D =$ Rated, $R_L =$ 1000 ohms
Peak On-Voltage	V_{FM}	—	—	1.53	Volts	$T_C = +25°C$, $I_T = 1000$A peak. Duty cycle $\leqq 0.01\%$
Circuited Commutated Turn-Off Time	t_q	—	200	300	μsec	$T_C = +125°C$, $I_T = 450$A, $V_R = 75$ volts min., V_{DRM} (reapplied) = ½ Rated, Rate of rise of reapplied forward blocking voltage = 25V/μsec linear, Gate bias = open during turn-off interval, Duty cycle $\leqq 0.01\%$

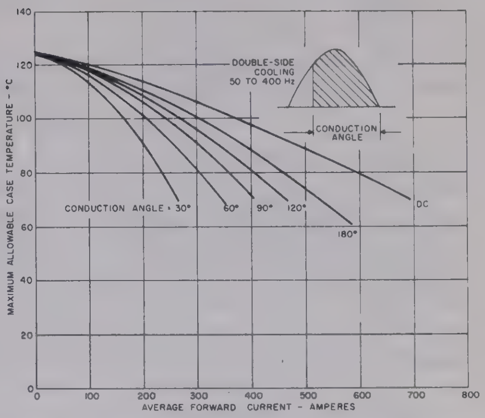
NOTE: T_C = Case Temperature (measured on heatsink ⅛ inch from base of SCR.)



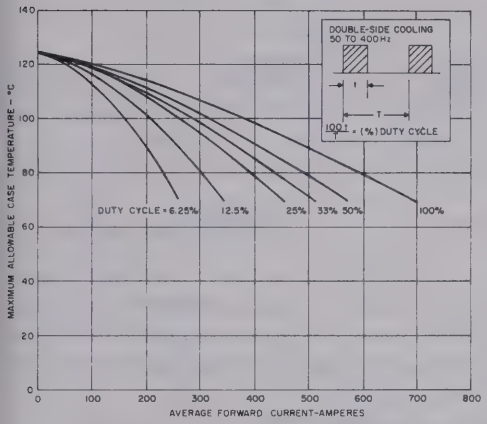
1. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM —SINGLE-SIDE COOLED



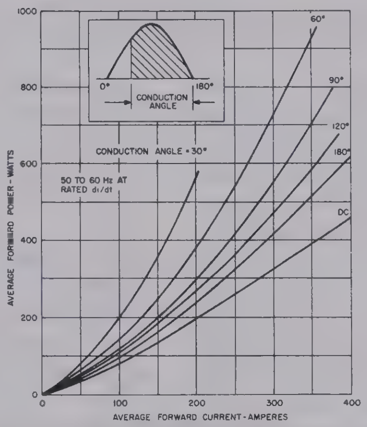
2. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM —SINGLE-SIDE COOLED



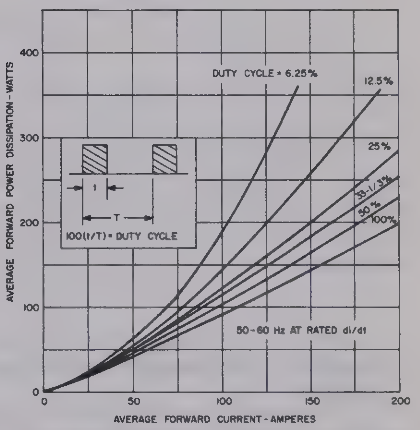
3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM —DOUBLE-SIDE COOLED



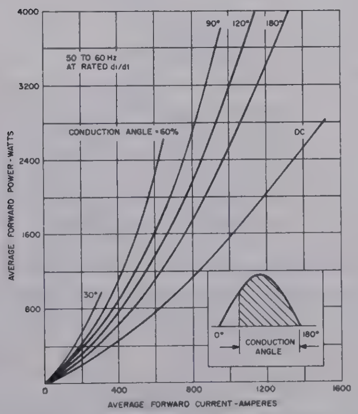
4. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM —DOUBLE-SIDE COOLED



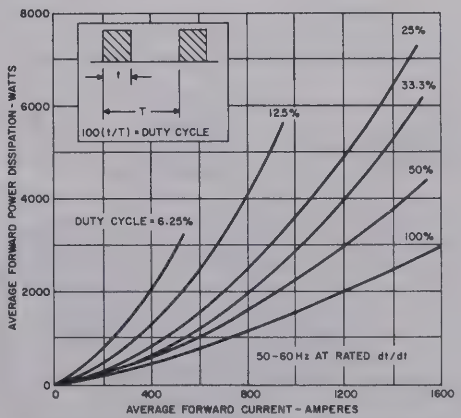
5. AVERAGE FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



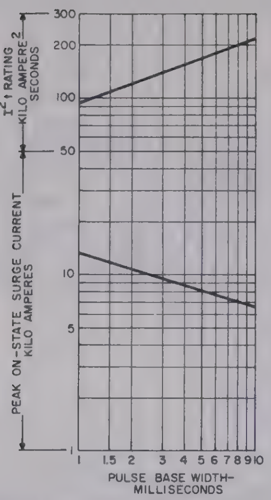
6. AVERAGE FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



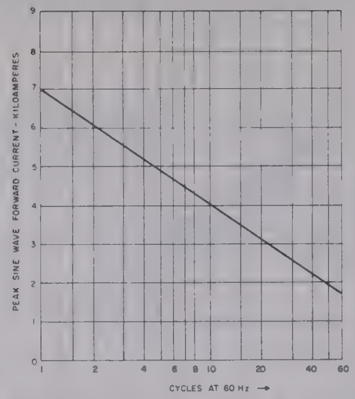
7. EXTENDED FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



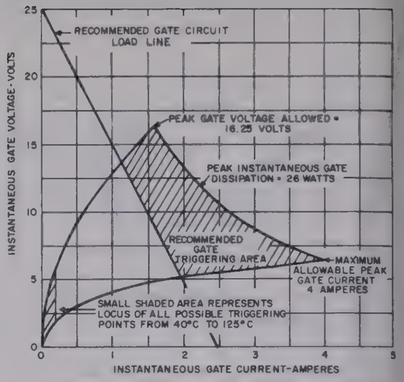
8. EXTENDED FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



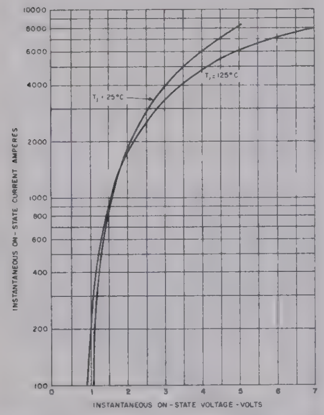
9. SUB-CYCLE SURGE AND I²t RATING FOLLOWING RATED LOAD CONDITIONS



10. MAXIMUM ALLOWABLE SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS

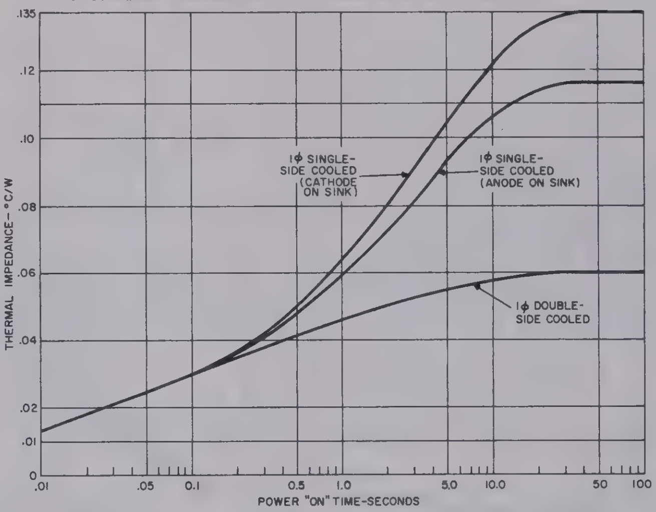


11. GATE TRIGGERING CHARACTERISTICS

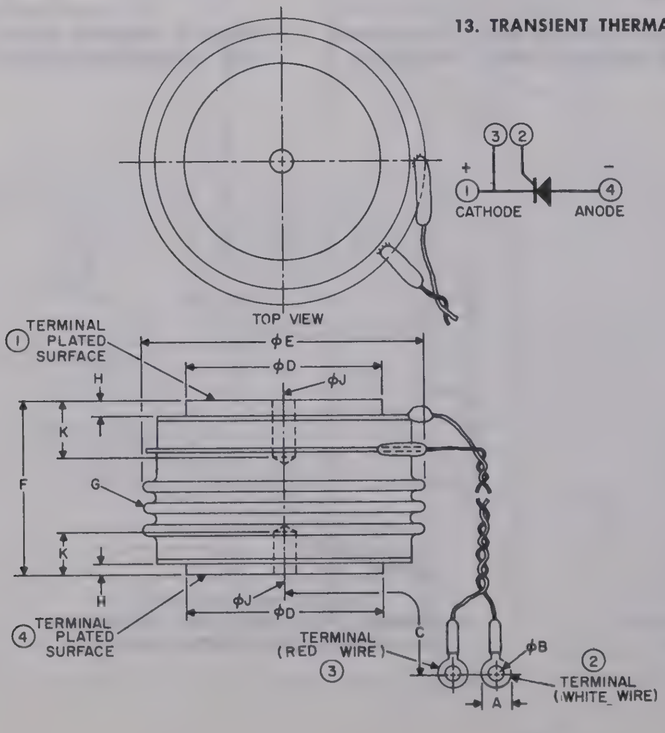


12. FORWARD CONDUCTION CHARACTERISTIC, ON-STATE

NOTES:
FOR 3φ THERMAL RESISTANCE ADD .005° C/W ALONG ENTIRE CURVE LENGTH
FOR 6φ THERMAL RESISTANCE ADD .017° C/W ALONG ENTIRE CURVE LENGTH
FOR DC THERMAL RESISTANCE SUB .007° C/W ALONG ENTIRE CURVE LENGTH



13. TRANSIENT THERMAL IMPEDANCE—JUNCTION TO SINK


TOP VIEW
③
②
+
①
CATHODE
−
④
ANODE
TERMINAL
① PLATED SURFACE
φE
φD
φJ
H
K
F
G
K
H
φJ
φD
TERMINAL
④ PLATED SURFACE
C
TERMINAL (RED WIRE)
③
φB
② TERMINAL (WHITE WIRE)
A

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	0.200	0.240	5.08	6.10	
φB	0.140		3.56		
C	16.000	20.000	406.40	508.00	
φD	1.240	1.260	31.50	32.00	
φE		1.875		47.63	
F	1.000	1.040	25.40	26.42	
G					1
H	.052			1.32	
φJ	0.136	0.146	3.45	3.71	
K	0.220	0.280	5.59	7.11	

NOTE:
1. 1.000(25.40MM) MIN INSULATION (SURFACE CREEPAGE)

14. OUTLINE

C501
SUGGESTED MOUNTING METHODS

When mounted in accordance with the following general instructions, ratings given in the transient thermal curve (Figure 13) will be obtained.

1. Check both surfaces of unit for nicks, etc. (the surfaces are prepared to meet flatness of 0.4 mils or less, and surface finish $\sqrt{32}$).

2. Check heat sink surfaces for the required flatness of 0.4 mils or less within a 1.5″ diameter. Wire brush these areas with Penetrox "A", Alcoa 2, or other grease compound for inhibiting oxides. Wipe off grease and apply a new, thin layer.

3. Assemble with 2200 ± 200 lbs. force applied through a self-leveling, swivel connection. The force has to be evenly distributed over the full area. Center holes on both sides of the device may be used for locating.

4. If separate current take off's are considered in order to obtain a more reliable connection, use ¼″ x 1½″ width annealed, nickel-plated copper strip of desired length between heatsinks and device surfaces. Grease interfaces with silicone grease*, or General Electric oil #SF 1017. The introduction of separate current take off's would add .02°C/W per strip to the thermal rating measured from 5 seconds to steady state.

---

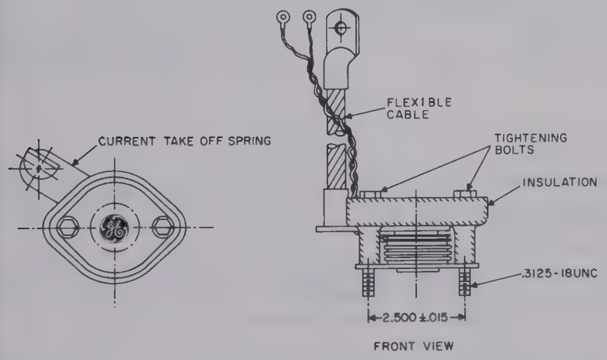
* G623, DC 3 and DC 4 are light and colorless silica-thickened, silicone greases. G623 is made by General Electric Co., Silicone Products Dept., Waterford, N.Y. DC 3 and DC 4 are made by Dow-Corning, Midland, Michigan.

MOUNTING C501 IN GENERAL ELECTRIC UNIT PAK

The Unit Pak, as presented in the outline, is intended for one-side cooling by application to one heatsink with two bolts. The standard current take off is shown, but other configurations are available.

Preparation of Heatsink

With heatsink thickness of .80″, or greater, use tapped hole for steel Helicoil #1185-5LN-781. If Helicoil is not used, tap hole for 5⁄16″-18 thread with a minimum of 1″ length of bolt engagement in heatsink.



The heatsink should be of alloy such as AA 6101, or of a material with similar specifications.

If aluminum, thinner than .80″ but thicker than .375″, is used, the bolts should be secured with the standard 5⁄16″-18 steel nut supplied with the Unit Pak.

For heatsink mounting area thinner than .375″ use a hardened back-up plate of steel, approximately 0.5″ thick x 1″ wide x 3.500″ long.

For best interface results, nickel plate the heatsink using a bronze strike process (Alstan 70) and a nickel bath giving a soft, semi-bright plating. Clean the surface immediately prior to assembly. A plated, copper current take off strip between the Unit Pak and heatsink could be used to avoid plating but still obtain a very reliable joint. (Use a silicone grease, or silicone oil SF 1017 for contact surfaces.)

Generally, a flatness of 0.4 mils or better and a $\sqrt{32}$ surface finish is required on the contact surface.

For a bare aluminum heatsink the contact area should be wire brushed with Penetrox "A", or Alcoa #2 joint compound, wiped clean and greased lightly again just prior to assembly.

Mounting Procedure

1. Check mounting surface for foreign particles, nicks, etc. Wipe off with lint-free paper towel.

2. Place Unit Pak on greased heatsink with end of bolts in mounting holes. By pressing Unit Pak down to heatsink, the bolts will snap up to align properly.

3. Pull down bolts hand tight with spring leveled. Locate current take off in desired orientation.

4. Turn each bolt 1½ turns with a wrench. Adjust level of spring with an additional 1 to 3 flats. The spring should now be flat and can be checked with a straight edge. Adjust the spring for flatness by turning an additional 1 to 3 flats on each bolt.

SCR

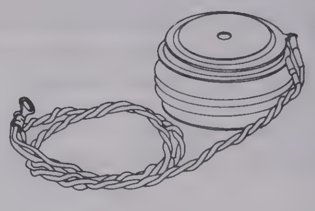
C510

700 Volts 450 A RMS

The General Electric Type C510 Series of silicon controlled rectifiers are reverse blocking triode thyristors designed primarily for power switching at frequencies considerably higher than the prevalent 50 to 400 Hz. The Type C510 SCR is explicitly rated for half sine wave and rectangular current up to 10k Hz.

For efficient operation in high speed applications, the C510 SCR provides a superior mix of capabilities:

- 125 amperes RMS at 10k Hz
- Forward and reverse blocking voltage to 700 volts
- 15 μsec max. turn-off-time at severe operating conditions†
- High di/dt and dv/dt at high frequency
- Very low switching losses at high frequency
- Available in factory assembled heat exchangers or ready-to-mount



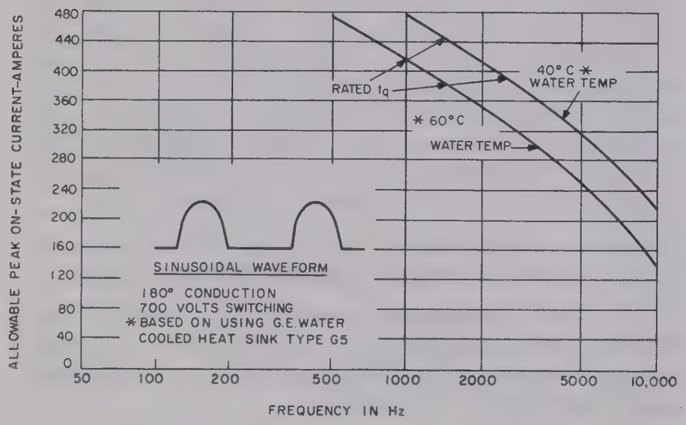


FIGURE 1

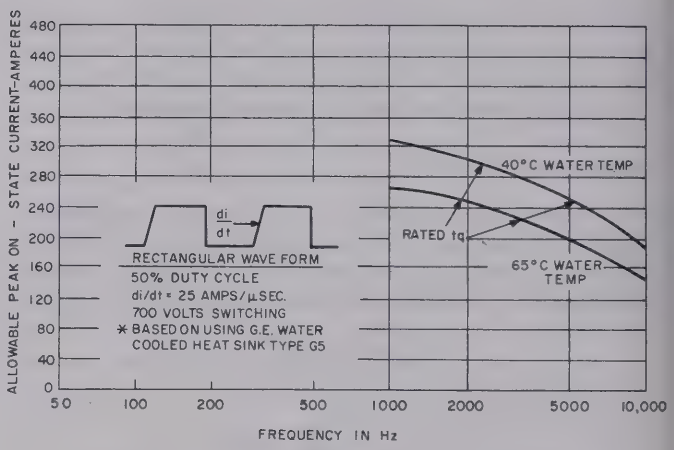


FIGURE 2

Equipment designers can use the C510 SCR in demanding applications, such as:

- **Choppers**
- **Inverters**
- **Regulated power supplies**
- **Sonar transmitters**
- **Induction heaters**
- **Radio transmitters**
- **Cycloconverters**
- **DC to DC converters**
- **High frequency lighting**

FOR SINE WAVE OPERATION

Like the Type C140/141 SCR (GE's first high-frequency SCR), the C510 SCR is rated for:

- **Peak current**
  vs.
- **Pulse width**
- **Frequency**
- **Case temperature**

FOR RECTANGULAR WAVE OPERATION

GE now introduces a new, high-frequency rating for the C510 SCR, which is:

- **Peak current**
  vs.
- **di/dt of leading edge**
- **Frequency**
- **Duty cycle**
- **Case temperature**

†Turn-off-time for the C510 SCR is rated for both reverse voltage and inverse parallel feedback diode.

MAXIMUM ALLOWABLE RATINGS

Types	Repetitive Peak Off-State Voltage, V_{DRM} (1)	Repetitive Peak Reverse Voltage, V_{RRM} (1)	Non-repetitive Peak Reverse Voltage, V_{RSM} (1) (2)
	$T_J = 0°C$ to $+ 125°C$	$T_J = 0°C$ to $+ 125°C$	$T_J = 0°C$ to $+ 125°C$
C510A	100 Volts	100 Volts	200 Volts
C510B	200 Volts	200 Volts	300 Volts
C510C	300 Volts	300 Volts	400 Volts
C510D	400 Volts	400 Volts	500 Volts
C510E	500 Volts	500 Volts	600 Volts
C510M	600 Volts	600 Volts	700 Volts
C510S	700 Volts	700 Volts	800 Volts

(1) Ratings apply for zero gate voltage. Maximum case to ambient thermal resistance for which maximum V_{DRM} and maximum V_{RRM} ratings apply equals 1.1°C/watt.

(2) Half sine wave voltage pulse, 10 millisecond maximum duration.

RMS On-State Current, $I_{T(RMS)}$	450 Amperes
Average On-State Current, $I_{T(AV)}$	(see Charts)
Peak One Cycle Surge (non-rep) On-State Current, I_{TSM}	4000 Amperes
I^2t (for fusing) for times $\geqq 1.5$ milliseconds	50,000 Ampere^{2}seconds
I^2t (for fusing) for times $\geqq 8.3$ milliseconds	65,000 Ampere^{2}Seconds
Critical Rate-of-Rise of On-State Current, di/dt, During Turn-On Interval	400 Amperes per microsecond†
Peak Gate Power Dissipation, P_{GM} . . . (Pulse Width $= 10\mu$sec)	400 Watts
Average Gate Power Dissipation, $P_{G(AV)}$	2 Watts
Peak Negative Gate Voltage, V_{GM}	20 Volts
Storage Temperature, T_{STG}	−40°C to +125°C
Operating Temperature, T_J	0°C to +125°C
Mounting Force Required	2000 Lb ± 10% 910 Kg ± 10%

†Required trigger source—20 volts, 10 ohms; maximum switching voltage—500 volts; short-circuit gate supply current risetime—0.25 µsec. (This short-circuit current may be measured with a TEKTRONICS current probe.); RC Snubber circuit used across SCR—(see Figure 5). Immediately after each current pulse, off-state (blocking) voltage capability may be temporarily lost for durations less than the period of the applied pulse repetition rate. The pulse repetition rate for this test is 60 Hz. The duration of the di/dt test condition is 60 seconds (minimum).

di/dt up to 100 amps/µsec, at specified gate drive and switching voltage is part of the rectangular current wave ratings (see rating curves of Figures 10 through 21). This is a repetitive, long-term rating confirmed by life test.

CHARACTERISTICS

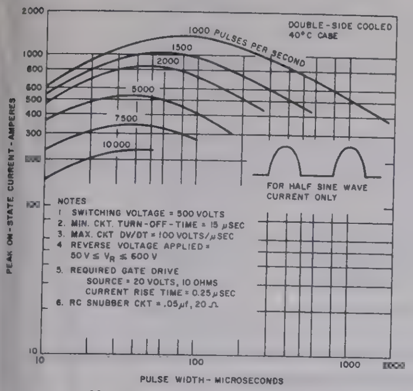
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
Peak Reverse and Off-State Current	I_{DRM} and I_{RRM}	—	2	10	mA	$T_C = +25°C$, $V = V_{DRM} = V_{RRM}$
Peak Reverse and Off-State Current	I_{DRM} and I_{RRM}	—	25	35	mA	$T_C = 125°C$, $V = {}_{DRM} = V_{RRM}$

CHARACTERISTICS

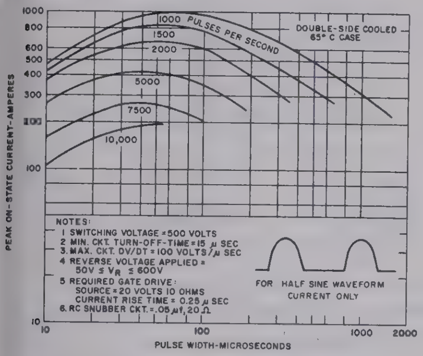
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
Effective Thermal Resistance	θ_{J-S}	— — —	— — —	.119 .141 .065	°C/ watt	Junction to sink, Single-side cooled, anode to sink Junction to sink, Single-side cooled, cathode to sink Junction to sink, Double-side cooled
Critical Exponential Rate of Rise of Forward Blocking Voltage (Higher values may cause device switching)	dv/dt	200	500	—	V/μsec	$T_C = +125°C$, Gate open, $V = .80V_{DRM}$
Holding Current	I_H	—	200	500	mAdc	$T_C = +25°C$, Anode supply = 24Vdc. Initial forward current = 2 amps.
Pulse Gate Trigger Current and Voltage	$i_{GT\ (pulse)}$ $V_{GT\ (pulse)}$	— —	1 8	2 20	mAdc Volts	$T_C = +25°C$, $t_p = 10$ μsec. 0.25 μsec rise time.
DC Gate Trigger Current	I_{GT}	— — —	50 75 35	200 250 120	mAdc mAdc mAdc	$T_C = +25°C$, $V_D = 6$Vdc, $R_L = 3$ ohms. $T_C = -40°C$, $V_D = 6$Vdc, $R_L = 3$ ohms. $T_C = +125°C$, $V_D = 6$Vdc, $R_L = 3$ ohms.
DC Gate Trigger Voltage	V_{GT}	— 0.15	1.75 —	5.0 —	Vdc Vdc	$T_C = -40°C$ to 0°C, $V_D = 6$Vdc, $R_L = 3$ ohms. $T_C = 125°C$, $R_L = 1000$ ohms, $V = .80V_{DRM}$
Peak On-State Voltage	V_{TM}	—	—	2.25	Volts	$T_C = +125°C$, $I_{TM} = 500$A peak. Duty cycle $\leq$ .01%
Turn-On Time (Delay Time + Rise Time)	t_{GT}	—	1.5	3	μsec	$T_C = +25°C$, $I_T = 50$Adc, $V = 100$V, Gate supply: 20 volt open circuit, 10 ohm, 0.15 μsec max. rise time.
Delay Time	t_d	—	0.8	2.0	μsec	$T_C = +25°C$, $I_T = 50$Adc, $V = 100$V, Gate supply: 20 volt open circuit, 10 ohm, 0.15 μsec max. rise time.
Conventional Circuit Commutated Turn-Off-Time (with Reverse Voltage)	t_q	—	12	15	μsec	(1) $T_J = +125°C$, (2) $I_T = 300$A, (3) $V_R = 50$ volts min., (4) $V = .80V_{DRM}$, (5) Rate of rise of reapplied forward blocking voltage = 100V/μsec (linear). (6) Commutation di/dt = 10 Amps/μsec. (7) Repetition rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts.
Conventional Circuit Commutated Turn-off-Time (with Feedback Diode)	$t_{q\ (diode)}$	—	14	18	μsec	(1) $T_J = +125°C$, (2) $I_T = 300$A, (3) $V_R = 1.5$ volt (Forward drop of GE A96 rectifier diode at $I_T = 300$A), (4) $V = .80V_{DRM}$ (5) Rate of rise of reapplied forward blocking voltage = 100V/μsec (linear). (6) Commutation di/dt = 10 Amps/μsec. (7) Repetition rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts.
Pulse Circuit Commutated Turn-Off-Time (with Reverse Voltage)	$t_{q\ (pulse)}$	—	12	15	μsec	(1) $T_J = +125°C$, $V = .80V_{DRM}$, (2) Rate of rise of reapplied forward blocking voltage = 100V/μsec (linear), (3) Rep. rate = 1_{pps} (4) Gate supply = 20 volts, 10 ohms, 0.25 μsec max. rise time. (5) $I_T = 500$A peak, $t_p = 3$ μsec (half sine wave), (6) $V_R = 50$ volts min.
Pulse Circuit Commutated Turn-Off-Time (with Feedback Diode)	$t_{q\ (pulse)\ (diode)}$	—	14	—†	μsec	(1) $T_J = +125°C$, $V = .80V_{DRM}$, (2) Rate of rise of reapplied forward blocking voltage = 100V/μsec (linear), (3) Rep. rate = 1_{pps}, (4) Gate supply = 20 volts, 10 ohms, 0.25 μsec max. rise time, (5) $I_T = 500$A peak, $t_p = 3$ μsec (half sine wave), (6) $V_R = 1.5$ volt (Forward drop of GE A96 rectifier diode at $I_T = 300$A).

†Consult Factory for specified maximum Turn-Off Time.

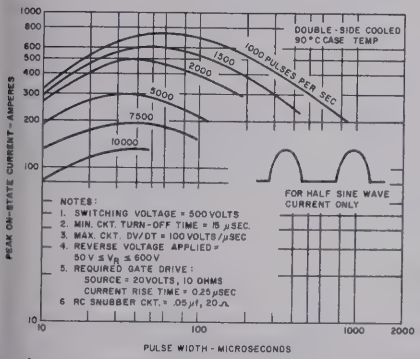
DOUBLE-SIDE COOLED



ximum allowable peak on-state current vs. width (T_C = 40°C)

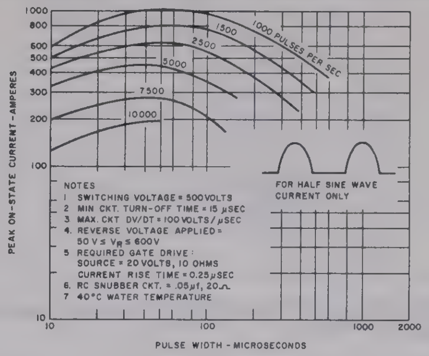


aximum allowable peak on-state current vs. width (T_C = 65°C)

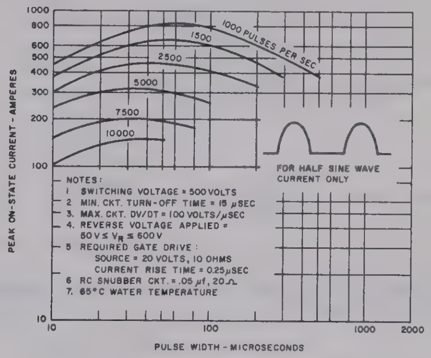


laximum allowable peak on-state current vs. width (T_C = 90°C)

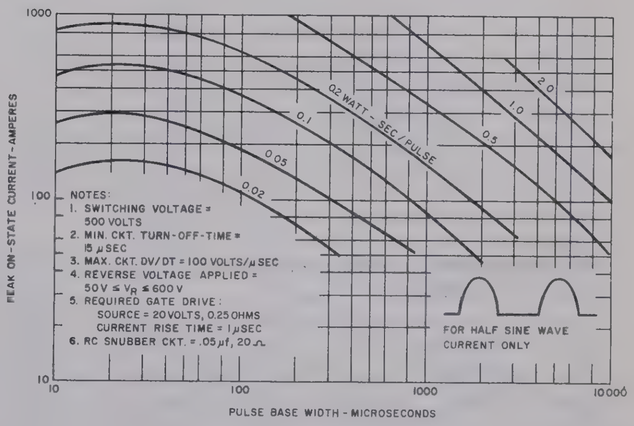
C510 MOUNTED ON GENERAL ELECTRIC G5 Double-side, Water-cooled Heatsink



7. Maximum allowable peak on-state current vs. pulse width (water temp. = 40°C)

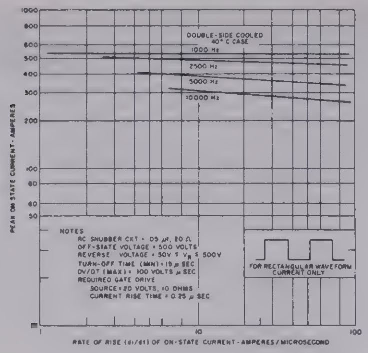


8. Maximum allowable peak on-state current vs. pulse width (water temp. = 65°C)

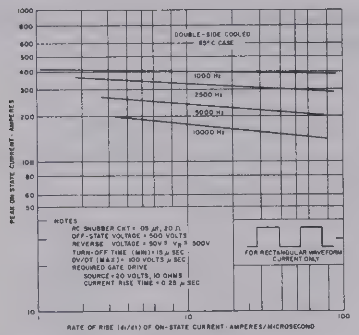


9. Energy per pulse for sinusoidal pulses

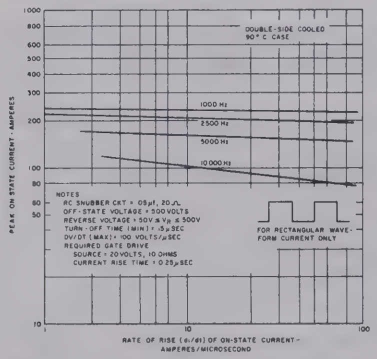
RECTANGULAR WAVE DATA 50% Duty Cycle
DOUBLE-SIDE COOLED



10. Maximum allowable peak on-state current vs. di/dt (T_C = 40°C)

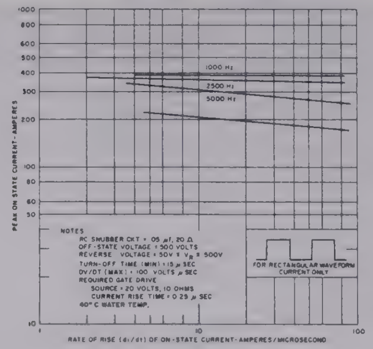


11. Maximum allowable peak on-state current vs. di/dt (T_C = 65°C)

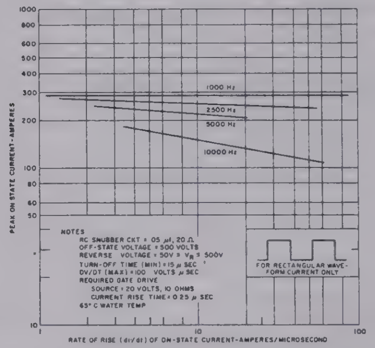


12. Maximum allowable peak on-state current vs. di/dt (T_C = 90°C)

C510 MOUNTED ON GENERAL ELECTRIC G5
Double-Side, Water-Cooled Heatsink

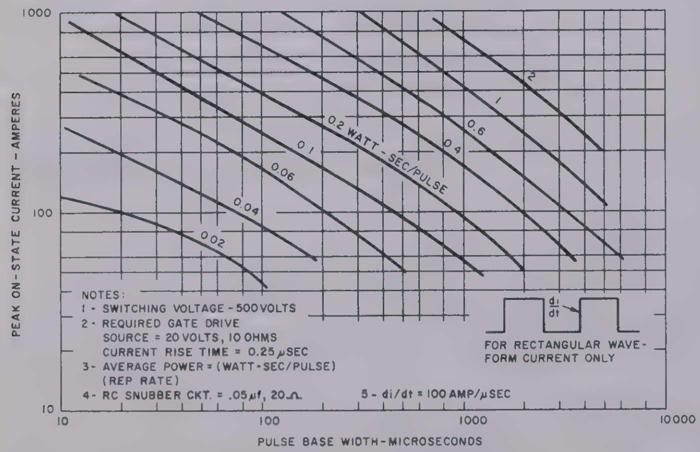


13. Maximum allowable peak on-state current vs. di/dt (40°C water temperature)

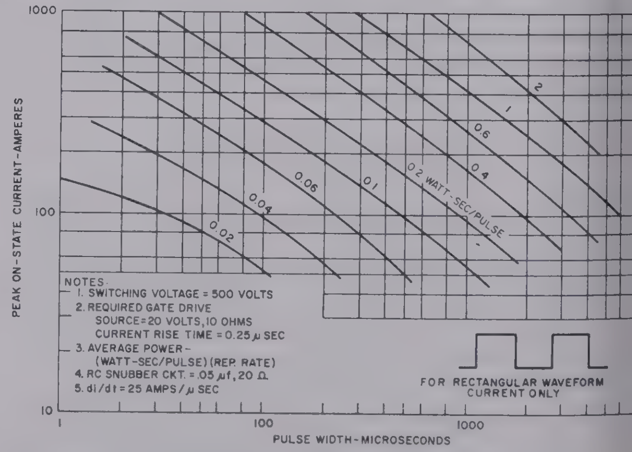


14. Maximum allowable peak on-state current vs. di/dt (65°C water temperature)

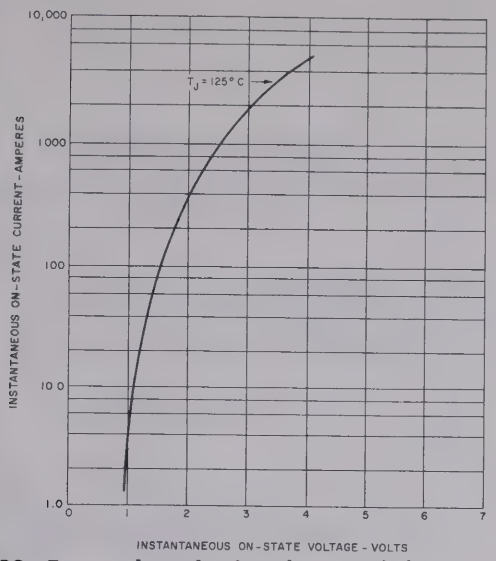
RECTANGULAR WAVE DATA
WATT-SECONDS PER PULSE



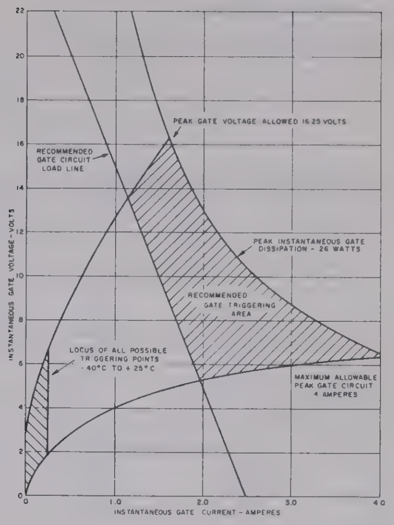
15. Energy per pulse vs. peak current and pulse width (di/dt = 100A/μsec)



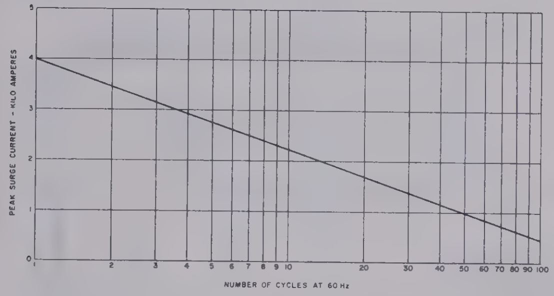
16. Energy per pulse vs. peak current and pulse width (di/dt = 25A/μsec)



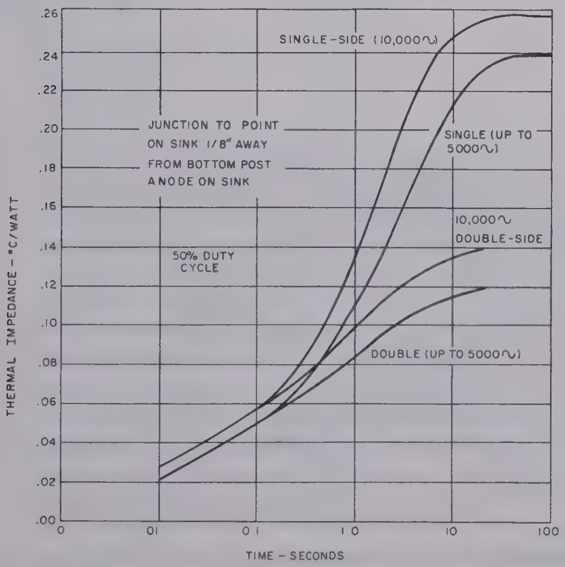
29. **Forward conduction characteristics, on-state**



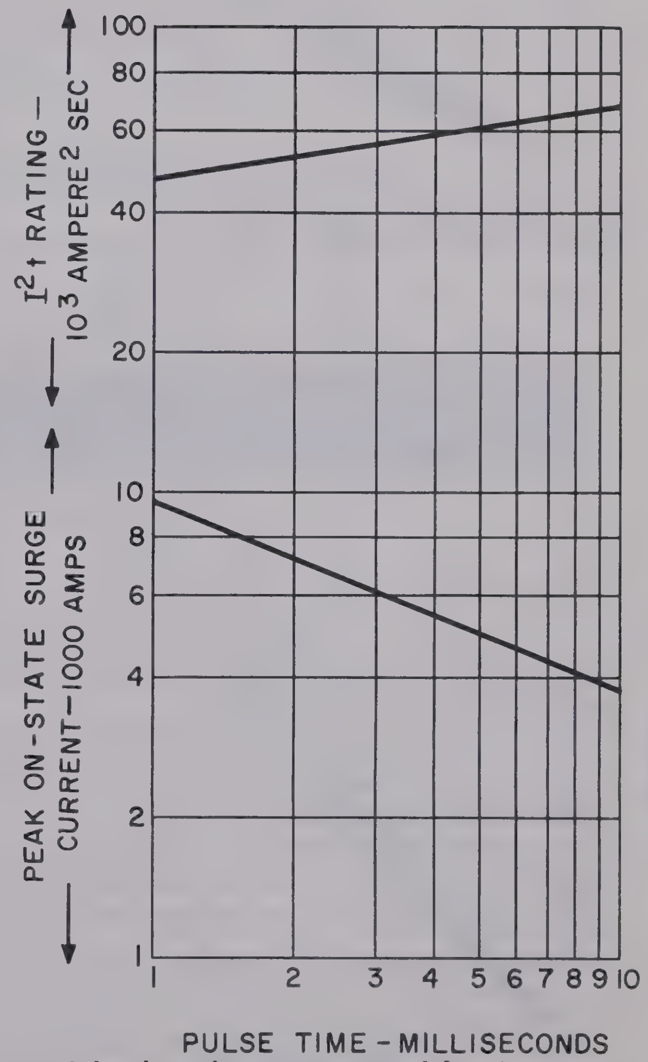
30. **Maximum allowable peak gate power vs. gate pulse width**



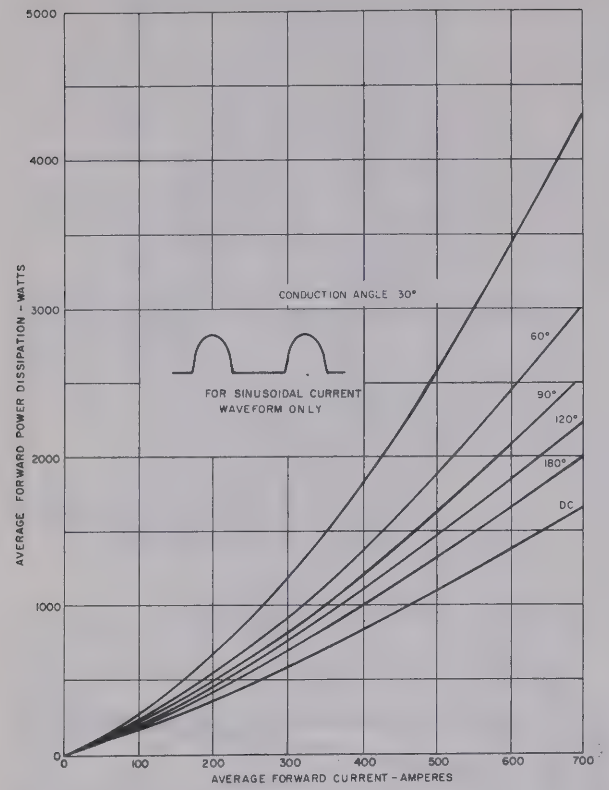
31. **Maximum allowable surge current following rated load conditions**



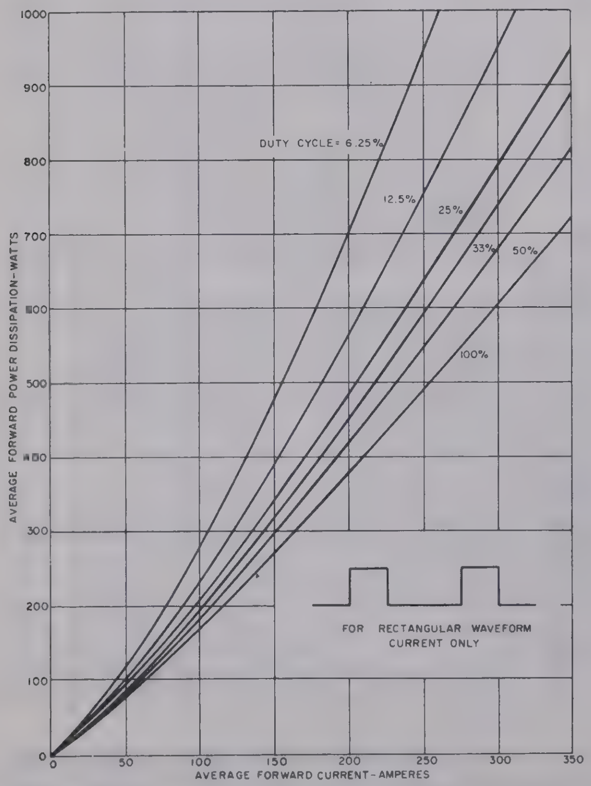
32. **Transient thermal impedance, junction to sink**



33. **Subcycle peak surge current and I^2t rating following rated load conditions**



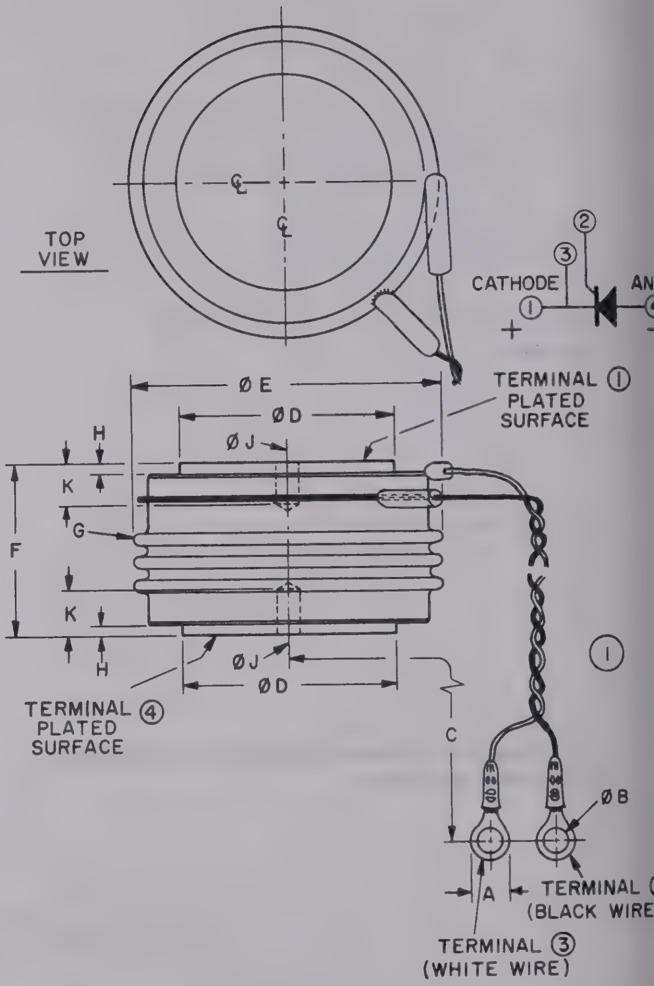
22. Average forward power dissipation for sinusoidal current waveform



23. Average forward power dissipation for rectangular current waveform

OUTLINE DRAWING

C510 OUTLINE


TOP VIEW
℄
℄
CATHODE
③
②
①
+
AN
TERMINAL ①
PLATED SURFACE
ØE
ØD
ØJ
H
K
G
F
K
H
ØJ
ØD
TERMINAL ④
PLATED SURFACE
①
C
ØB
A
TERMINAL (
(BLACK WIRE
TERMINAL ③
(WHITE WIRE)

SYMBOL	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX	NOTES
A	0.200	0.240	5.08	6.10	
ØB	0.140		3.56		
C	16.000	20.000	406.40	508.00	
ØD	1.240	1.260	31.50	32.00	
ØE		1.875		47.63	
F	1.000	1.040	25.40	26.42	
G					1
H	.052			1.32	
ØJ	0.136	0.146	3.45	3.71	
K	0.220	0.280	5.59	7.11	

NOTES:

1. 1.000 (25.40 mm) MIN INSULATION (SURFACE CREE

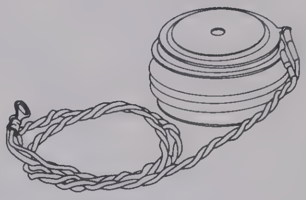
FOR MOUNTING HARDWARE SEE SELECTOR GUIDE PAGE 171

SCR

C520

The C520 Series of high power devices feature the proven, alloy-diffused construction in a new, larger General Electric pressure-mounted package.

Special characteristics of these new devices are:



- Short delay time
- Pressure contacts
- Highest current rating available on the market
- 150°C maximum junction temperature
- Reversibility (eliminates need for special reverse polarity units)
- Hermetic seal
- Available in factory assembled heat exchangers or ready-to-mount

IMPORTANT: Mounting instructions on the last page of this specification must be followed.

MAXIMUM ALLOWABLE RATINGS

TYPE	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM} [1] $T_J = -40°C$ to $+150°C$	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM} [1] $T_J = -40°C$ to $+150°C$	TRANSIENT PEAK REVERSE VOLTAGE (Non-recurrent $<$ 5 Millisec.), V_{RSM} $T_J = -40°C$ to $+150°C$
C520A	100 Volts	100 Volts	200 Volts
C520B	200	200	300
C520C	300	300	350
C520D	400	400	425

Average Forward Current, On-State	Depends on conduction angle (See Charts 1 and 3)
Peak One-Cycle Surge Forward Current, I_{TSM}	10,000 amperes
Maximum Rate of Rise of Anode Current During Turn-on Interval (High Gate Drive Required. See Chart 11) (Switching Rates ≦ 400 Hz.)	Switch From <400V 75A/μsec
I^2t (for fusing) (for times ≧ 1.5 milliseconds)	230,000 ampere² seconds
I^2t (for fusing) (at 8.3 milliseconds)	415,000 ampere² seconds
Peak Gate Power Dissipation, P_{GM}	26 Watts
Average Gate Power Dissipation, $P_{G(AV)}$	5 Watts
Peak Reverse Gate Voltage, V_{GRM}	5 Volts
Storage and Operating Temperature, T_{STG} & T_J	−40°C to +150°C
Mounting Force Required	2200 lbs. ±10% 910 kg. ±10%

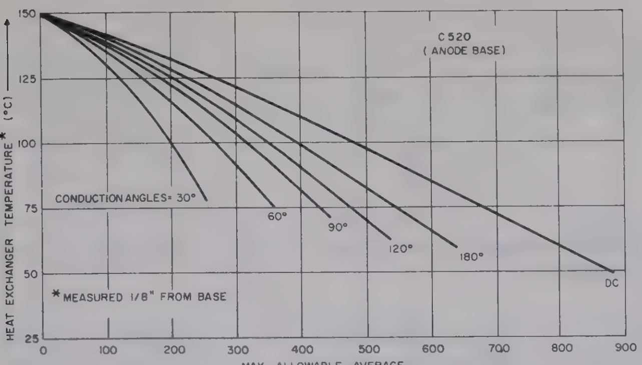
---

[1] Ratings apply for zero gate voltage. The C520 SCR will trigger ON with negative gate current. Maximum heatsink thermal resistance for which maximum PRV ratings apply equal 1.1°C/watt.

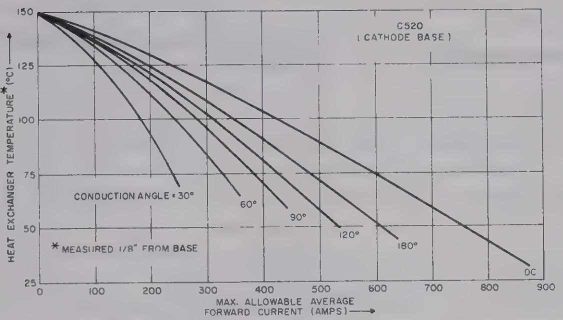
CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Peak Reverse and Forward Blocking Current	I_{DRM} and I_{RRM}	—	1	10	mA	$T_J = +25°C$, $V = V_{DRM} = V_{RRM}$
Peak Reverse and Forward Blocking Current	I_{DRM} and I_{RRM}	—	15	25	mA	$T_J = +125°C$, $V = V_{DRM} = V_{RRM}$
Effective Thermal Resistance (DC)	$\theta_{J\text{-}S}$	—	—	0.108	°C/watt	Junction to Sink—One side cooled, anode to Sink
		—	—	0.129		Junction to Sink—One side cooled, cathode to Sink
		—	—	0.054		Junction to Sink—Two sides cooled
Critical Exponential Rate of Rise of Forward Blocking Voltage (Higher values may cause device switching)	dv/dt	100	—	—	V/μsec	$T_J = +125°C$, $V = ½\ V_{DRM}$, Gate open.
		15	—	—		$T_J = +125°C$, $V = V_{DRM}$, Gate open.
Holding Current	I_H	—	100	250	mAdc	$T_C = +25°C$, Anode supply = 20Vdc, Initial forward current = 500 amps.
Latching Current	I_L	—	—	1	Adc	$T_C = +25°C$, Anode voltage = 24Vdc, Load resistance, 24 ohms max.
Turn-On Time (Delay Time + Rise Time)	$t_d + t_r$	—	—	4.0	μsec	$T_C = +25°C$, $I_F = 25$ Adc, $V_{DRM} =$ 140V, Gate supply: 24 volt open circuit, 10 ohm, 0.1 μsec max. rise time.
Gate Pulse Width Necessary to Trigger		—	—	15	μsec	$T_C = +25°C$, Bias voltage = 5V, Gate Supply: 24 volt open circuit, 10 ohm, 0.1 μsec rise time.
Gate Trigger Current	I_{GT}	—	—	150	mAdc	$T_C = +25°C$, $V_D = 10$Vdc, $R_L =$ 10 ohms
		—	—	200		$T_C = 0°C$, $V_D = 10$Vdc, $R_L = 10$ ohms
Gate Trigger Voltage	V_{GT}	—	—	4.0	Vdc	$T_C = +25°C$, $V_D = 10$Vdc, $R_L =$ 10 ohms.
Peak On-Voltage	V_{FM}	—	—	1.225	Volts	$T_C = +25°C$, $I_{FM} = 1100$A peak, Duty cycle $\leqq 0.01\%$
Circuited Commutated Turn-Off Time	t_q	—	—	150	μsec	$T_C = +110°C$, $I_{FM} = 50$A, $V_R = 60$ volts min., V_{DRM} (reapplied) = 100V, Rate of rise of reapplied forward blocking voltage = 20V/μsec linear.

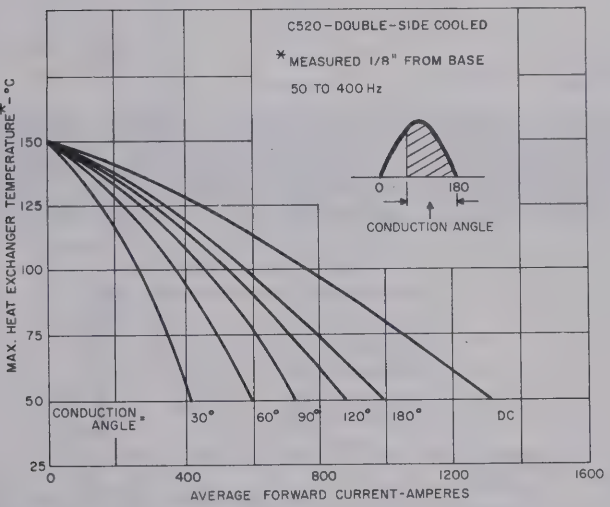
NOTE: T_C = Case Temperature (measured on heatsink ⅛ inch from base of SCR.)



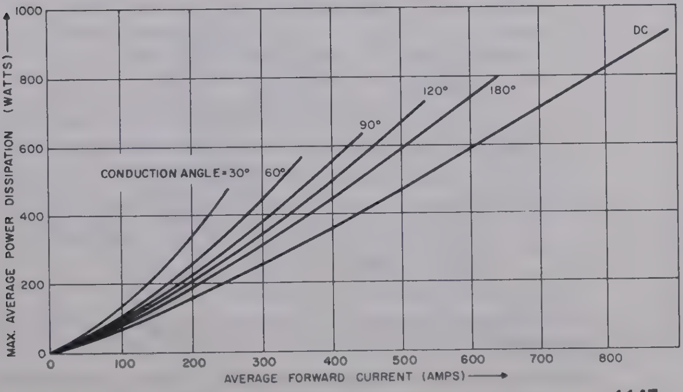
1. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM (ANODE BASE)



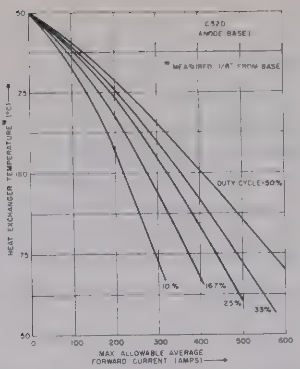
3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM (CATHODE BASE)



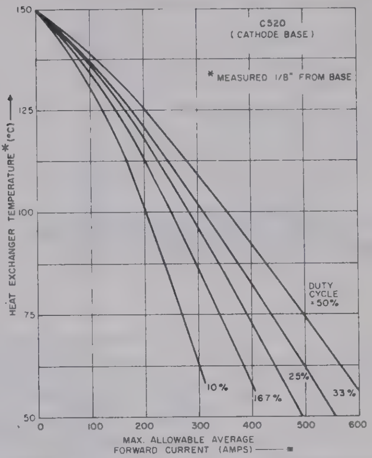
5. MAXIMUM ALLOWABLE HEAT EXCHANGER TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM—DOUBLE-SIDE COOLED



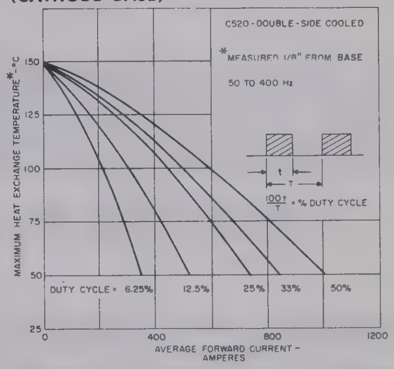
7. AVERAGE FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



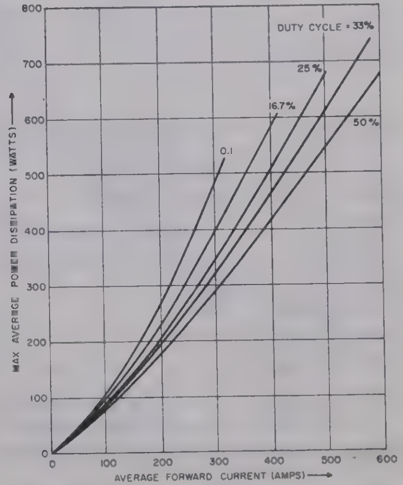
2. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM (ANODE BASE)



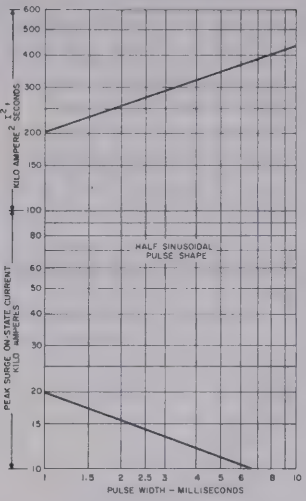
4. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM (CATHODE BASE)



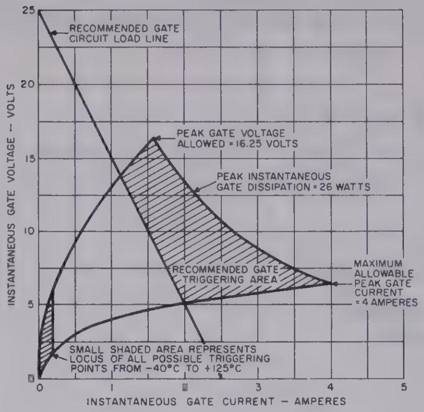
6. MAXIMUM ALLOWABLE HEAT EXCHANGER TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM—DOUBLE-SIDE COOLED



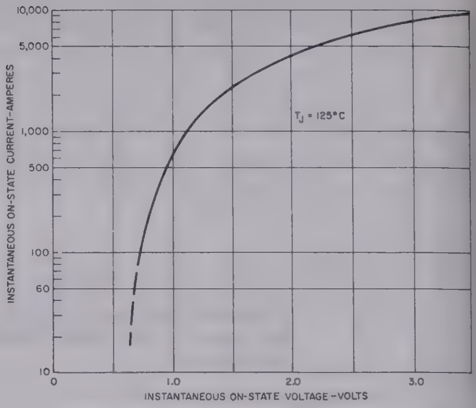
8. AVERAGE FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



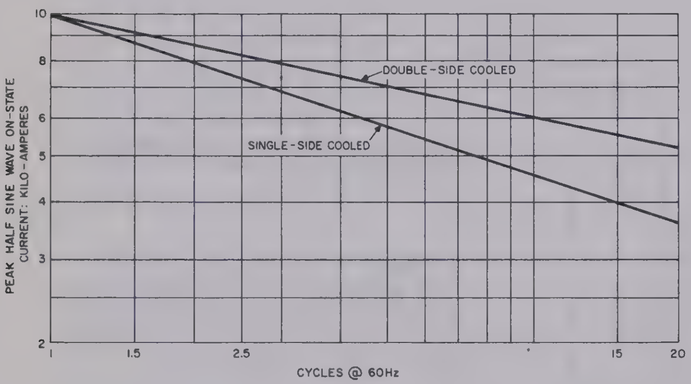
9. PEAK SUB-CYCLE SURGE AND I²t RATING FOLLOWING RATED LOAD CONDITIONS



11. GATE TRIGGERING CHARACTERISTICS

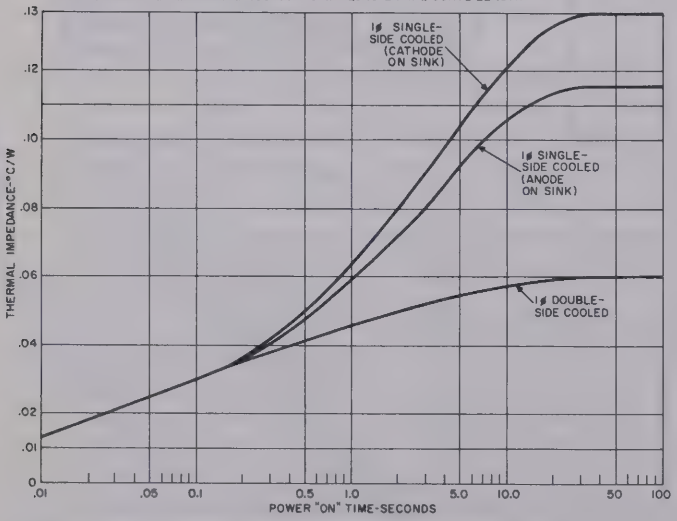


12. FORWARD CONDUCTION CHARACTERISTIC, ON-STATE

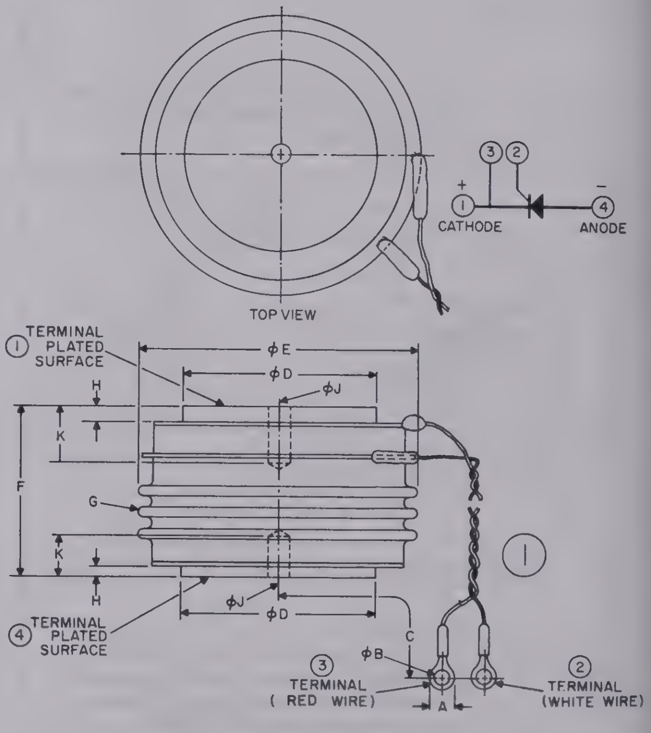


10. MAXIMUM ALLOWABLE SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS

NOTES:
FOR 3ϕ THERMAL RESISTANCE ADD .005°C/W ALONG ENTIRE CURVE LENGTH
FOR 6ϕ THERMAL RESISTANCE ADD .017°C/W ALONG ENTIRE CURVE LENGTH
FOR DC THERMAL RESISTANCE SUB .007°C/W ALONG ENTIRE CURVE LENGTH



13. TRANSIENT THERMAL IMPEDANCE— JUNCTION TO SINK


TOP VIEW
③
②
+
①
CATHODE
–
④
ANODE
① TERMINAL PLATED SURFACE
ϕE
ϕD
ϕJ
H
K
F
G
K
H
ϕJ
ϕD
④ TERMINAL PLATED SURFACE
①
C
ϕB
③ TERMINAL (RED WIRE)
A
② TERMINAL (WHITE WIRE)

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	0.200	0.240	5.08	6.10	
ϕB	0.140		3.56		
C	16.000	20.000	406.40	508.00	
ϕD	1.240	1.260	31.50	32.00	
ϕE		1.875		47.63	
F	1.000	1.040	25.40	26.42	
G					1
H	.052			1.32	
ϕJ	0.136	0.146	3.45	3.71	
K	0.220	0.280	5.59	7.11	

NOTE:
1. 1.000 (25.40 MM) MIN INSULATION (SURFACE CREEPAGE).

14. OUTLINE

FOR MOUNTING HARDWARE SEE SELECTOR GUIDE PAGE 171

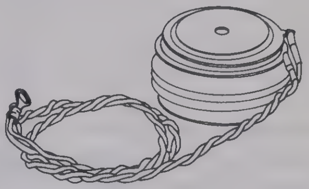
SCR

C530

The C530 Series of high power devices feature the proven, alloy-diffused construction in a new, larger General Electric pressure-mounted package.

Special features of these new devices are:

- Short delay time
- Pressure contacts
- Very high current
- Glazed ceramic package with 1″ creepage path
- Reversibility (eliminates need for special reverse polarity units)
- Hermetic seal
- Available in factory assembled heat exchangers or ready-to-mount



IMPORTANT: Mounting instructions on the last page of this specification must be followed.

MAXIMUM ALLOWABLE RATINGS

TYPE	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM} [1] $T_J = -40°C$ to $+125°C$	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM} [1] $T_J = -40°C$ to $+125°C$	TRANSIENT PEAK REVERSE VOLTAGE (Non-recurrent < 5 Millisec.), V_{RSM} $T_J = -40°C$ to $+125°C$
C530A	100 Volts	100 Volts	200 Volts
C530B	200	200	300
C530C	300	300	350
C530D	400	400	450
C530E	500	500	550
C530M	600	600	650

Average Forward Current, On-State	Depends on conduction angle (See Charts 1 and 3)
Peak One-Cycle Surge Forward Current, I_{TSM}	10,000 amperes
Maximum Rate of Rise of Anode Current During Turn-on Interval (High Gate Drive Required. See Chart 11) (Switching Rates ≦ 400 Hz.)	Switch From <500V 75A/μsec
I^2t (for fusing) (for times ≧ 1.5 milliseconds)	230,000 ampere² seconds
I^2t (for fusing) (at 8.3 milliseconds)	415,000 ampere² seconds
Peak Gate Power Dissipation, P_{GM}	26 Watts
Average Gate Power Dissipation, $P_{G(AV)}$	3 Watts
Peak Reverse Gate Voltage, V_{GRM}	5 Volts
Storage and Operating Temperature, T_{STG} & T_J	−40°C to +125°C
Mounting Force Required	2200 lbs. ±10% 910 kg. ±10%

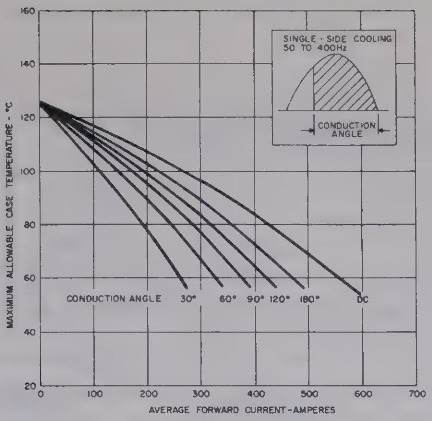
---

[1] Ratings apply for zero gate voltage. The C530 will trigger ON with negative gate current. Maximum heatsink thermal resistance for which maximum PRV ratings apply equal 1.1°C/watt.

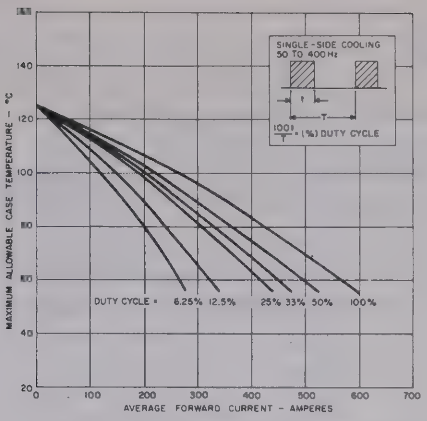
CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Peak Reverse and Forward Blocking Current	I_{DRM} and I_{RRM}	—	1	10	mA	$T_J = +25^\circ C$, $V = V_{DRM} = V_{RRM}$
Peak Reverse and Forward Blocking Current	I_{DRM} and I_{RRM}	—	15	25	mA	$T_J = 125^\circ C$, $V = V_{DRM} = V_{RRM}$
Effective Thermal Resistance (DC)	$\theta_{J\text{-}S}$	—	—	0.108	°C/watt	Junction to Sink—One side cooled, anode to Sink
		—	—	0.129		Junction to Sink—One side cooled, cathode to Sink
		—	—	0.054		Junction to Sink—Two sides cooled
Critical Exponential Rate of Rise of Forward Blocking Voltage (Higher values may cause device switching)	dv/dt	100	—	—	V/μsec	$T_J = +125^\circ C$, $V = \frac{1}{2} V_{DRM}$, Gate open.
		15	—	—		$T_J = 125^\circ C$, $V = V_{DRM}$, Gate open.
Holding Current	I_H	—	100	250	mAdc	$T_C = +25^\circ C$, Anode supply = 20Vdc, Initial forward current = 500 amps.
Latching Current	I_L	—	—	1	Adc	$T_C = +25^\circ C$, Anode voltage = 24Vdc, Load resistance, 24 ohms max.
Turn-On Time (Delay Time + Rise Time)	$t_d + t_r$	—	—	4.0	μsec	$T_C = +25^\circ C$, $I_F = 25$ Adc, $V_{DRM} =$ 140V, Gate supply: 24 volt open circuit, 10 ohm, 0.1 μsec max. rise time.
Gate Pulse Width Necessary to Trigger		—	—	15	μsec	$T_C = +25^\circ C$, Bias voltage = 5V, Gate Supply: 24 volt open circuit, 10 ohm, 0.1 μsec rise time.
Gate Trigger Current	I_{GT}	—	—	150	mAdc	$T_C = +25^\circ C$, $V_D = 10$Vdc, $R_L =$ 10 ohms
		—	—	200		$T_C = 0^\circ C$, $V_D = 10$Vdc, $R_L = 10$ ohms
Gate Trigger Voltage	V_{GT}	—	—	4.0	Vdc	$T_C = +25^\circ C$, $V_D = 10$Vdc, $R_L =$ 10 ohms.
Peak-On Voltage	V_{FM}	—	—	1.225	Volts	$T_C = +25^\circ C$, $I_{FM} = 1100$A peak, Duty cycle $\leqq 0.01\%$
Circuited Commutated Turn-Off Time	t_q	—	—	150	μsec	$T_C = +110^\circ C$, $I_{FM} = 50$A, $V_R = 60$ volts min., V_{DRM} (reapplied) = 100V, Rate of rise of reapplied forward blocking voltage = 20V/μsec linear.

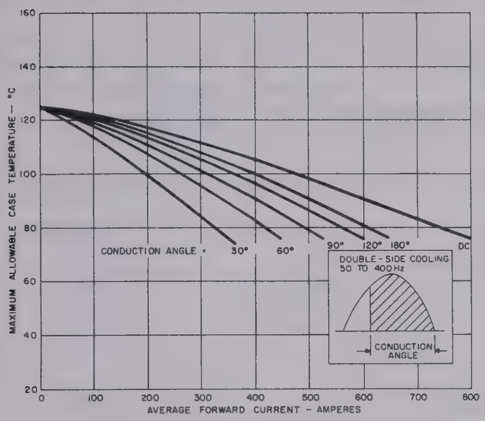
NOTE: T_C = Case Temperature (measured on heatsink ⅛ inch from base of SCR.)



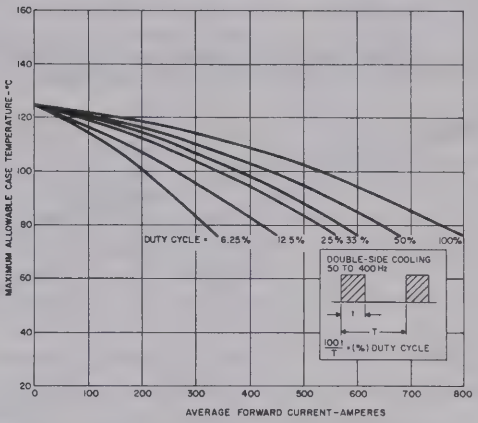
1. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



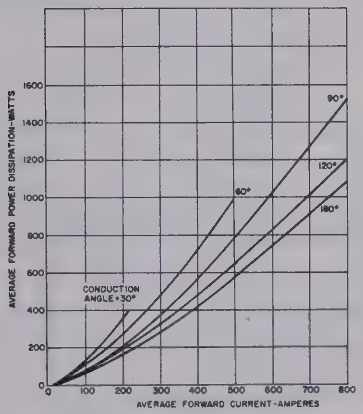
2. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



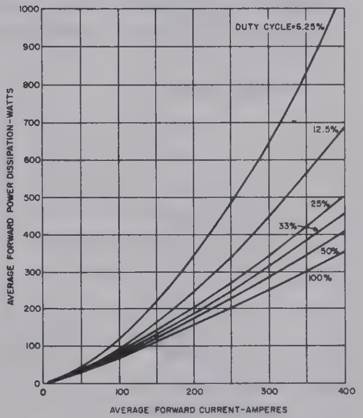
3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



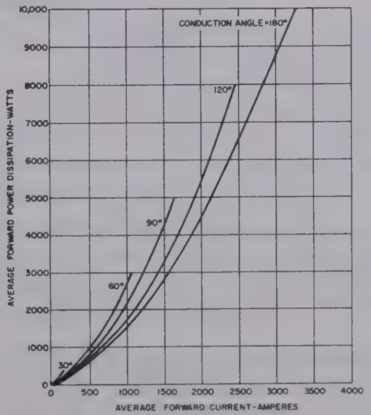
4. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



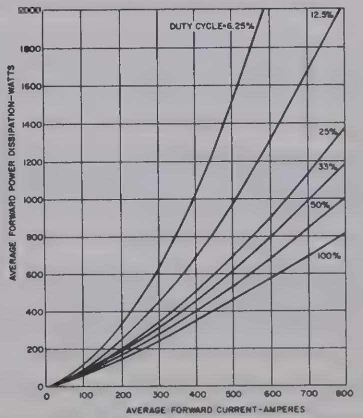
5. AVERAGE FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



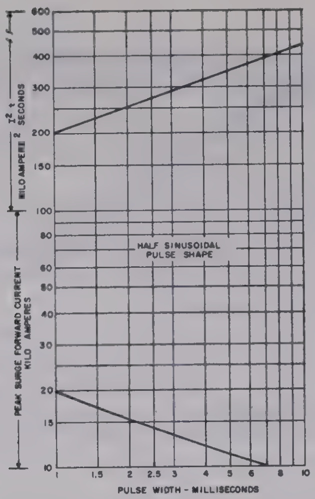
6. AVERAGE FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



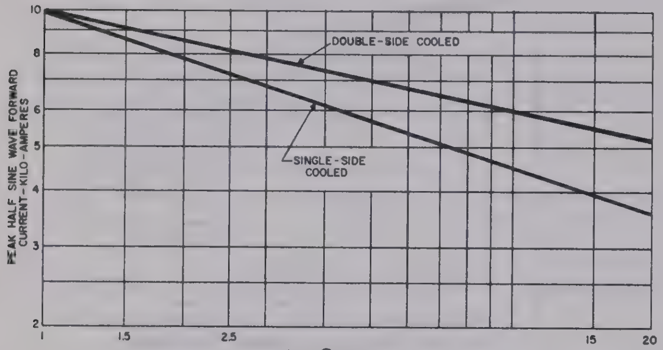
7. EXTENDED FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



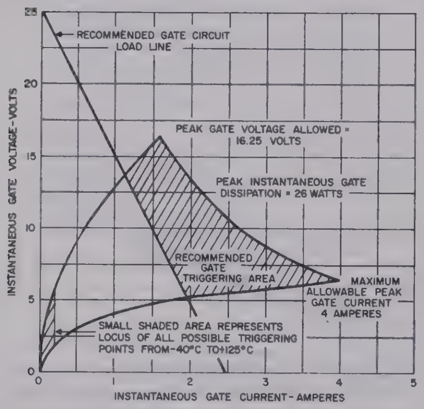
8. EXTENDED FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



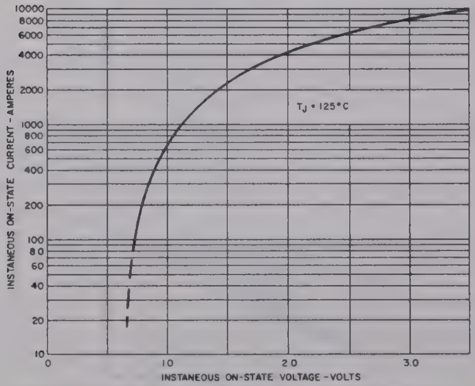
9. PEAK SUB-CYCLE SURGE AND I²t RATING FOLLOWING RATED LOAD CONDITIONS



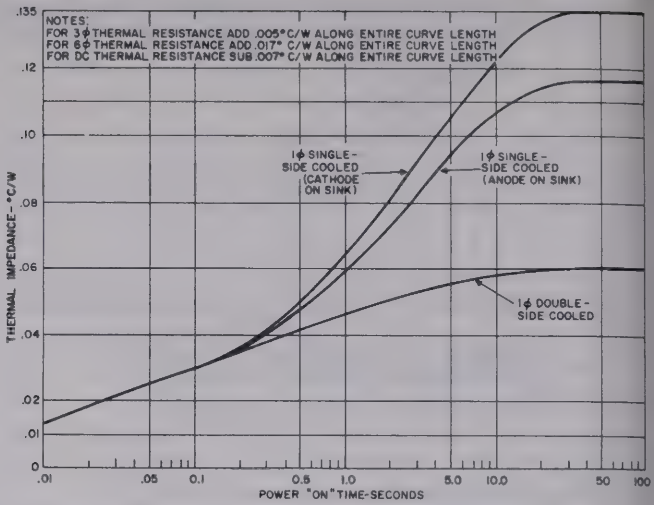
10. MAXIMUM ALLOWABLE SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS



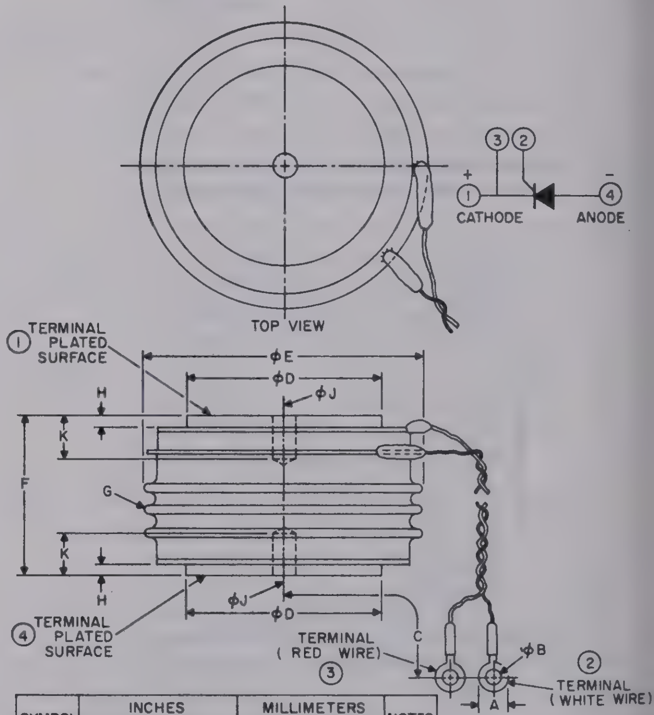
11. GATE TRIGGERING CHARACTERISTICS



12. FORWARD CONDUCTION CHARACTERISTIC, ON-STATE



13. TRANSIENT THERMAL IMPEDANCE—JUNCTION TO FIN


TOP VIEW
+
①
CATHODE
③
②
-
④
ANODE
① TERMINAL PLATED SURFACE
φE
φD
φJ
H
K
F
G
K
H
φJ
φD
④ TERMINAL PLATED SURFACE
TERMINAL (RED WIRE) ③
C
φB
A
② TERMINAL (WHITE WIRE)

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	0.200	0.240	5.08	6.10	
φB	0.140		3.56		
C	16.000	20.000	406.40	508.00	
φD	1.240	1.260	31.50	32.00	
φE		1.875		47.63	
F	1.000	1.040	25.40	26.42	
G					1
H	.052			1.32	
φJ	0.136	0.146	3.45	3.71	
K	0.220	0.280	5.59	7.11	

NOTE:
1. 1.000 (25.40MM) MIN. INSULATION (SURFACE CREEPAGE)

14. OUTLINE

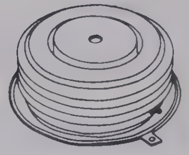
FOR MOUNTING HARDWARE SEE SELECTOR GUIDE PAGE 171

High Power
Silicon Controlled Rectifier

C600

900A AVG., UP TO 1300 VOLTS

The C600 Series of high power SCR's feature the proven alloy-diffused construction on a new, larger pressure-mounted package for phase control.



Special features of these new devices are:

- 900 Amps average single phase current in G6 water cooled heat exchanger
- 13,000 Amps surge current
- Glazed ceramic hermetic package with 1'' creepage path
- Reliability of pressure contacts plus reversibility of the package
- Available in factory assembled heat exchanger or ready to mount
- Complementary Rectifiers

MAXIMUM ALLOWABLE RATINGS

Type	V_{DRM}/V_{RRM} Repetitive $T_J = -40°C$ to $+125°C$	V_{DRM}/V_{RSM} Repetitive $T_J = 0°C$ to $+125°C$	Transient Peak Reverse Voltage (Non-Recurrent $<$ 5 Millisec.), V_{RSM} $T_J = -40°C$ to $+125°C$
C600E	500 Volts	600 Volts	600 Volts
C600M	600	700	700
C600S	700	800	800
C600N	800	900	900
C600T	900	1000	1000
C600P	1000	1100	1100
C600PA	1100	1200	1200
C600PB	1200	1300	1300

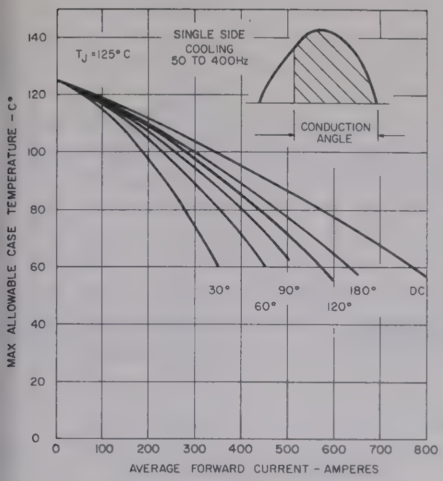
Average Forward Current, On-State	Depends on conduction angle	
Peak One-Cycle Surge ON-state Current, I_{TSM}		13000 amperes
Maximum Rate of Rise of Anode Current Turn-on Interval (Switching Rates $\leq$ 400 Hz.)	Switch From $\leq$ 600 V	150 A/usec
See Recommended Load Line Fig. 11	Switch From $\leq$ 1000V	125 A/usec
I^2t (for fusing) (at 8.3 milliseconds)		700,000 ampere² seconds
Peak Gate Power Dissipation, P_{GM}		40 Watts
Average Gate Power Dissipation, $P_{G(AV)}$		5 Watts
Peak Reverse Gate Voltage, V_{GRM}		5 Volts
Storage and Operating Temperature, T_{STG} & T_J		Refer Above
Mounting Force Required		4000 lbs. ± 10%

---

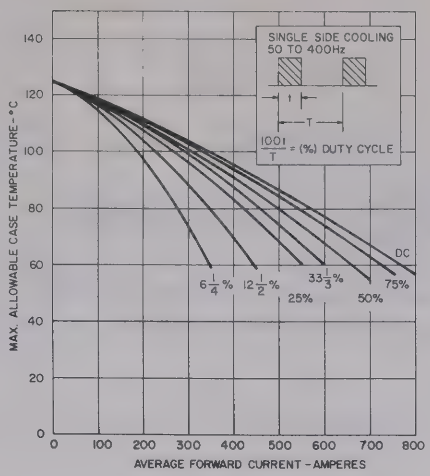
[1] Ratings apply for zero gate voltage. The C600 SCR will trigger ON with negative gate current. This is not a recommended method of triggering.

CHARACTERISTICS

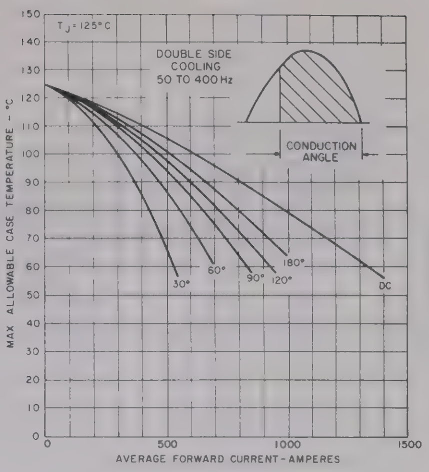
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Peak Reverse and Forward Blocking Current	I_{DRM} and I_{RRM}	—	10	15	mA	$T_J = +25°C$, $V = V_{DRM} = V_{RRM}$
Peak Reverse and ON-state Blocking Current	I_{DRM} and I_{RRM}	—	15	35	mA	$T_J = +125°C$, $V = V_{DRM} = V_{RRM}$
Effective Thermal Resistance (DC), $R_{\theta JS}$	DC	—	—	.041	°C/watt	Junction to Sink Double Side Cooled
	1∅			.045		
	3∅	—	—	.048		
	6∅	—	—	.056		
Critical Exponential Rate of Rise of Forward Blocking Voltage (Higher values may cause device switching)	dv/dt	100	—	—	V/usec	$T_J = +125°C$, $V_{DRM} = .67$ Rated Gate open.
Holding Current	I_H	—	100	250	mAdc	$T_C = +25°C$, Anode supply = 20Vdc. Initial forward current=500 amps.
Latching Current	I_L	—	—	1	Adc	$T_C = +25°C$, Anode voltage=24Vdc. Load resistance 12 ohms max.
Delay Time	t_d	—	4.0		usec	Switching From 140 Volts 14 Volt, 40Ω Gate 2 usec Rise Time
Gate Pulse Width Necessary to Trigger		—	—	10	usec	See Figure 11
Gate Trigger Current **See Fig #11**	I_{GT}	—	— 80	— 150	mAdc	$T_C = 25°C$, $V_D = 10$ VDC, $R_L = 3$ Ohms
		5.0	15	75		$T_C = +125°C$, $V_D = .5$ x Rated $R_L = 1000$ Ohms
Gate Trigger Voltage **See Fig #11**	V_{GT}	—	2.6	4.5	Vdc	$T_C = 0°C$, to $+125°C$, $V_D = 10$ VDC, $R_L = 3$ Ohms
		.2	—	—		$T_C = 125°C$, $V_D = .5$ x Rated, $R_L = 1000$ Ohms
Peak On-Voltage	V_{FM}	—	—	1.50	Volts	$T_C = +125°C$, $I_T = 2200$ Amp Peak Duty Cycle $\leqq 0.01\%$
Circuit Commutated Turn-Off Time	t_q	—	300	350	usec	$T_C = +125°C$, $I_T = 450A$, $V_R = 75$ volts min., V_{DRM} (reapplied) = ½ Rated, Rate of rise of reapplied forward blocking voltage = .25V/usec linear, Gate bias = open during turn-off interval, Duty cycle $\leqq 0.01\%$



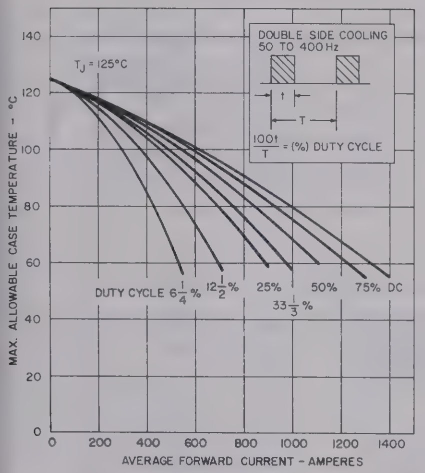
1. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM —SINGLE-SIDE COOLED



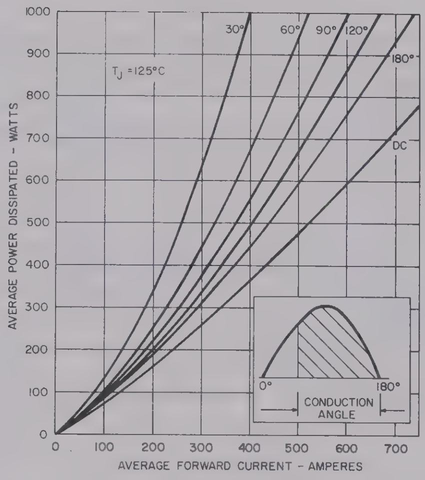
2. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM —SINGLE-SIDE COOLED



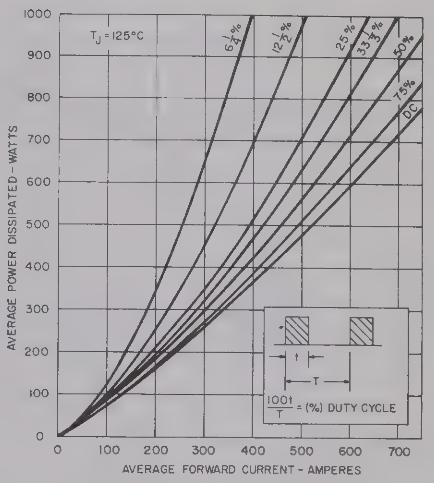
3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM —DOUBLE-SIDE COOLED



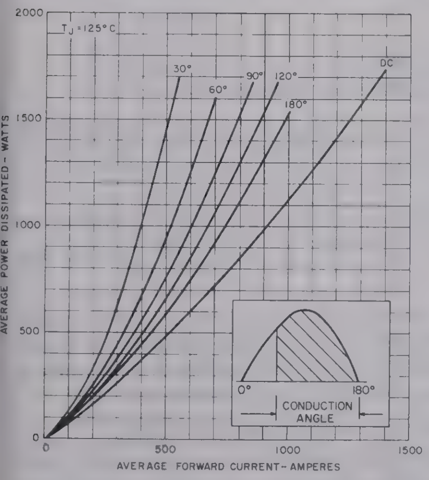
4. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM —DOUBLE-SIDE COOLED



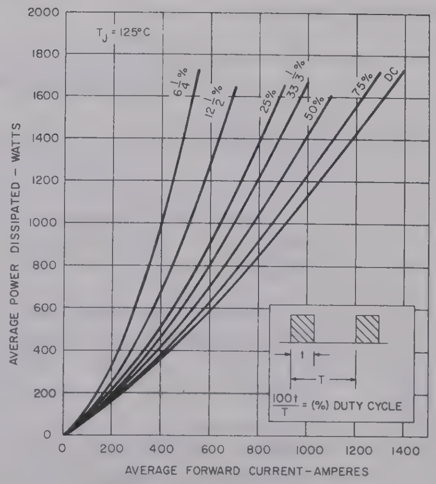
5. AVERAGE FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



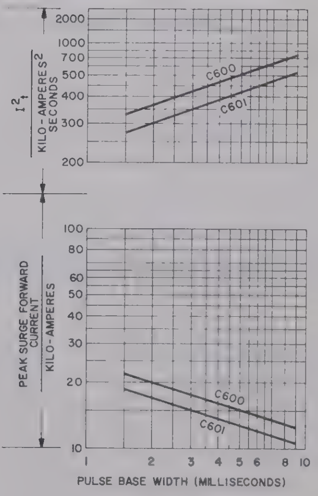
6. AVERAGE FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



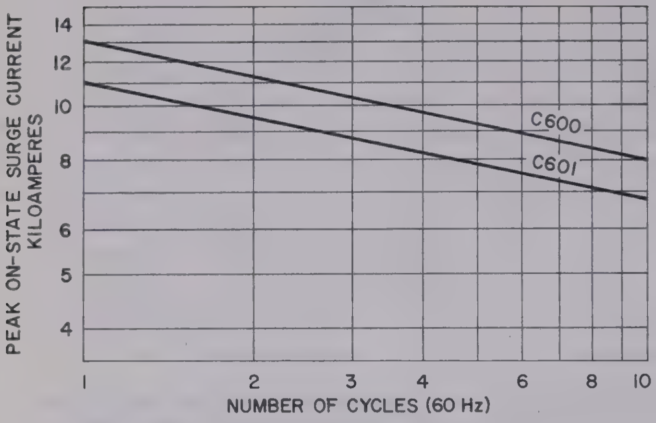
7. EXTENDED FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



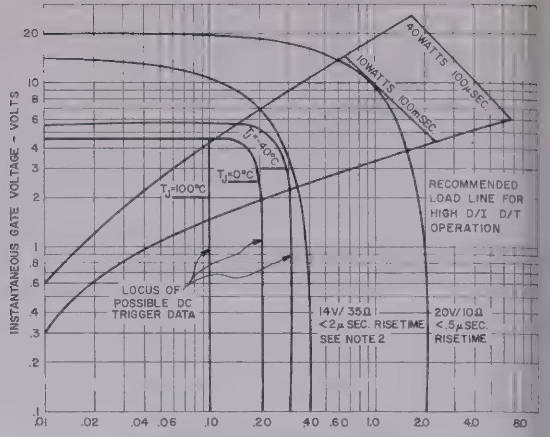
8. EXTENDED FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



9. SUB-CYCLE SURGE AND I²t RATING FOLLOWING RATED LOAD CONDITIONS

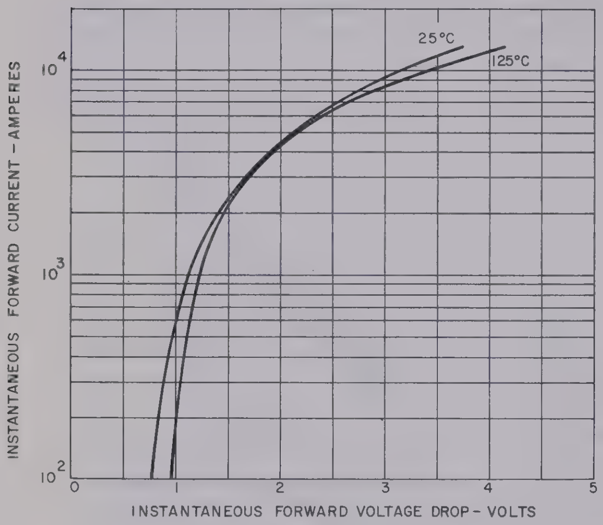


10. MAXIMUM ALLOWABLE SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS

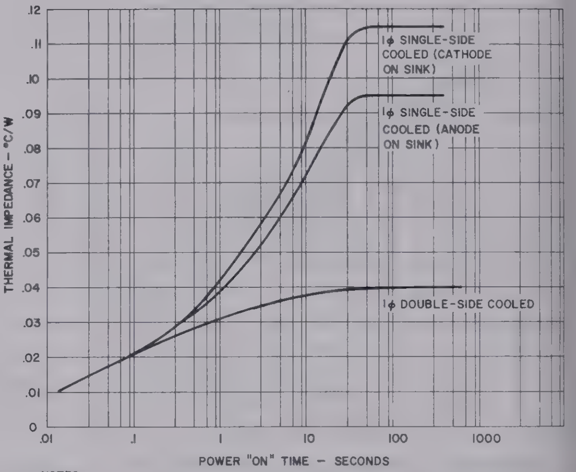


NOTES
(1) NON TRIGGER DATA ±5mA, ±.2V AT 125°C, 1/2 PFV
(2) 14V/35Ω LOAD LINE NOT RECOMMENDED FOR OPERATION BELOW 0°C

11. GATE TRIGGERING CHARACTERISTICS



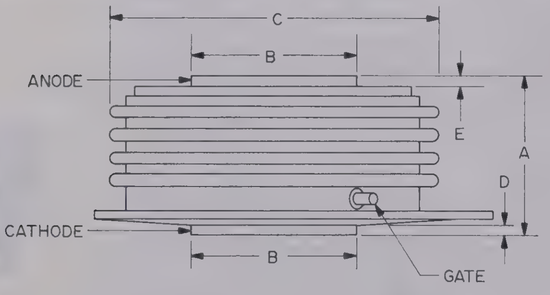
12. FORWARD CONDUCTION CHARACTERISTIC, ON-STATE



NOTES:
FOR 3 ϕ THERMAL RESISTANCE ADD .0032°C/W ALONG ENTIRE CURVE LENGTH
FOR 6 ϕ THERMAL RESISTANCE ADD .011°C/W ALONG ENTIRE CURVE LENGTH
FOR DC THERMAL RESISTANCE SUB .0045°C/W ALONG ENTIRE CURVE LENGTH

13. TRANSIENT THERMAL IMPEDANCE—JUNCTION TO CASE

FOR MOUNTING HARDWARE SEE SELECTOR GUIDE PAGE 171



	DECIMAL (INCHES)		METRIC (MM)	
	MIN.	MAX.	MIN.	MAX.
A	1.000	1.040	25.40	26.42
B	1.330	1.350	33.78	34.29
C	—	2.100	—	53.44
D	.020	.105	.508	2.67
E	.020	.096	.508	2.44

STD AUX. CATHODE & GATE LEAD - 12"

14. OUTLINE

C600
SUGGESTED MOUNTING METHODS

When mounted in accordance with the following general instructions, ratings given in the transient thermal curve (Figure 13) will be obtained.

1. Check both surfaces of unit for nicks, etc. (the surfaces are prepared to meet flatness of 0.4 mils or less, and surface finish √32).

2. Check heat sink surfaces for the required flatness of 0.4 mils or less within a 1.5" diameter. Wire brush these areas with Penetrox "A", Alcoa 2, or other grease compound for inhibiting oxides. Wipe off grease and apply a new, thin layer.

3. Assemble with 3900 ± 400 lbs. force applied through a self-leveling, swivel connection. The force has to be evenly distributed over the full area. Center holes on both sides of the device may be used for locating.

---

* G623, DC 3 and DC 4 are light and colorless silica-thickened, silicone greases. G623 is made by General Electric Co., Silicone Products Dept., Waterford, N.Y. DC 3 and DC 4 are made by Dow-Corning, Midland, Michigan.

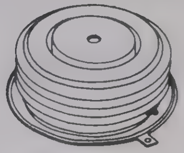
High Power

Silicon Controlled Rectifier

C601

750 A AVG., UP TO 1800 VOLTS

The C601 Series of high power SCR's feature the proven alloy-diffused construction in a new, larger pressure-mounted package for phase control.



Special features of these new devices are:

- 750 Amps average single phase current in G6 water cooled heat exchanger
- 11,000 Amps surge current
- Glazed ceramic hermetic package with 1'' creepage path
- Reliability of pressure contacts plus reversibility of the package
- Available in factory assembled heat exchanger or ready to mount
- Complementary rectifiers

MAXIMUM ALLOWABLE RATINGS

Type	V_{DRM}/V_{RRM} Repetitive $T_J = -40°C$ to $+125°C$	V_{DRM}/V_{RRM} Repetitive $T_J = 0°C$ to $+125°C$	Transient Peak Reverse Voltage (Non-Recurrent <5 Millisec.), V_{RSM}, $T_J = -40°C$ to $+125°C$
C601PA	1100Volts	1200 Volts	1200 Volts
C601PB	1200	1300	1300
C601PC	1300	1400	1400
C601PD	1400	1500	1500
C601PE	1500	1600	1600
C601PM	1600	1700	1700
C601PS	1700	1800	1800

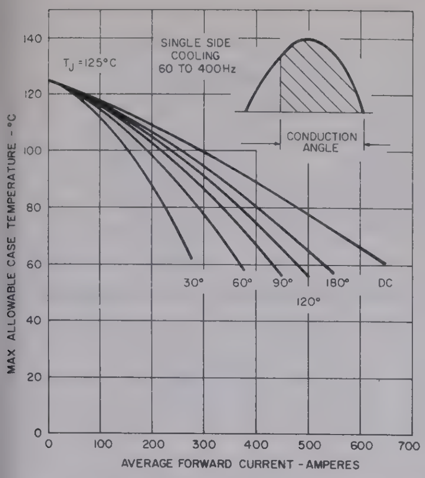
Average Forward Current, On-State		Depends on conduction angle
Peak One-Cycle Surge ON-State Current, I_{TSM}		11,000 amperes
Maximum Rate of Rise of Anode Current Turn-on Interval (See Chart 11) (Switching Rates $\leqq$ 400 Hz.)	Switch From $\leq$ 600 V	150A/usec
	Switch From $<$ 1000V	100A/usec
	Switch From $\geq$ 1300V	80A/usec
I^2t (for fusing) (at 8.3 milliseconds)		500,000 ampere^2 seconds
Peak Gate Power Dissipation, P_{GM}		40 Watts
Average Gate Power Dissipation, $P_{G(AV)}$		5 Watts
Peak Reverse Gate Voltage, V_{GRM}		5 Volts
Storage and Operating Temperature T_{STG} & T_J		Refer Above
Mounting Force Required		4000 lbs. ± 10%

---

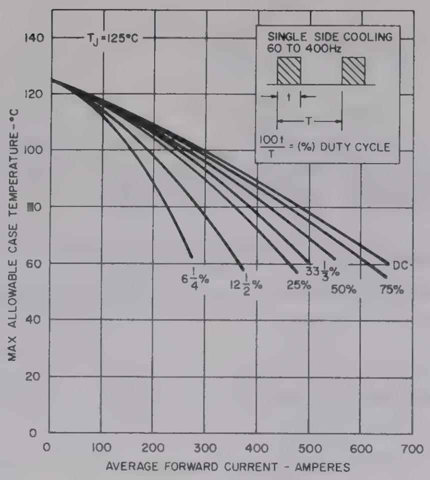
[1] Ratings apply for zero gate voltage. The C601 SCR will trigger ON with negative gate current. This is not a recommended method of triggering.

CHARACTERISTICS

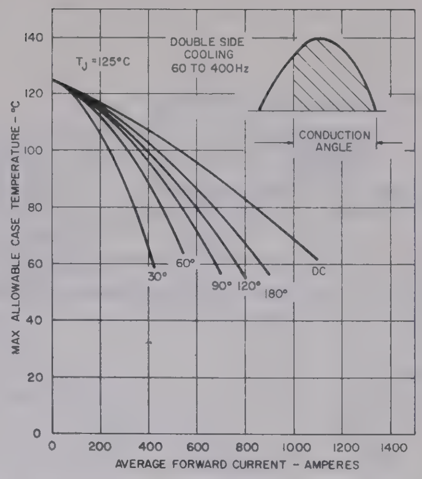
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Peak Reverse and Forward Blocking Current	I_{DRM} and I_{RRM}	—	10	15	mA	T_J=+25°C, V = V_{DRM} = V_{RRM}
Peak Reverse and ON-state Blocking Current	I_{DRM} and I_{RRM}	—	15	35	mA	T_J = +125°C, V = V_{DRM} = V_{RRM}
Effective Thermal Resistance (DC), $R_{\theta JS}$	DC	—	—	.041	°C/watt	Junction to Sink Double Side Cooled
	1Ø			.045		
	3Ø	—	—	.048		
	6Ø	—	—	.056		
Critical Exponential Rate of Rise of Forward Blocking Voltage (Higher values may cause device switching)	dv/dt	100	—	—	V/usec	T_J = +125°C, V_{DRM} = .67 Rated Gate open.
Holding Current	I_H	—	100	250	mAdc	T_C = +25°C, Anode supply = 20Vdc. Initial forward current=500 amps.
Latching Current	I_L	—	—	1	Adc	T_C = +25°C, Anode voltage=24Vdc. Load resistance 12 ohms max.
Delay Time	t_d	—	4.0		usec	Switching From 140 Volts 14 Volt, 40Ω Gate 2 usec Rise Time
Gate Pulse Width Necessary to Trigger		—	—	10	usec	See Figure 11
Gate Trigger Current See Fig # 11	I_{GT}	—	— 80	— 150	mAdc	T_C = 25°C, V_D = 10 VDC, R_L = 3 Ohms
		5.0	15	75		T_C = +125°C, V_D = .5 x Rated R_L = 1000 Ohms
Gate Trigger Voltage See Fig #11	V_{GT}	—	2.6	4.5	Vdc	T_C = 0°C, to +125°C, V_D = 10 VDC, R_L = 3 Ohms
		.2	—	—		T_C = 125°C, V_D = .5 x Rated, R_L = 1000 Ohms
Peak On-Voltage	V_{FM}	—	—	1.50	Volts	T_C = + 125°C, I_T = 1500 Amp Peak Duty Cycle ≦ 0.01%
Circuit Commutated Turn-Off Time	t_q	—	300	350	usec	T_C = +125°C, I_T = 450A, V_R = 75 volts min., V_{DRM} (reapplied) = ½ Rated, Rate of rise of reapplied forward blocking voltage = .25V/usec linear, Gate bias = open during turn-off interval, Duty cycle ≦ 0.01%



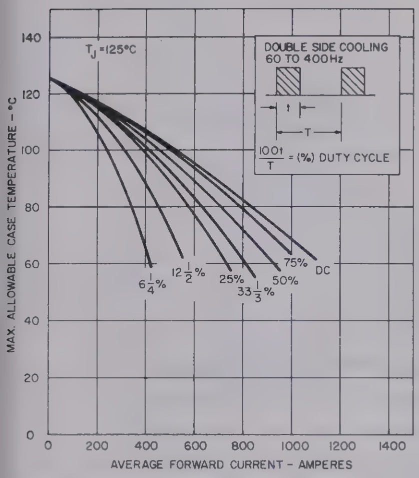
1. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM —SINGLE-SIDE COOLED



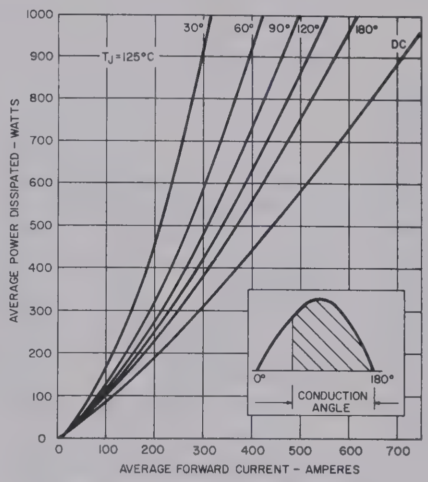
2. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM —SINGLE-SIDE COOLED



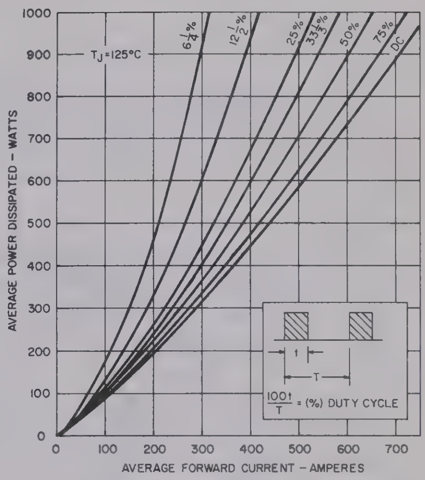
3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM —DOUBLE-SIDE COOLED



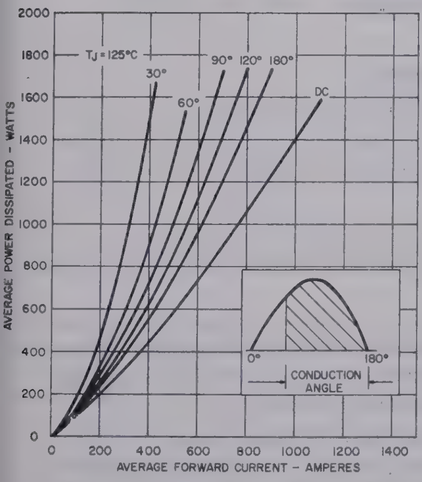
4. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM —DOUBLE-SIDE COOLED



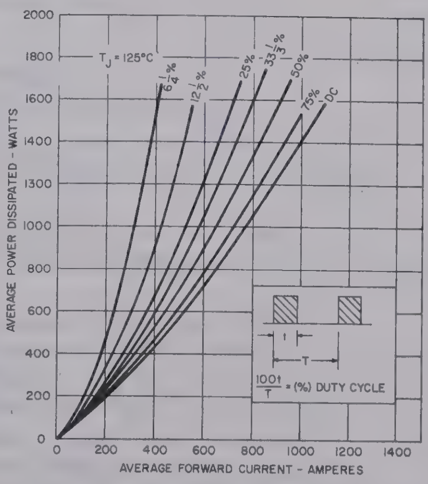
5. AVERAGE FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



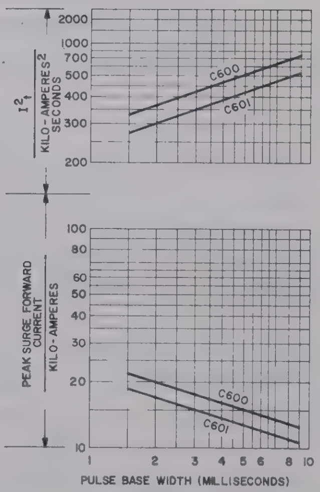
6. AVERAGE FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



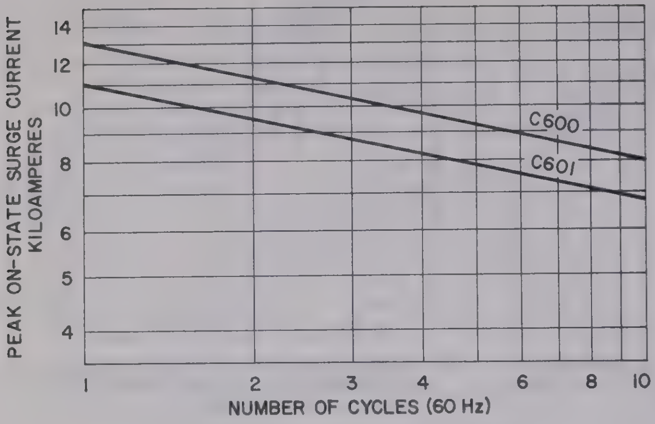
7. EXTENDED FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



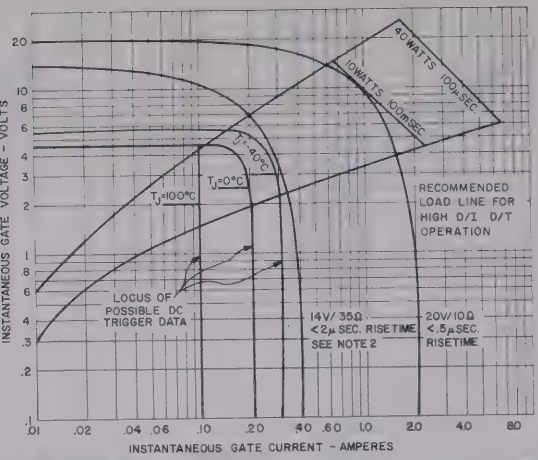
8. EXTENDED FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



9. SUB-CYCLE SURGE AND I^2t RATING FOLLOWING RATED LOAD CONDITIONS

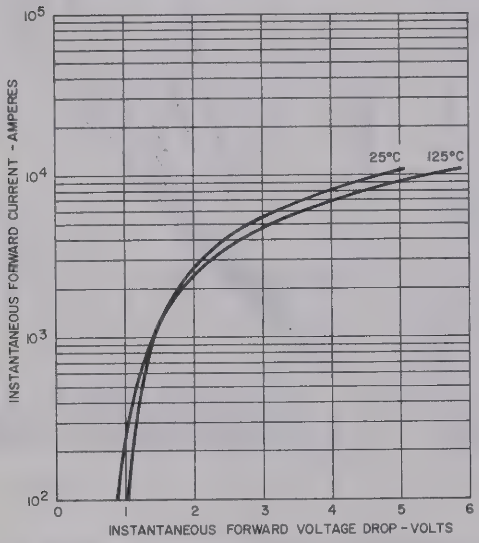


10. MAXIMUM ALLOWABLE SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS

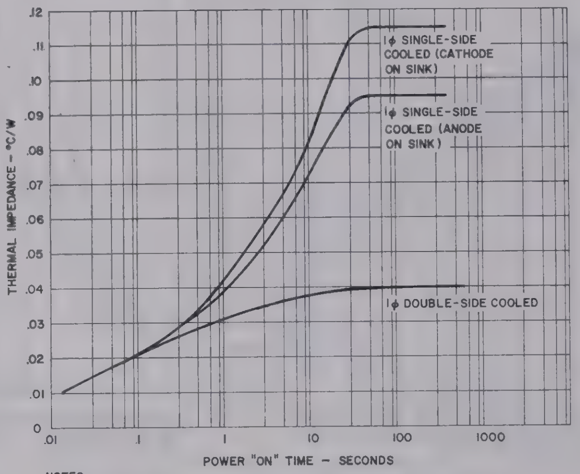


NOTES:
(1) NON TRIGGER DATA ±5mA, ±.2V AT 125°C, 1/2 PFV
(2) 14V/35Ω LOAD LINE NOT RECOMMENDED FOR OPERATION BELOW 0°C

11. GATE TRIGGERING CHARACTERISTICS



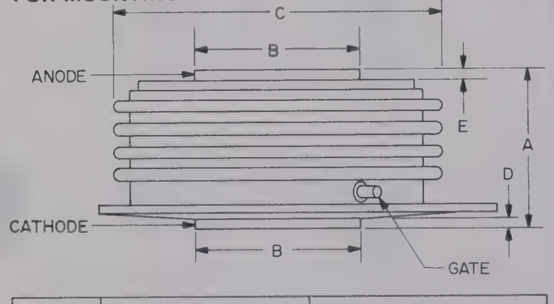
12. FORWARD CONDUCTION CHARACTERISTIC, ON-STATE



NOTES:
FOR 3 φ THERMAL RESISTANCE ADD .0032°C/W ALONG ENTIRE CURVE LENGTH
FOR 6 φ THERMAL RESISTANCE ADD .011°C/W ALONG ENTIRE CURVE LENGTH
FOR DC THERMAL RESISTANCE SUB .0045°C/W ALONG ENTIRE CURVE LENGTH

13. TRANSIENT THERMAL IMPEDANCE—JUNCTION TO CASE

FOR MOUNTING HARDWARE SEE SELECTOR GUIDE PAGE 171



	DECIMAL (INCHES)		METRIC (MM)	
	MIN.	MAX.	MIN.	MAX
A	1.000	1.040	25.40	26.42
B	1.330	1.350	33.78	34.29
C	—	2.100	—	53.44
D	.020	.105	.508	2.67
E	.020	.096	.508	2.44

STD AUX. CATHODE & GATE LEAD - 12"

14. OUTLINE

C600 SERIES SUGGESTED MOUNTING METHODS

When mounted in accordance with the following general instructions, ratings given in the transient thermal curve (Figure 13) will be obtained.

1. Check both surfaces of unit for nicks, etc. (the surfaces are prepared to meet flatness of 0.4 mils or less, and surface finish √32).

2. Check heat sink surfaces for the required flatness of 0.4 mils or less within a 1.5" diameter. Wire brush these areas with Penetrox "A", Alcoa 2, or other grease compound for inhibiting oxides. Wipe off grease and apply a new, thin layer.

3. Assemble with 3900 ± 400 lbs. force applied through a self-leveling, swivel connection. The force has to be evenly distributed over the full area. Center holes on both sides of the device may be used for locating.

*** G623, DC 3 and DC 4 are light and colorless silica-thickened, silicone greases. G623 is made by General Electric Co., Silicone Products Dept., Waterford, N.Y. DC 3 and DC 4 are made by Dow-Corning, Midland, Michigan.**

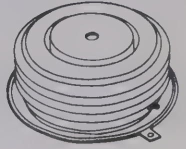
High Power

Silicon Controlled Rectifier

C602

600A AVG., UP TO 2600 VOLTS

The C602 Series of high power SCR's feature the proven alloy-diffused construction in a new, larger pressure-mounted package for phase control.



Special features of these new devices are:

- 2600 Volt blocking voltage capability
- Glazed ceramic hermetic package with 1'' creepage path
- Reliability of pressure contacts plus reversibility of the package
- Available in factory assembled heat exchanger or ready to mount
- Complementary Rectifiers

MAXIMUM ALLOWABLE RATINGS

Type	V_{DRM}/V_{RRM} Repetitive $T_J = -40°C$ to $+125°C$	V_{DRM}/V_{DRM} Repetitive $T_J = 0°C$ to $+125°C$	Transient Peak Reverse Voltage (Non-Recurrent < 5 Millisec.), V_{RSM} $T_J = -40°C$ to $+125°C$
C602PS	1700 Volts	1800 Volts	1800 Volts
C602PN	1800	1900	1900
C602PT	1900	2000	2000
C602L	2000	2100	2100
C602LA	2100	2200	2200
C602LB	2200	2300	2300
C602LC	2300	2400	2400
C602LD	2400	2500	2500
C602LE	2500	2600	2600

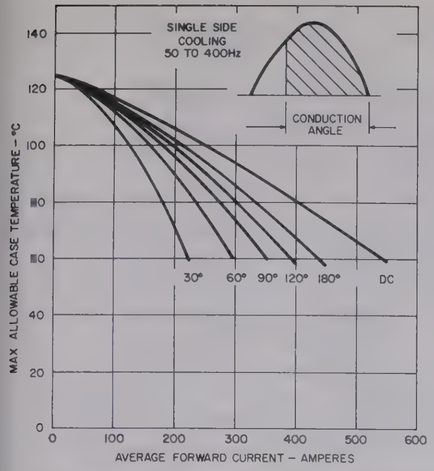
Average Forward Current, On-State . . . . Depends on conduction angle
Peak One-Cycle Surge ON-state Current, I_{TSM} . . . . 7000 amperes
Maximum Rate of Rise of Anode Current Turn-on Interval
(Switching Rates ≦ 400Hz.). . . . . Switch From < 600 V. 75A/usec
See Curve 11 For Recommended Load Line Switch From < 1000 V. 50A/usec
Switch From < 1500 V. 35A/usec

I2t (for fusing) (at 8.3 milliseconds). . . . . 200,000 ampere2 seconds
Peak Gate Power Dissipation, P_{GM} . . . . 40 Watts
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 5 Watts
Peak Rverse Gate Voltage, V_{GRM} . . . . 5 Volts
Storage and Operating Temperature, T_{STG} & T_J. . . . . Refer Above
Mounting Force Required . . . . 4000 lbs. ± 10%

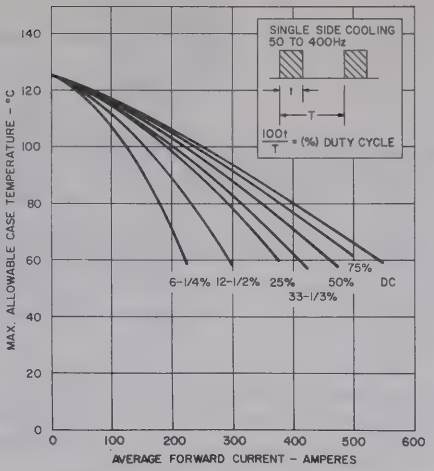
[1] Ratings apply for zero gate voltage. The C602 SCR will trigger ON with negative gate current. Maximum heatsink thermal resistance for which maximum PRV ratings apply equal 1.1°C/watt. This is not a recommended method of triggering.

CHARACTERISTICS

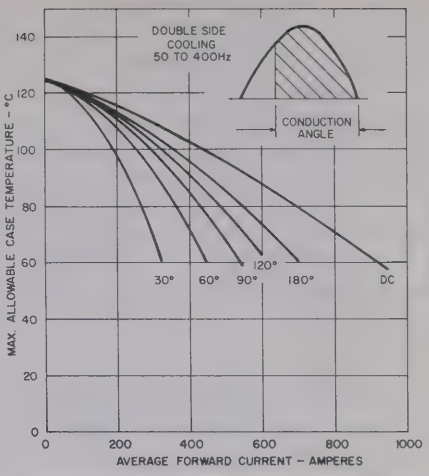
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Peak Reverse and Forward Blocking Current	I_{DRM} and I_{RRM}	—	10	15	mA	$T_J = +25°C$, $V = V_{DRM} = V_{RRM}$
Peak Reverse and ON-state Blocking Current	I_{DRM} and I_{RRM}	—	15	35	mA	$T_J = +125°C$, $V = V_{DRM} = V_{RRM}$
Effective Thermal Resistance (DC), $R_{\Theta JS}$	DC	—	—	.041	°C/watt	Junction to Sink Double Side Cooled
	1φ			.045		
	3φ	—	—	.048		
	6φ	—	—	.056		
Critical Exponential Rate of Rise of Forward Blocking Voltage (Higher values may cause device switching)	dv/dt	100	—	—	V/usec	$T_J = +125°C$, $V_{DRM} = .67$ Rated Gate open.
Holding Current	I_H	—	100	250	mAdc	$T_C = +25°C$, Anode supply = 20Vdc. Initial forward current=500 amps.
Latching Current	I_L	—	—	1	Adc	$T_C = +25°C$, Anode voltage=24Vdc. Load resistance 12 ohms max.
Delay Time	t_d	—	4.0		usec	Switching From 140 Volts 14 Volt, 40Ω Gate 2 usec Rise Time
Gate Pulse Width Necessary to Trigger		—	—	10	usec	See Figure 11
Gate Trigger Current Fig #11	I_{GT}	—	— 80	— 150	mAdc	$T_C = 25°C$, $V_D = 10$ VDC, $R_L = 3$ Ohms
		5.0	15	75		$T_C = +125°C$, $V_D = .5$ x Rated $R_L = 1000$ Ohms
Gate Trigger Voltage Fig # II	V_{GT}	—	2.6	4.5	Vdc	$T_C = 0°C$, to $+125°C$, $V_D = 10$ VDC, $R_L = 3$ Ohms
		.2	—	—		$T_C = 125°C$, $V_D = .5$ x Rated, $R_L = 1000$ Ohms
Peak On-Voltage	V_{FM}	—	—	1.90	Volts	$T_C = +125°C$, $I_T = 1000$ Amp Peak Duty Cycle ≦ 0.01%
Circuit Commutated Turn-Off Time	t_q	—	300	350	usec	$T_C = +125°C$, $I_T = 450A$, $V_R = 75$ volts min., V_{DRM} (reapplied) = ½ Rated, Rate of rise of reapplied forward blocking voltage = .25V/usec linear, Gate bias = open during turn-off interval, Duty cycle ≦ 0.01%



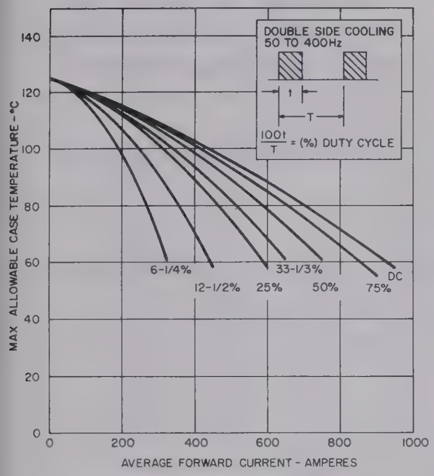
1. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM —SINGLE-SIDE COOLED



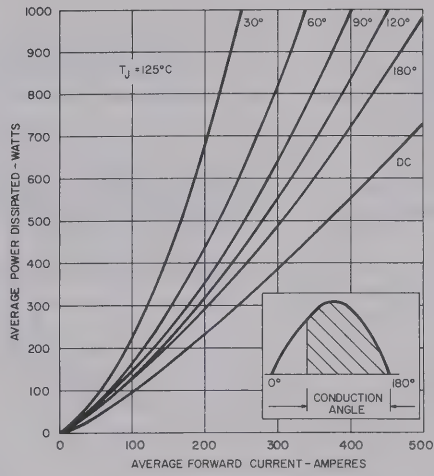
2. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM —SINGLE-SIDE COOLED



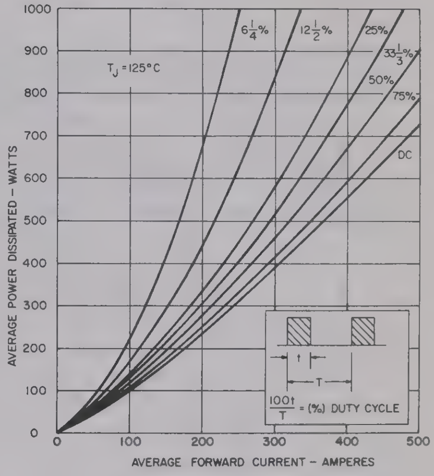
3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM —DOUBLE-SIDE COOLED



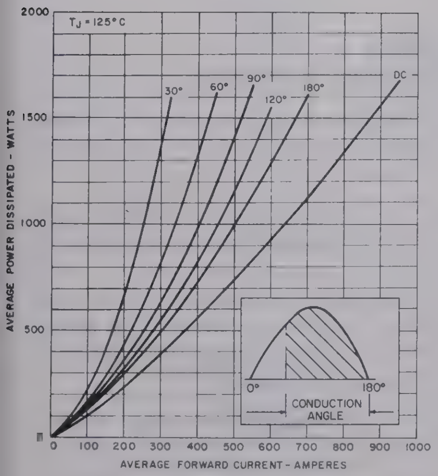
4. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM —DOUBLE-SIDE COOLED



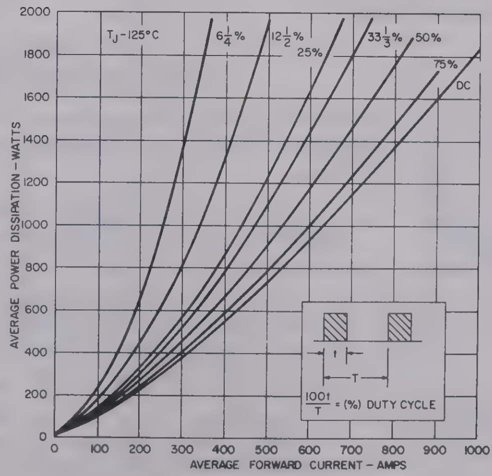
5. AVERAGE FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



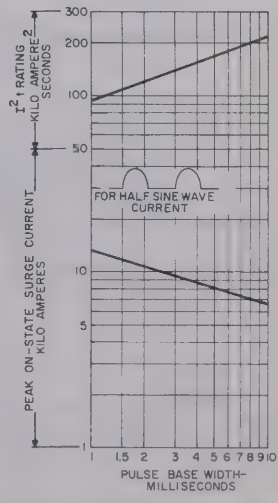
6. AVERAGE FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



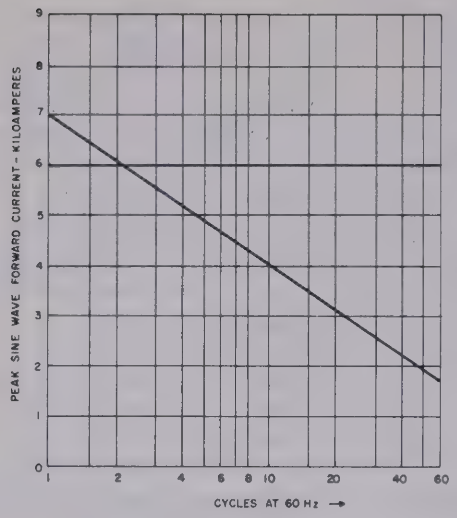
7. EXTENDED FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



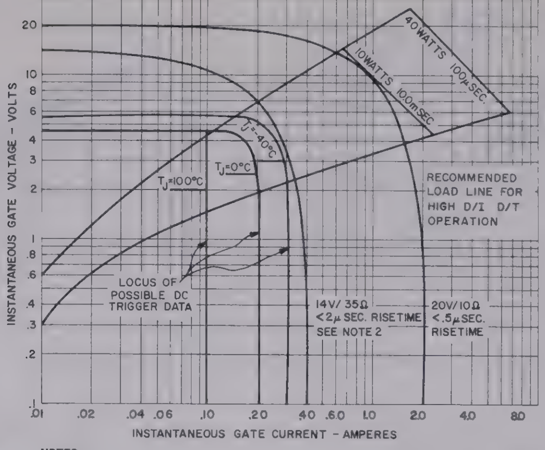
8. EXTENDED FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



9. SUB-CYCLE SURGE AND I^{2}t RATING FOLLOWING RATED LOAD CONDITIONS

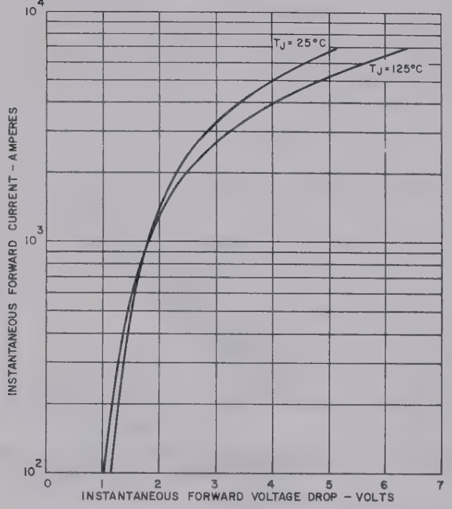


10. MAXIMUM ALLOWABLE SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS

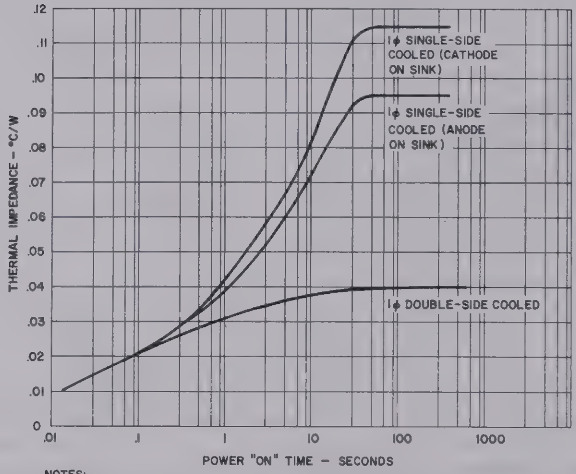


NOTES:
(1) NON TRIGGER DATA ±5mA, ±.2V AT 125°C, 1/2 PFV
(2) 14V/35Ω LOAD LINE NOT RECOMMENDED FOR OPERATION BELOW 0°C

11. GATE TRIGGERING CHARACTERISTICS



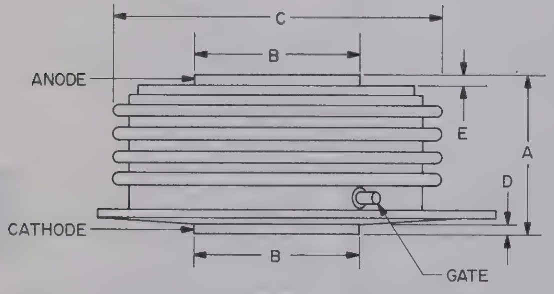
12. FORWARD CONDUCTION CHARACTERISTIC, ON-STATE



NOTES:
FOR 3 ϕ THERMAL RESISTANCE ADD .0032°C/W ALONG ENTIRE CURVE LENGTH
FOR 6 ϕ THERMAL RESISTANCE ADD .011°C/W ALONG ENTIRE CURVE LENGTH
FOR DC THERMAL RESISTANCE SUB .0045°C/W ALONG ENTIRE CURVE LENGTH

13. TRANSIENT THERMAL IMPEDANCE—JUNCTION TO CASE

FOR MOUNTING HARDWARE SEE SELECTOR GUIDE PAGE 171



	DECIMAL (INCHES)		METRIC (MM)	
	MIN.	MAX.	MIN.	MAX.
A	1.000	1.040	25.40	26.42
B	1.330	1.350	33.78	34.29
C	—	2.100	—	53.44
D	.020	.105	.508	2.67
E	.020	.096	.508	2.44

STD AUX. CATHODE & GATE LEAD - 12"

14. OUTLINE

C600 SERIES SUGGESTED MOUNTING METHODS

When mounted in accordance with the following general instructions, ratings given in the transient thermal curve (Figure 13) will be obtained.

1. Check both surfaces of unit for nicks, etc. (the surfaces are prepared to meet flatness of 0.4 mils or less, and surface finish $\sqrt{32}$).

2. Check heat sink surfaces for the required flatness of 0.4 mils or less within a 1.5" diameter. Wire brush these areas with Penetrox "A", Alcoa 2, or other grease compound for inhibiting oxides. Wipe off grease and apply a new, thin layer.

3. Assemble with 3900 ± 400 lbs. force applied through a self-leveling, swivel connection. The force has to be evenly distributed over the full area. Center holes on both sides of the device may be used for locating.

---

* G623, DC 3 and DC 4 are light and colorless silica-thickened, silicone greases. G623 is made by General Electric Co., Silicone Products Dept., Waterford, N.Y. DC 3 and DC 4 are made by Dow-Corning, Midland, Michigan.

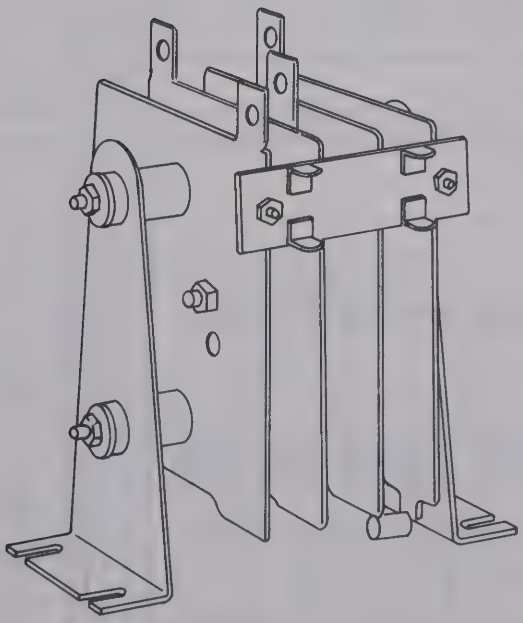
SCR

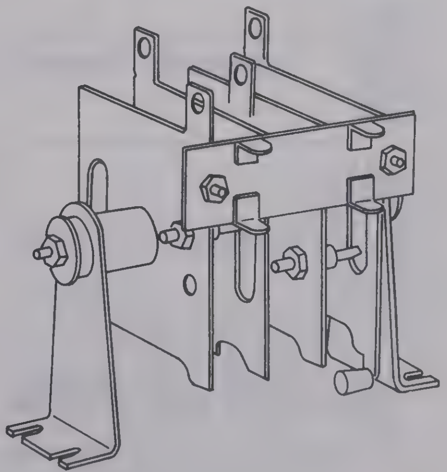
LOW AND MEDIUM CURRENT STACKS

C1012-13
C1112-13
C1212-13
C3512-13
C4012-13

Now, for the first time, from the originator of the Silicon Controlled Rectifier, packaged SCR building blocks, complete with SCR's, compatible rectifiers, heat sinks, interconnections, and all required hardware in one package. Requires only mounting bolts and electrical connections for power and triggering signal. Check the rest of these outstanding features:

FLEXIBLE DESIGN	Two fin sizes (3" x 3", 5" x 5") and 5 SCR types permit an optimum designed assembly for each application. Stacks can be mounted in either vertical or horizontal plane. An almost limitless number of circuit configurations possible.
WIDE RANGE OF OPERATING AND STORAGE TEMPERATURE	Will operate from — 65°C to + 150°C Ambient.
SHIELDED TRIGGERING SIGNAL	Coaxial shielded leads from gate/cathode terminal board to the SCR's minimize the possibility of erroneous firing caused by extraneous transients or pick up from the power leads.
PROVEN CONSTRUCTION	General Electric's long years of experience in designing and supplying thousands of industrial rectifier stacks form the basis for this rugged construction. Painted fins yield high emissivity, providing optimum ratings without blowers or fans for forced air cooling.
DEPENDABILITY	Backed by a General Electric one year written warranty.





CONDENSED ELECTRICAL RATINGS SCR STACKS[1]

OPERATING TEMPERATURE RANGE	SCR TYPE	COMPATIBLE[2] RECTIFIER TYPE	MAXIMUM REPETITIVE PEAK REVERSE AND MINIMUM FORWARD BREAKOVER VOLTAGE	TRANSIENT PEAK REVERSE VOLTAGE (Non-Recurrent <5 Millisec)	MAX. AVG. FORWARD CURRENT/CELL[4] −25°C AMB. FREE CONVECTION						FOR OTHER AMBIENTS OR UNDER FORCED AIR COND., SEE CHARTS	PEAK ONE CYCLE SURGE CURRENT	MAXIMUM V_{GF} AND I_{GF} TO TRIGGER (25°C)
					3″ FIN			5″ FIN					
					Single Phase (180° Cond. Angle)	Three Phase (120° Cond. Angle)	D. C.	Single Phase (180° Cond. Angle)	Three Phase (120° Cond. Angle)	D. C.			
−65°C TO +125°C	C35U	1N2154	25V	35V	6.30A	5.80A	8.50A	10.1A	9.50A	13.65A	1 & 2	150A	3V, 40 ma
	F	1N2154	50	75									
	A	1N2155	100	150									
	G	1N2156	150	225									
	B	1N2156	200	300									
	H	1N2157	250	350									
	C	1N2157	300	400									
	D	1N2158	400	500									
	E	1N2159	500	600									
	C40U[3]	1N2154	25V	35V	6.30A	5.80A	8.50A	10.1A	9.50A	13.65A	1 & 2	150A	3V, 40 ma
	F	1N2154	50	75									
	A	1N2155	100	150									
	G	1N2156	150	225									
	B	1N2156	200	300									
	H	1N2157	250	350									
	C	1N2157	300	400									
	C11U	1N1341A	25V	35V	3.98A	3.55A	5.80A	4.72A	4.43A	7.00A	3 & 4	60A	2V, 15 ma
	F	1N1341A	50	75									
	A	1N1342A	100	150									
	G	1N1343A	150	225									
	B	1N1344A	200	300									
	H	1N1345A	250	350									
	C	1N1345A	300	400									
	D	1N1346A	400	500									
	C12U[3]	1N1341A	25V	35V	3.98A	3.55A	5.80A	4.72A	4.43A	7.00A	3 & 4	60A	2V, 15 ma
	F	1N1341A	50	75									
	A	1N1342A	100	150									
	G	1N1343A	150	225									
	B	1N1344A	200	300									
	H	1N1345A	250	350									
	C	1N1345A	300	400									
−65°C TO +150°C	C10U	1N1341A	25V	35V	4.72A	3.95A	7.00A	4.72A	3.95A	7.00A	5 & 6	60A	2V, 15 ma
	F	1N1341A	50	75									
	A	1N1342A	100	150									
	G	1N1343A	150	225									
	B	1N1344A	200	300									
	H	1N1345A	250	350									
	C	1N1345A	300	400									
	D	1N1346A	400	500									

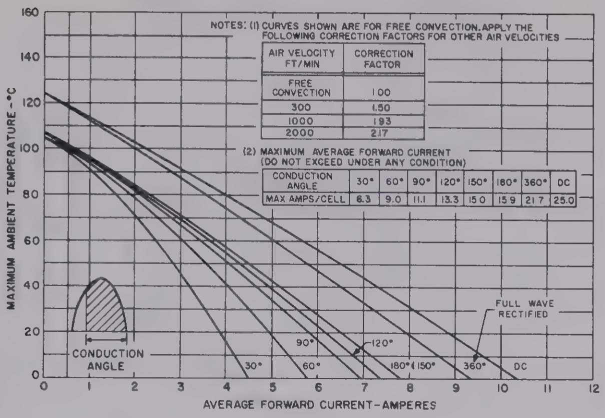
---

[1] For complete specifications covering both the SCR's and compatible rectifiers, see appropriate GE Spec Sheet.

[2] The compatible rectifier type, where ever used, has been chosen deliberately so that the SCR, in all cases, is the limiting component.

[3] These types offer a Maximum Turn-off time of 12 Microseconds under test conditions specified on their Data Sheets.

[4] SCR's can be successfully operated in series and parallel if necessary precautions are observed. Also, depending on the specific application SCR's and rectifiers may be subjected to transient overvoltage and overcurrent conditions for which protective steps should be taken. For further details, on these application considerations, see GE Controlled Rectifier Manual, Chapter 3.



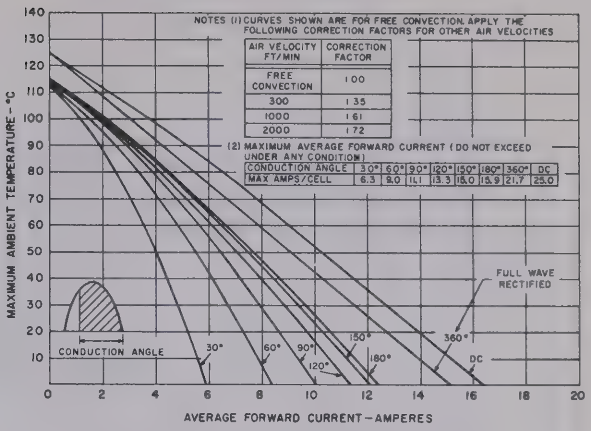
NOTES: (1) CURVES SHOWN ARE FOR FREE CONVECTION. APPLY THE FOLLOWING CORRECTION FACTORS FOR OTHER AIR VELOCITIES

AIR VELOCITY FT/MIN	CORRECTION FACTOR
FREE CONVECTION	1.00
300	1.50
1000	1.93
2000	2.17

(2) MAXIMUM AVERAGE FORWARD CURRENT (DO NOT EXCEED UNDER ANY CONDITION)

CONDUCTION ANGLE	30°	60°	90°	120°	150°	180°	360°	DC
MAX AMPS/CELL	6.3	9.0	11.1	13.3	15.0	15.9	21.7	25.0

1. **AMBIENT TEMP. VS. AVG. FORW. CURRENT**
3″ FIN-C35, 40



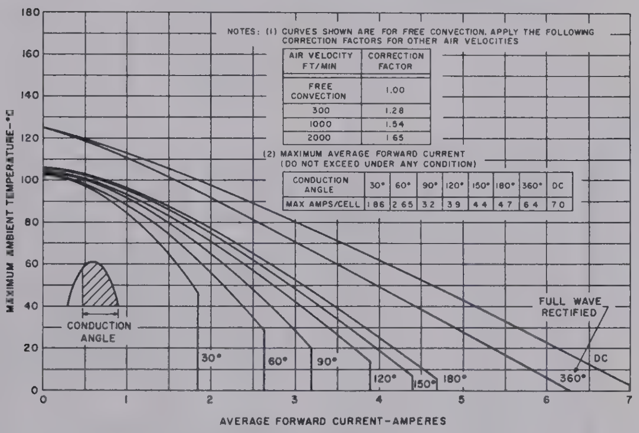
NOTES (1) CURVES SHOWN ARE FOR FREE CONVECTION. APPLY THE FOLLOWING CORRECTION FACTORS FOR OTHER AIR VELOCITIES

AIR VELOCITY FT/MIN	CORRECTION FACTOR
FREE CONVECTION	1.00
300	1.35
1000	1.61
2000	1.72

(2) MAXIMUM AVERAGE FORWARD CURRENT (DO NOT EXCEED UNDER ANY CONDITION)

CONDUCTION ANGLE	30°	60°	90°	120°	150°	180°	360°	DC
MAX AMPS/CELL	6.3	9.0	11.1	13.3	15.0	15.9	21.7	25.0

2. **AMBIENT TEMP. VS. AVG. FORW. CURRENT**
5″ FIN-C35, 40



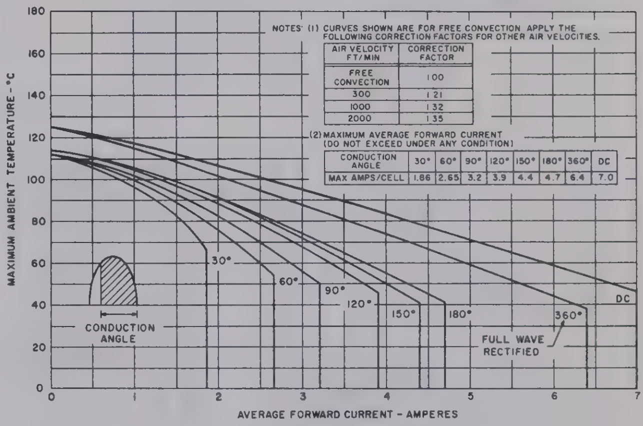
NOTES: (1) CURVES SHOWN ARE FOR FREE CONVECTION. APPLY THE FOLLOWING CORRECTION FACTORS FOR OTHER AIR VELOCITIES

AIR VELOCITY FT/MIN	CORRECTION FACTOR
FREE CONVECTION	1.00
300	1.28
1000	1.54
2000	1.65

(2) MAXIMUM AVERAGE FORWARD CURRENT (DO NOT EXCEED UNDER ANY CONDITION)

CONDUCTION ANGLE	30°	60°	90°	120°	150°	180°	360°	DC
MAX AMPS/CELL	1.86	2.65	3.2	3.9	4.4	4.7	6.4	7.0

3. **AMBIENT TEMP. VS. AVG. FORW. CURRENT**
3″ FIN-C11, 12



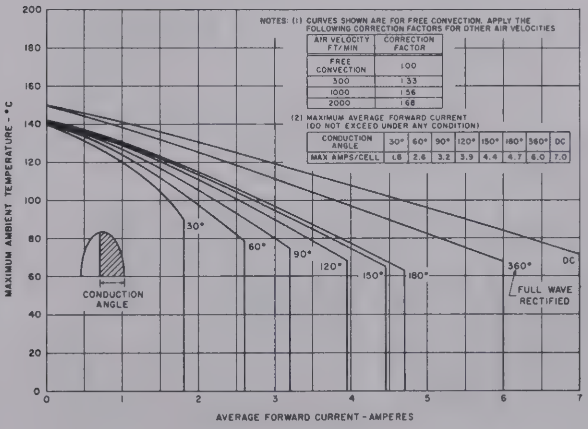
NOTES (1) CURVES SHOWN ARE FOR FREE CONVECTION. APPLY THE FOLLOWING CORRECTION FACTORS FOR OTHER AIR VELOCITIES.

AIR VELOCITY FT/MIN	CORRECTION FACTOR
FREE CONVECTION	1.00
300	1.21
1000	1.32
2000	1.35

(2) MAXIMUM AVERAGE FORWARD CURRENT (DO NOT EXCEED UNDER ANY CONDITION)

CONDUCTION ANGLE	30°	60°	90°	120°	150°	180°	360°	DC
MAX AMPS/CELL	1.86	2.65	3.2	3.9	4.4	4.7	6.4	7.0

4. **AMBIENT TEMP. VS. AVG. FORW. CURRENT**
5″ FIN-C11, 12



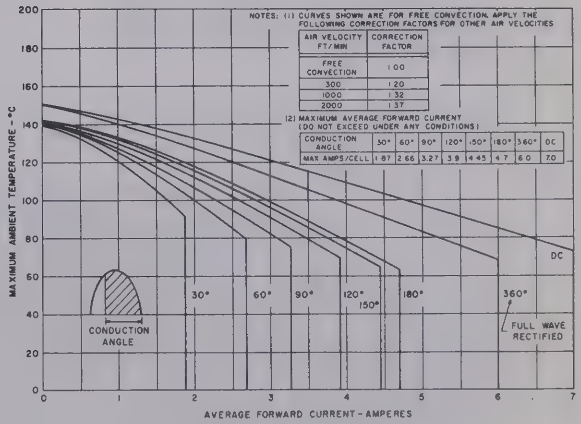
NOTES: (1) CURVES SHOWN ARE FOR FREE CONVECTION. APPLY THE FOLLOWING CORRECTION FACTORS FOR OTHER AIR VELOCITIES

AIR VELOCITY FT/MIN	CORRECTION FACTOR
FREE CONVECTION	1.00
300	1.33
1000	1.56
2000	1.68

(2) MAXIMUM AVERAGE FORWARD CURRENT (DO NOT EXCEED UNDER ANY CONDITION)

CONDUCTION ANGLE	30°	60°	90°	120°	150°	180°	360°	DC
MAX AMPS/CELL	1.8	2.6	3.2	3.9	4.4	4.7	6.0	7.0

5. **AMBIENT TEMP. VS. AVG. FORW. CURRENT**
3″ FIN-C10



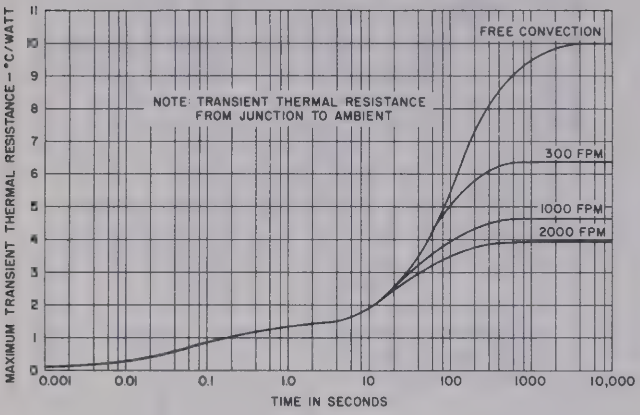
NOTES: (1) CURVES SHOWN ARE FOR FREE CONVECTION. APPLY THE FOLLOWING CORRECTION FACTORS FOR OTHER AIR VELOCITIES

AIR VELOCITY FT/MIN	CORRECTION FACTOR
FREE CONVECTION	1.00
300	1.20
1000	1.32
2000	1.37

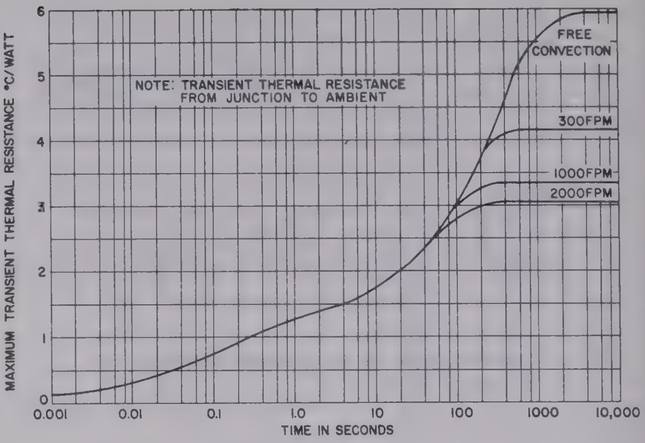
(2) MAXIMUM AVERAGE FORWARD CURRENT (DO NOT EXCEED UNDER ANY CONDITIONS)

CONDUCTION ANGLE	30°	60°	90°	120°	150°	180°	360°	DC
MAX AMPS/CELL	1.87	2.66	3.27	3.9	4.45	4.7	6.0	7.0

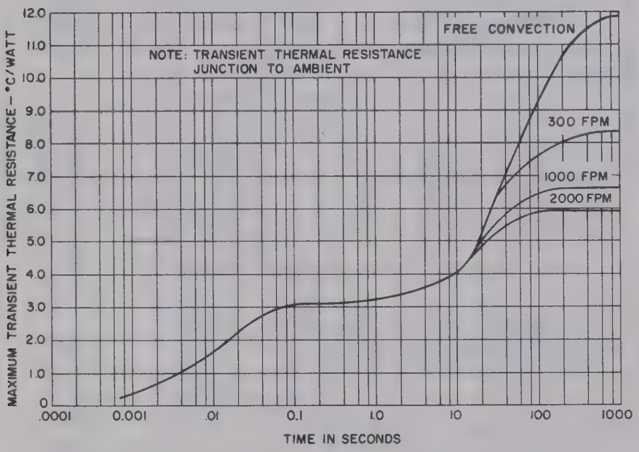
6. **AMBIENT TEMP. VS. AVG. FORW. CURRENT**
5″ FIN-C10



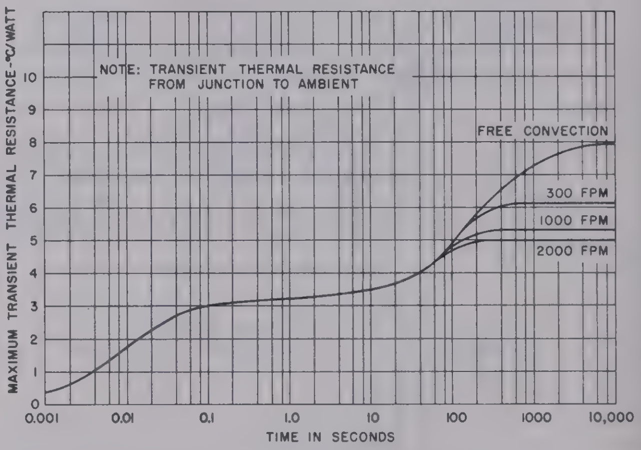
***7. MAXIMUM TRANSIENT THERMAL RESISTANCE**
3″ FIN-C35, 40



***8. MAXIMUM TRANSIENT THERMAL RESISTANCE**
5″ FIN-C35, 40



***9. MAXIMUM TRANSIENT THERMAL RESISTANCE**
3″ FIN-C10, 11, 12



***10. MAXIMUM TRANSIENT THERMAL RESISTANCE**
5″ FIN-C10, 11, 12

Note: *

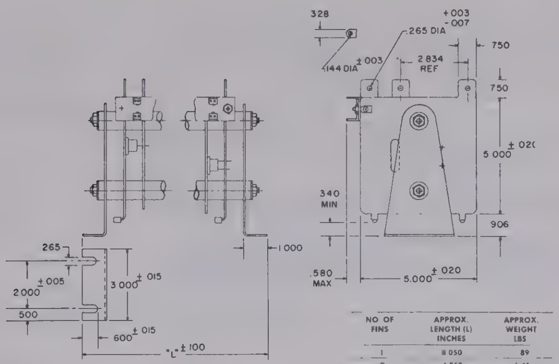
Charts 7, 8, 9, and 10 define the temperature rise of the junction above the ambient for a single load pulse of duration t. The peak allowable dissipation in the controlled rectifier for time t, if starting from ambient temperature, equals the Maximum Junction Temperature of the SCR used minus the maximum ambient temperature, divided by the transient thermal resistance:

$$P_{Peak} = \frac{T_j \text{ max} - T_{amb.}}{r_T}$$

For optimum ratings and further information, see Publication 200.9 entitled "Power Semiconductor Ratings under Transient and Intermittent Loads."

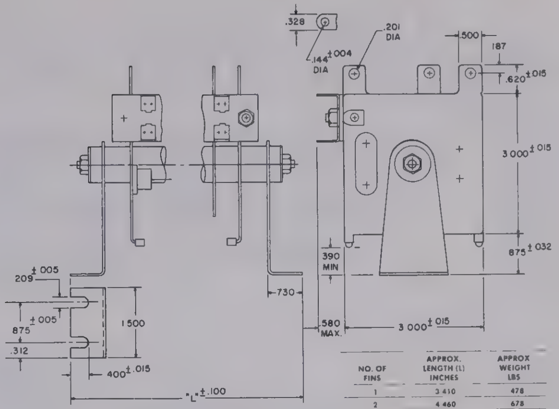
MECHANICAL SPECIFICATIONS

OUTLINE AND WEIGHT (5 INCH FINS)
C3512, C4012, C1012, C1112, C1212 SERIES


328
+003
-007
265 DIA
144 DIA ±003
2 834 REF
750
750
5 000 ± 020
340 MIN
906
580 MAX
5.000 ± 020
265
± 005
2 000
3 000 ± 015
500
600 ± 015
"L" ± 100
1 000

NO OF FINS	APPROX. LENGTH (L) INCHES	APPROX. WEIGHT LBS
1	8 050	89
2	4 850	1 41
3	5 600	1 93
4	6 000	2 44
5	6 850	2 95
6	7 800	3 97
7	9 200	4 48
8	10 050	5 51
9	10 850	6 02
10	11 700	6 53
11	12 650	7 04
12	13 500	7 55

OUTLINE AND WEIGHT (3 INCH FINS)
C3513, C4013, C1013, C1113, C1213 SERIES


.328
.201 DIA
.144 ±.004 DIA
.500
.187
.620 ±.015
3.000 ±.015
875 ±.032
390 MIN
.580 MAX.
3 000 ± 015
730
209 ±.005
±.005
875
.312
1 500
400 ±.015
"L" ±.100

NO. OF FINS	APPROX. LENGTH (L) INCHES	APPROX WEIGHT LBS
1	3 410	478
2	4 460	678
3	5 260	885
4	5 460	1 09
5	6 310	1 3
6	6 960	1 51
7	7 810	1 72
8	8 660	1 93
9	9 510	2 14
10	10 360	2 35
11	11 210	2 56
12	12 060	2 77

Maximum number of fins/stack = 12

Maximum Hi-Pot Voltage to Mounting Brackets . . . . 2600 V. R.M.S. @ 25°C Amb., Sea Level

Salt Spray . . . . MIL-STD-202A, Method 101A, 96 hrs.

Humidity . . . . MIL-STD-202A, Method 103A, 240 hrs.

SCR STACK NOMENCLATURE

C35	12	A	H	1	A	D	1

SCR CELL MODEL NUMBER
C35, C10, C11
C12, C40

FIN SIZE:
12 — 5" sq.
13 — 3" sq.

SCR PEAK REVERSE VOLTAGE RATINGS

U — 25V	B — 200
F — 50	H — 250
A — 100	C — 300
G — 150	D — 400
	E — 500

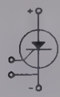
SERIES CELLS/LEG

MINOR ELECTRICAL MODIFICATIONS
Polarity of Output, etc.

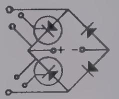
MINOR MECHANICAL MODIFICATIONS
D-Standard

PARALLEL CELLS/LEG

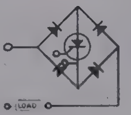
CIRCUIT CONFIGURATION: (Many Additional Variations Are Available Upon Request.)



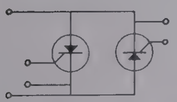
H — Single Phase Halfwave



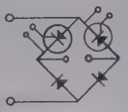
B*— Single Phase Bridge (SCR's Common Cathode)



B*— Single Phase Bridge (Fullwave Rectified)

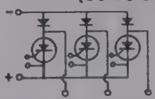


A — Back To Back



B*— Single Phase Bridge (SCR Rect. Common Cathode)

F — Three Phase Fullwave Bridge (SCR's Common Cathode)



X — Special (Followed By Arbitrary Number)

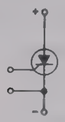
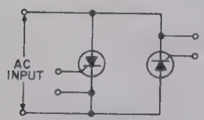
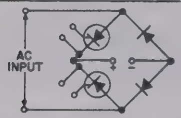
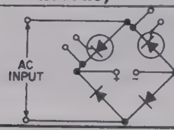
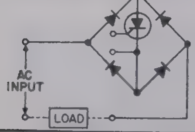
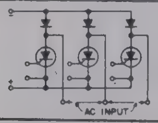
*Note: Circuit description is necessary when ordering stacks to this circuit configuration.

Controlled Rectifier

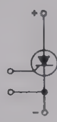
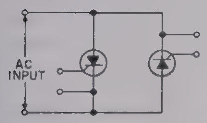
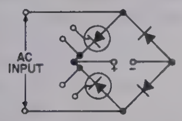
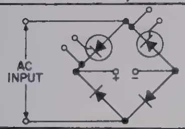
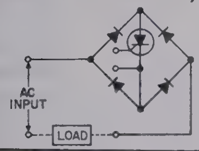
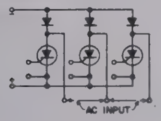
You may now quickly select and obtain the Low and Medium Current Combination SCR Stacks that fit your Controlled Rectifier applications.

- Fast Selection - Rating Tables Cover More Than 300 Stack Models
- Availability - Call Your Authorized G-E Semiconductor Distributor or Semiconductor Products District Sales Manager

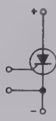
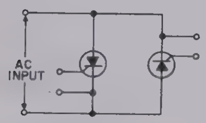
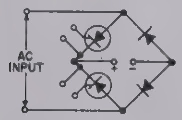
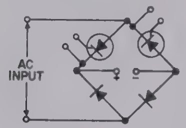
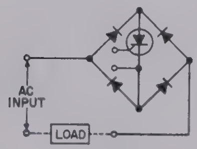
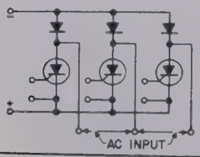
C10 MOUNTED ON A 3" FIN *

Circuit	Max Circuit Output Res. Load 25°C Amb		Max Repetitive AC Input Volts "RMS"	SCR/ Cell PRV-VBO	Transient PRV (Non-recurrent)	No. of Fins/ Stack	Model Number
	Volts DC	Amps DC					
Single Phase Halfwave	7.0	4.72(180°)	17	25	35	1	C1013UH1AD1
	15.0	↓	35	50	75	↓	FH1AD1
	30.5		70	100	150		AH1AD1
	46.5		105	150	225		GH1AD1
	62.0		140	200	300		BH1AD1
	77.0		175	250	350		HH1AD1
	93.5		210	300	400		CH1AD1
	125.0		280	400	500		DH1AD1
Back to Back	15.0(RMS)	10.50(RMS)	17	25	35	2	C1013UA1AD1
	33.0	↓	35	50	75	↓	FA1AD1
	68.0		70	100	150		AA1AD1
	103.0		105	150	225		GA1AD1
	138.0		140	200	300		BA1AD1
	173.0		175	250	350		HA1AD1
	208.0		210	300	400		CA1AD1
	278.0		280	400	500		DA1AD1
Single Phase Bridge (SCR's Common Cathode)	12.0	9.44(360°)	17	25	35	4	C1013UB1CD1
	28.5	↓	35	50	75	↓	FB1CD1
	60.0		70	100	150		AB1CD1
	91.5		105	150	225		GB1CD1
	123.0		140	200	300		BB1CD1
	154.5		175	250	350		HB1CD1
	186.0		210	300	400		CB1CD1
	249.0		280	400	500		DB1CD1
Single Phase Bridge (SCR-Rect Common Cathode)	12.0	9.44(360°)	17	25	35	4	C1013UB1AD1
	28.5	↓	35	50	75	↓	FB1AD1
	60.0		70	100	150		AB1AD1
	91.5		105	150	225		GB1AD1
	123.0		140	200	300		BB1AD1
	154.5		175	250	350		HB1AD1
	186.0		210	300	400		CB1AD1
	249.0		280	400	500		DB1AD1
Single Phase Bridge (Fullwave Rectified)	12.0	6.40(360°)	17	25	35	5	C1013UB1FD1
	28.0	↓	35	50	75	↓	FB1FD1
	59.7		70	100	150		AB1FD1
	91.5		105	150	225		GB1FD1
	123.0		140	200	300		BB1FD1
	154.0		175	250	350		HB1FD1
	186.0		210	300	400		CB1FD1
	249.0		280	400	500		DB1FD1
3 Phase Fullwave Bridge (SCR's Common Cathode)	20.0	11.85	17	25	35	6	C1013UF1AD1
	44.0	↓	35	50	75	↓	FF1AD1
	91.5		70	100	150		AF1AD1
	138.5		105	150	225		GF1AD1
	186.0		140	200	300		BF1AD1
	223.0		175	250	350		HF1AD1
	280.5		210	300	400		CF1AD1
	375.0		280	400	500		DF1AD1

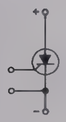
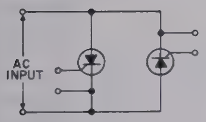
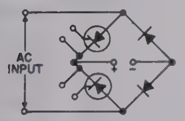
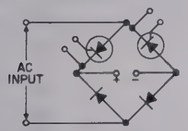
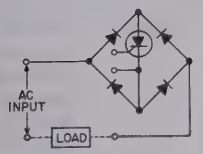
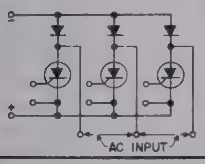
C10 MOUNTED ON A 5" FIN *

Circuit	Max Circuit Output Res. Load 25°C Amb Volts DC	Max Circuit Output Res. Load 25°C Amb Amps DC	Max Repetitive AC Input Volts "RMS"	SCR/ Cell PRV-VBO	Transient PRV (Non-recurrent)	No. of Fins/ Stack	Model Number
Single Phase Halfwave	7.0	4.72(180°)	17	25	35	1	C1012UH1AD1
	15.0		35	50	75		FH1AD1
	30.5		70	100	150		AH1AD1
	46.5		105	150	225		GH1AD1
	62.0		140	200	300		BH1AD1
	77.0		175	250	350		HH1AD1
	93.5		210	300	400		CH1AD1
	125.0	↓	280	400	500	↓	DH1AD1
Back to Back	15.0(RMS)	10.50(RMS)	17	25	35	2	C1012UA1AD1
	33.0		35	50	75		FA1AD1
	68.0		70	100	150		AA1AD1
	103.0		105	150	225		GA1AD1
	138.0		140	200	300		BA1AD1
	173.0		175	250	350		HA1AD1
	208.0		210	300	400		CA1AD1
	278.0	↓	280	400	500	↓	DA1AD1
Single Phase Bridge (SCR's Common Cathode)	12.0	9.44(360°)	17	25	35	4	C1012UB1CD1
	28.5		35	50	75		FB1CD1
	60.0		70	100	150		AB1CD1
	91.5		105	150	225		GB1CD1
	123.0		140	200	300		BB1CD1
	154.5		175	250	350		HB1CD1
	186.0		210	300	400		CB1CD1
	249.0	↓	280	400	500	↓	DB1CD1
Single Phase Bridge (SCR-Rect Common Cathode)	12.0	9.44(360°)	17	25	35	4	C1012UB1AD1
	28.5		35	50	75		FB1AD1
	60.0		70	100	150		AB1AD1
	91.5		105	150	225		GB1AD1
	123.0		140	200	300		BB1AD1
	154.5		175	250	350		HB1AD1
	186.0		210	300	400		CB1AD1
	249.0	↓	280	400	500	↓	DB1AD1
Single Phase Bridge (Fullwave Rectified)	12.0	6.40(360°)	17	25	35	5	C1012UB1FD1
	28.0		35	50	75		FB1FD1
	59.7		70	100	150		AB1FD1
	91.5		105	150	225		GB1FD1
	123.0		140	200	300		BB1FD1
	154.0		175	250	350		HB1FD1
	186.0		210	300	400		CB1FD1
	249.0	↓	280	400	500	↓	DB1FD1
3 Phase Fullwave Bridge (SCR's Common Cathode)	20.0	11.85	17	25	35	6	C1012UF1AD1
	44.0		35	50	75		FF1AD1
	91.5		70	100	150		AF1AD1
	138.5		105	150	225		GF1AD1
	186.0		140	200	300		BF1AD1
	223.0		175	250	350		HF1AD1
	280.5		210	300	400		CF1AD1
	375.0	↓	280	400	500	↓	DF1AD1

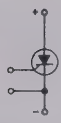
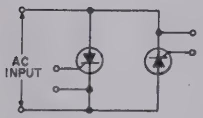
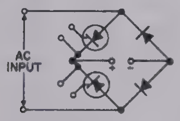
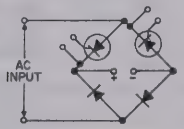
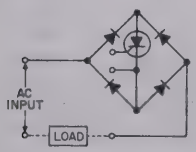
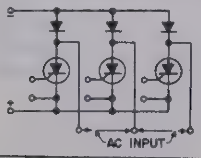
C11 MOUNTED ON A 3" FIN *

Circuit	Max Circuit Output Res. Load 25°C Amb Volts DC	Max Circuit Output Res. Load 25°C Amb Amps DC	Max Repetitive AC Input Volts "RMS"	SCR/ Cell PRV-VBO	Transient PRV (Non-recurrent)	No. of Fins/ Stack	Model Number
Single Phase Halfwave	7.0	3.98(180°)	17	25	35	1	C1113UH1AD1
	15.0		35	50	75		FH1AD1
	30.5		70	100	150		AH1AD1
	46.5		105	150	225		GH1AD1
	62.0		140	200	300		BH1AD1
	77.0		175	250	350		HH1AD1
	93.5		210	300	400		CH1AD1
	125.0		280	400	500		DH1AD1
	156.5		350	500	600		EH1AD1
	190.0	↓	425	600	720	↓	MH1AD1
Back to Back	15.0(RMS)	8.83(RMS)	17	25	35	2	C1113UA1AD1
	33.0		35	50	75		F A1AD1
	68.0		70	100	150		A A1AD1
	103.0		105	150	225		G A1AD1
	138.0		140	200	300		B A1AD1
	173.0		175	250	350		H A1AD1
	208.0		210	300	400		C A1AD1
	278.0		280	400	500		D A1AD1
	348.0		350	500	600		E A1AD1
	422.0	↓	425	600	720	↓	MA1AD1
Single Phase Bridge (SCR's Common Cathode)	12.0	7.96(360°)	17	25	35	4	C1113U B1CD1
	28.5		35	50	75		F B1CD1
	60.0		70	100	150		A B1CD1
	91.5		105	150	225		G B1CD1
	123.0		140	200	300		B B1CD1
	154.5		175	250	350		H B1CD1
	186.0		210	300	400		C B1CD1
	249.0		280	400	500		D B1CD1
	312.0		350	500	600		E B1CD1
	376.0	↓	425	600	720	↓	MB1CD1
Single Phase Bridge (SCR-Rect Common Cathode)	12.0	7.96(360°)	17	25	35	4	C1113UB1AD1
	28.5		35	50	75		F B1AD1
	60.0		70	100	150		A B1AD1
	91.5		105	150	225		G B1AD1
	123.0		140	200	300		B B1AD1
	154.5		175	250	350		H B1AD1
	186.0		210	300	400		C B1AD1
	249.0		280	400	500		D B1AD1
	312.0		350	500	600		E B1AD1
	376.0	↓	425	600	720	↓	MB1AD1
Single Phase Bridge (Fullwave Rectified)	12.0	5.20(360°)	17	25	35	5	C1113UB1FD1
	28.5		35	50	75		F B1FD1
	60.0		70	100	150		A B1FD1
	91.5		105	150	225		G B1FD1
	123.0		140	200	300		B B1FD1
	154.5		175	250	350		H B1FD1
	186.0		210	300	400		C B1FD1
	249.0		280	400	500		D B1FD1
	312.0		350	500	600		E B1FD1
	376.0	↓	425	600	720	↓	MB1FD1
3 Phase Fullwave Bridge (SCR's Common Cathode)	20.0	10.65	17	25	35	6	C1113UF1AD1
	44.0		35	50	75		F F1AD1
	91.5		70	100	150		A F1AD1
	138.5		105	150	225		G F1AD1
	186.0		140	200	300		B F1AD1
	223.0		175	250	350		H F1AD1
	280.5		210	300	400		C F1AD1
	375.0		280	400	500		D F1AD1
	469.5		350	500	600		E F1AD1
	565.5	↓	425	600	720	↓	M F1AD1

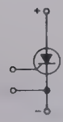
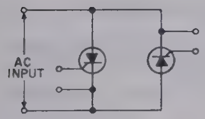
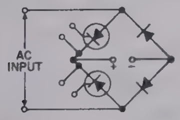
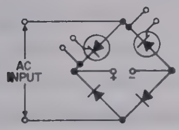
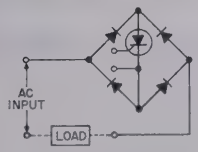
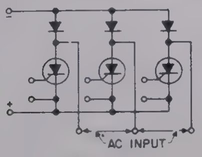
C11 MOUNTED ON A 5" FIN *

Circuit	Max Circuit Output Res. Load 25°C Amb		Max Repetitive AC Input Volts "RMS"	SCR/ Cell PRV-VBO	Transient PRV (Non-recurrent)	No. of Fins/ Stack	Model Number
	Volts DC	Amps DC					
Single Phase Halfwave	7.0	4.72(180°)	17	25	35	1	C1112UH1AD1
	15.0		35	50	75		FH1AD1
	30.5		70	100	150		AH1AD1
	46.5		105	150	225		GH1AD1
	62.0		140	200	300		BH1AD1
	77.0		175	250	350		HH1AD1
	93.5		210	300	400		CH1AD1
	125.0		280	400	500		DH1AD1
	156.5		350	500	600		EH1AD1
	190.0		425	600	720		MH1AD1
Back to Back	15.0(RMS)	10.50(RMS)	17	25	35	2	C1112UA1AD1
	33.0		35	50	75		FA1AD1
	68.0		70	100	150		AA1AD1
	103.0		105	150	225		GA1AD1
	138.0		140	200	300		BA1AD1
	173.0		175	250	350		HA1AD1
	208.0		210	300	400		CA1AD1
	278.0		280	400	500		DA1AD1
	348.0		350	500	600		EA1AD1
	422.0		425	600	720		MA1AD1
Single Phase Bridge (SCR's Common Cathode)	12.0	9.44(360°)	17	25	35	4	C1112UB1CD1
	28.5		35	50	75		FB1CD1
	60.0		70	100	150		AB1CD1
	91.5		105	150	225		GB1CD1
	123.0		140	200	300		BB1CD1
	154.5		175	250	350		HB1CD1
	186.0		210	300	400		CB1CD1
	249.0		280	400	500		DB1CD1
	312.0		350	500	600		EB1CD1
	376.0		425	600	720		MB1CD1
Single Phase Bridge (SCR-Rect Common Cathode)	12.0	9.44(360°)	17	25	35	4	C1112UB1AD1
	28.5		35	50	75		FB1AD1
	60.0		70	100	150		AB1AD1
	91.5		105	150	225		GB1AD1
	123.0		140	200	300		BB1AD1
	154.5		175	250	350		HB1AD1
	186.0		210	300	400		CB1AD1
	249.0		280	400	500		DB1AD1
	312.0		350	500	600		EB1AD1
	376.0		425	600	720		MB1AD1
Single Phase Bridge (Fullwave Rectified)	12.0	6.40(360°)	17	25	35	5	C1112UB1FD1
	28.5		35	50	75		FB1FD1
	60.0		70	100	150		AB1FD1
	91.5		105	150	225		GB1FD1
	123.0		140	200	300		BB1FD1
	154.5		175	250	350		HB1FD1
	186.0		210	300	400		CB1FD1
	249.0		280	400	500		DB1FD1
	312.0		350	500	600		EB1FD1
	376.0		425	600	720		MB1FD1
3 Phase Fullwave Bridge (SCR's Common Cathode)	20.0	11.85	17	25	35	6	C1112UF1AD1
	44.0		35	50	75		FF1AD1
	91.5		70	100	150		AF1AD1
	138.5		105	150	225		GF1AD1
	186.0		140	200	300		BF1AD1
	223.0		175	250	350		HF1AD1
	280.5		210	300	400		CF1AD1
	375.0		280	400	500		DF1AD1
	469.5		350	500	600		EF1AD1
	565.5		425	600	720		MF1AD1

C35 MOUNTED ON A 3" FIN *

Circuit	Max Circuit Output Res. Load 25°C Amb Volts DC	Amps DC	Max Repetitive AC Input Volts "RMS"	SCR/ Cell PRV-VBO	Transient PRV (Non-recurrent)	No. of Fins/ Stack	Model Number
Single Phase Halfwave	7.0	6.3(180°)	17	25	35	1	C3513UH1AD1
	15.0	↓	35	50	75	↓	FH1AD1
	30.5		70	100	150		AH1AD1
	46.5		105	150	225		GH1AD1
	62.0		140	200	300		BH1AD1
	77.0		175	250	350		HH1AD1
	93.5		210	300	400		CH1AD1
	125.0		280	400	500		DH1AD1
	156.5		350	500	600		EH1AD1
	190.0		425	600	720		MH1AD1
Back to Back	15.0(RMS)	13.9(RMS)	17	25	35	2	C3513UA1AD1
	33.0	↓	35	50	75	↓	FA1AD1
	68.0		70	100	150		AA1AD1
	103.0		105	150	225		GA1AD1
	138.0		140	200	300		BA1AD1
	173.0		175	250	350		HA1AD1
	208.0		210	300	400		CA1AD1
	278.0		280	400	500		DA1AD1
	348.0		350	500	600		EA1AD1
	422.0		425	600	720		MA1AD1
Single Phase Bridge (SCR's Common Cathode)	12.0	12.6(360°)	17	25	35	4	C3513UB1CD1
	28.5	↓	35	50	75	↓	FB1CD1
	60.0		70	100	150		AB1CD1
	91.5		105	150	225		GB1CD1
	123.0		140	200	300		BB1CD1
	154.5		175	250	350		HB1CD1
	186.0		210	300	400		CB1CD1
	249.0		280	400	500		DB1CD1
	312.0		350	500	600		EB1CD1
	376.0		425	600	720		MB1CD1
Single Phase Bridge (SCR-Rect Common Cathode)	12.0	12.6(360°)	17	25	35	4	C3513UB1AD1
	28.5	↓	35	50	75	↓	FB1AD1
	60.0		70	100	150		AB1AD1
	91.5		105	150	225		GB1AD1
	123.0		140	200	300		BB1AD1
	154.5		175	250	350		HB1AD1
	186.0		210	300	400		CB1AD1
	249.0		280	400	500		DB1AD1
	312.0		350	500	600		EB1AD1
	376.0		425	600	720		MB1AD1
Single Phase Bridge (Fullwave Rectified)	12.0	7.6(360°)	17	25	35	5	C3513UB1FD1
	28.5	↓	35	50	75	↓	FB1FD1
	60.0		70	100	150		AB1FD1
	91.5		105	150	225		GB1FD1
	123.0		140	200	300		BB1FD1
	154.5		175	250	350		HB1FD1
	186.0		210	300	400		CB1FD1
	249.0		280	400	500		DB1FD1
	312.0		350	500	600		EB1FD1
	376.0		425	600	720		MB1FD1
3 Phase Fullwave Bridge (SCR's Common Cathode)	20.0	17.4	17	25	35	6	C3513UF1AD1
	44.0	↓	35	50	75	↓	FF1AD1
	91.5		70	100	150		AF1AD1
	138.5		105	150	225		GF1AD1
	186.0		140	200	300		BF1AD1
	223.0		175	250	350		HF1AD1
	280.5		210	300	400		CF1AD1
	375.0		280	400	500		DF1AD1
	469.5		350	500	600		EF1AD1
	565.5		425	600	720		MF1AD1

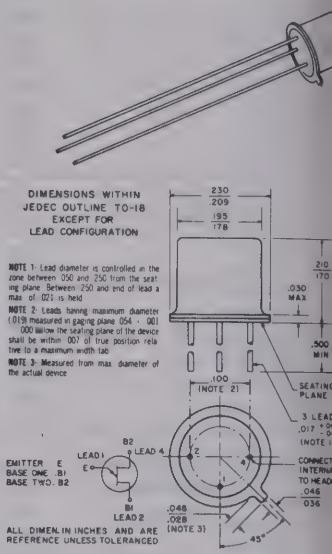
C35 MOUNTED ON A 5" FIN *

	Max Circuit Output Res. Load 25°C Amb						
Circuit	Volts DC	Amps DC	Max Repetitive AC Input Volts "RMS"	SCR/ Cell PRV-VBO	Transient PRV (Non-recurrent)	No. of Fins/ Stack	Model Number
Single Phase Halfwave	7.0	10.1(180°)	17	25	35	1	C3512UH1AD1
	15.0		35	50	75		FH1AD1
	30.5		70	100	150		AH1AD1
	46.5		105	150	225		GH1AD1
	62.0		140	200	300		BH1AD1
	77.0		175	250	350		HH1AD1
	93.5		210	300	400		CH1AD1
	125.0		280	400	500		DH1AD1
	156.5		350	500	600		EH1AD1
	190.0	↓	425	600	720	↓	MH1AD1
Back to Back	15.0(RMS)	22.4(RMS)	17	25	35	2	C3512UA1AD1
	33.0		35	50	75		FA1AD1
	68.0		70	100	150		AA1AD1
	103.0		105	150	225		GA1AD1
	138.0		140	200	300		BA1AD1
	173.0		175	250	350		HA1AD1
	208.0		210	300	400		CA1AD1
	278.0		280	400	500		DA1AD1
	348.0		350	500	600		EA1AD1
	422.0	↓	425	600	720	↓	MA1AD1
Single Phase Bridge (SCR's Common Cathode)	12.0	20.2(360°)	17	25	35	4	C3512UB1CD1
	28.5		35	50	75		FB1CD1
	60.0		70	100	150		AB1CD1
	91.5		105	150	225		GB1CD1
	123.0		140	200	300		BB1CD1
	154.5		175	250	350		HB1CD1
	186.0		210	300	400		CB1CD1
	249.0		280	400	500		DB1CD1
	312.0		350	500	600		EB1CD1
	376.0	↓	425	600	720	↓	MB1CD1
Single Phase Bridge (SCR-Rect Common Cathode)	12.0	20.2(360°)	17	25	35	4	C3512UB1AD1
	28.5		35	50	75		FB1AD1
	60.0		70	100	150		AB1AD1
	91.5		105	150	225		GB1AD1
	123.0		140	200	300		BB1AD1
	154.5		175	250	350		HB1AD1
	186.0		210	300	400		CB1AD1
	249.0		280	400	500		DB1AD1
	312.0		350	500	600		EB1AD1
	376.0	↓	425	600	720	↓	MB1AD1
Single Phase Bridge (Fullwave Rectified)	12.0	12(360°)	17	25	35	5	C3512UB1FD1
	28.5		35	50	75		FB1FD1
	60.0		70	100	150		AB1FD1
	91.5		105	150	225		GB1FD1
	123.0		140	200	300		BB1FD1
	154.5		175	250	350		HB1FD1
	186.0		210	300	400		CB1FD1
	249.0		280	400	500		DB1FD1
	312.0		350	500	600		EB1FD1
	376.0	↓	425	600	720	↓	MB1FD1
3 Phase Fullwave Bridge (SCR's Common Cathode)	20.0	28.5	17	25	35	6	C3512UF1AD1
	44.0		35	50	75		FF1AD1
	91.5		70	100	150		AF1AD1
	138.5		105	150	225		GF1AD1
	186.0		140	200	300		BF1AD1
	223.0		175	250	350		HF1AD1
	280.5		210	300	400		CF1AD1
	375.0		280	400	500		DF1AD1
	469.5		350	500	600		EF1AD1
	565.5	↓	425	600	720	↓	MF1AD1

Silicon
Transistor

D5E37

Please refer to G-E Semiconductor specification number 60.62 (2N2646-47) for further information on this device.


DIMENSIONS WITHIN
JEDEC OUTLINE TO-18
EXCEPT FOR
LEAD CONFIGURATION
230
.209
195
178
210
170
.030
MAX
.500
MIN
.100
(NOTE 2)
SEATING
PLANE
3 LEAD
.017
(NOTE
CONNECT
INTERNA
TO HEAD
.046
036
.048
.028
(NOTE 3)
45°
B2
LEAD 4
LEAD 1
E
B1
LEAD 2
2
4
1
EMITTER E
BASE ONE .B1
BASE TWO. B2

NOTE 1- Lead diameter is controlled in the zone between 050 and 250 from the seating plane Between 250 and end of lead a max of 021 is held

NOTE 2- Leads having maximum diameter (019) measured in gaging plane 054 + 001 000 below the seating plane of the device shall be within 007 of true position relative to a maximum width tab

NOTE 3- Measured from max diameter of the actual device

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

ABSOLUTE MAXIMUM RATINGS: (25°C)

Power Dissipation (Note 1)	300 mw
RMS Emitter Current	50 ma
Peak Emitter Current (Note 2)	2 amperes
Emitter Reverse Voltage	30 volts
Interbase Voltage	35 volts
Operating Temperature Range	−65°C to +125°C
Storage Temperature Range	−65°C to +150°C

ELECTRICAL CHARACTERISTICS: (25°C)

PARAMETER		D5E37 MIN.	TYP.	MAX.	
Intrinsic Standoff Ratio ($V_{BB} = 10V$) (Note 4)	η	.47		.85	
Interbase Resistance ($V_{BB} = 3V, I_E = 0$)	R_{BBO}	4.0		12.0	KΩ
Emitter Saturation Voltage ($V_{BB} = 10V, I_E = 50$ ma)	$V_{E(SAT)}$		2		volts
Modulated Interbase Current ($V_{BB} = 10V, I_E = 50$ ma)	$I_{B2(MOD)}$	4		22	ma
Emitter Reverse Current ($V_{B2E} = 30V, I_{B1} = 0$)	I_{EO}			12	μa
Peak Point Emitter Current ($V_{BB} = 25V$)	I_P			25	μa
Valley Point Current ($V_{BB} = 20V, R_{B2} = 100\ \Omega$)	I_V	4			ma
Base-One Peak Pulse Voltage (Note 3)	V_{OB1}	3			volts

NOTES:

1. Derate 3.0 MW/°C increase in ambient temperature. The total power dissipation (available power to Emitter and Base-Two) must be limited by the external circuitry.
2. Capacitor discharge — 10μfd or less, 30 volts or less.
3. The Base-One Peak Pulse Voltage is measured in the circuit below. This specification on the D5E37 is used to ensure a minimum pulse amplitude for applications in SCR firing circuits and other types of pulse circuits.
4. The intrinsic standoff ratio η, is essentially constant with interbase voltage. η is defined by the equation:

$$V_P = \eta V_{BB} + V_D$$

Where V_P = Peak Point Emitter Voltage
V_{BB} = Interbase Voltage
V_D = Junction Diode Drop (Approx. .5V)

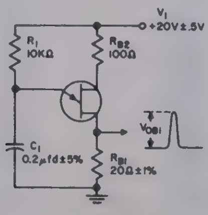
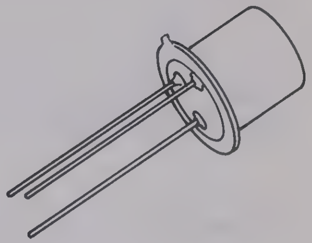

V_1
+20V±.5V
R_1
10KΩ
R_{B2}
100Ω
V_{OB1}
C_1
0.2μfd±5%
R_{B1}
20Ω±1%

FIGURE I

Silicon
Transistor

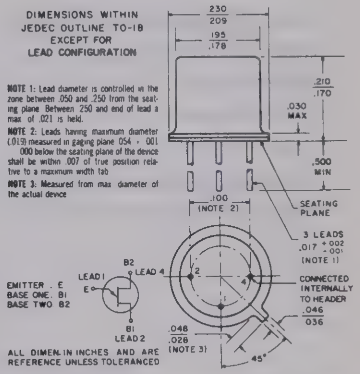
D5E43

Please refer to GE Semiconductor specification number 60.62 (2N2646-47) for further information on this device.



absolute maximum ratings: (25°C)

Power Dissipation (Note 1)	300 mW
RMS Emitter Current	50 mA
Peak Emitter Current (Note 2)	2Amperes
Emitter Reverse Voltage	30Volts
Interbase Voltage	35Volts
Operating Temperature Range	−65°C to +125°C
Storage Temperature Range	−65°C to +150°C


DIMENSIONS WITHIN JEDEC OUTLINE TO-18 EXCEPT FOR LEAD CONFIGURATION
.230
.209
.195
.178
.210
.170
.030 MAX
.500 MIN
NOTE 1: Lead diameter is controlled in the zone between .050 and .250 from the seating plane Between .250 and end of lead a max of .021 is held.
NOTE 2: Leads having maximum diameter (.019) measured in gaging plane .054 + .001 .000 below the seating plane of the device shall be within .007 of true position relative to a maximum width tab
NOTE 3: Measured from max diameter of the actual device
.100 (NOTE 2)
SEATING PLANE
3 LEADS .017 +.002 −.001 (NOTE 1)
CONNECTED INTERNALLY TO HEADER
.046
.036
EMITTER . E
BASE ONE . B1
BASE TWO B2
LEAD 1
E
B2
LEAD 4
B1
LEAD 2
2
4
1
.048
.028
(NOTE 3)
45°
ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

---

electrical characteristics: (25°C)

		MIN.	TYP.	MAX.	
Intrinsic Standoff Ratio ($V_{BB} = 10V$) (Note 4)	η	.68		.82	
Interbase Resistance ($V_{BB} = 3V, I_E = 0$)	R_{BBO}	4.7		9.1	kΩ
Emitter Saturation Voltage ($V_{BB} = 10V, I_E = 50$ ma)	$V_{E(SAT)}$		2		Volts
Modulated Interbase Current ($V_{BB} = 10V, I_E = 50$ ma)	$I_{B2(MOD)}$		12		mA
Emitter Reverse Current ($V_{B2E} = 30V, I_{B1} = 0$)	I_{EO}			1.0	μA
Peak Point Emitter Current ($V_{BB} = 25V$)	I_P			2.0	μA
Valley Point Current ($V_{BB} = 20V, R_{B2} = 100\ \Omega$)	I_V	6			mA
Base-One Peak Pulse Voltage (Note 3)	V_{OB1}	5			Volts

NOTES:

1. Derate 3.0 MW/°C increase in ambient temperature. The total power dissipation (available power to Emitter and Base-Two) must be limited by the external circuitry.
2. Capacitor discharge — 10μF or less, 30 volts or less.
3. The Base-One Peak Pulse Voltage is measured in the circuit below. This specification on the D5E43 is used to ensure a minimum pulse amplitude for applications in SCR firing circuits and other types of pulse circuits.
4. The intrinsic standoff ratio η, is essentially constant with interbase voltage. η is defined by the equation:

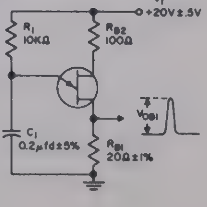
$$V_P = \eta V_{BB} + V_D$$

Where V_P = Peak Point Emitter Voltage

V_{BB} = Interbase Voltage

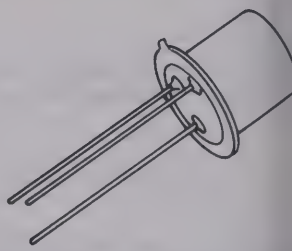
V_D = Junction Diode Drop (Approx. .5V)

FIGURE 1

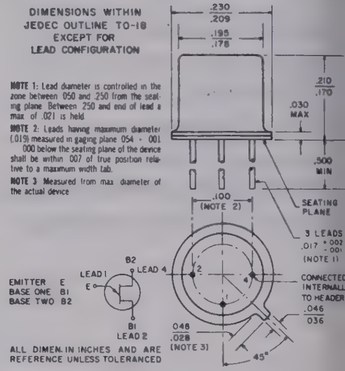

V_1
+20V±.5V
R_1
10KΩ
R_{B2}
100Ω
V_{OB1}
C_1
0.2μfd±5%
R_{B1}
20Ω±1%

Silicon
Transistor

D5E44



Please refer to GE Semiconductor specification number 60.62 (2N2646-47) for further information on this device.


DIMENSIONS WITHIN JEDEC OUTLINE TO-18 EXCEPT FOR LEAD CONFIGURATION
NOTE 1: Lead diameter is controlled in the zone between .050 and .250 from the sealing plane. Between .250 and end of lead a max. of .021 is held.
NOTE 2: Leads having maximum diameter (.019) measured in gaging plane .054 + .001 .000 below the seating plane of the device shall be within .007 of true position relative to a maximum width tab.
NOTE 3: Measured from max. diameter of the actual device
.230
.209
.195
.178
.210
.170
.030 MAX
.500 MIN
.100 (NOTE 2)
SEATING PLANE
3 LEADS .017 +.002 -.001 (NOTE 1)
CONNECTED INTERNALLY TO HEADER
.046
.036
.048
.028
(NOTE 3)
45°
EMITTER E
BASE ONE B1
BASE TWO B2
B2
LEAD 4
LEAD 1
E
B1
LEAD 2
2
4
1
ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

absolute maximum ratings: (25°C)

Power Dissipation (Note 1)	300 mW
RMS Emitter Current	50 mA
Peak Emitter Current (Note 2)	2 Amperes
Emitter Reverse Voltage	30 Volts
Interbase Voltage	35 Volts
Operating Temperature Range	−65°C to +125°C
Storage Temperature Range	−65°C to +150°C

electrical characteristics: (25°C)

		MIN.	TYP.	MAX.	
Intrinsic Standoff Ratio ($V_{BB} = 10V$) (Note 4)	η	.68		.82	
Interbase Resistance ($V_{BB} = 3V, I_E = 0$)	R_{BBO}	4.7		9.1	kΩ
Emitter Saturation Voltage ($V_{BB} = 10V, I_E = 50$ ma)	$V_{E(SAT)}$		2		Volts
Modulated Interbase Current ($V_{BB} = 10V, I_E = 50$ ma)	$I_{B2(MOD)}$		12		mA
Emitter Reverse Current ($V_{B2E} = 30V, I_{B1} = 0$)	I_{EO}			12	μA
Peak Point Emitter Current ($V_{BB} = 25V$)	I_P			5	μA
Valley Point Current ($V_{BB} = 20V, R_{B2} = 100\ \Omega$)	I_V	4			mA
Base-One Peak Pulse Voltage (Note 3)	V_{OB1}	4			Volts

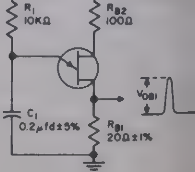
NOTES:

1. Derate 3.0 MW/°C increase in ambient temperature. The total power dissipation (available power to Emitter and Base-Two) must be limited by the external circuitry.
2. Capacitor discharge — 10μF or less, 30 volts or less.
3. The Base-One Peak Pulse Voltage is measured in the circuit below. This specification on the D5E44 is used to ensure a minimum pulse amplitude for applications in SCR firing circuits and other types of pulse circuits.
4. The intrinsic standoff ratio η, is essentially constant with interbase voltage. η is defined by the equation:

$$V_P = \eta V_{BB} + V_D$$

Where V_P = Peak Point Emitter Voltage
V_{BB} = Interbase Voltage
V_D = Junction Diode Drop (Approx. .5V)

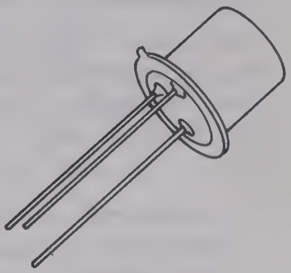
FIGURE 1


V_1
+20V±.5V
R_1
10KΩ
R_{B2}
100Ω
C_1
0.2μfd±5%
R_{B1}
20Ω±1%
V_{OB1}

Silicon
Transistor

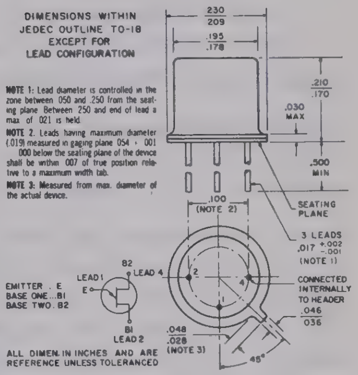
D5E45

Please refer to GE Semiconductor specification number 60.62 (2N2646-47) for further information on this device.



absolute maximum ratings: (25°C)

Power Dissipation (Note 1)	300 mW
RMS Emitter Current	50 mA
Peak Emitter Current (Note 2)	2Amperes
Emitter Reverse Voltage	30 Volts
Interbase Voltage	35 Volts
Operating Temperature Range	−65°C to +125°C
Storage Temperature Range	−65°C to +150°C


DIMENSIONS WITHIN JEDEC OUTLINE TO-18 EXCEPT FOR LEAD CONFIGURATION
NOTE 1: Lead diameter is controlled in the zone between .050 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.
NOTE 2. Leads having maximum diameter (.019) measured in gaging plane .054 + .001 .000 below the seating plane of the device shall be within .007 of true position relative to a maximum width tab.
NOTE 3: Measured from max. diameter of the actual device.
.230
.209
.195
.178
.210
.170
.030 MAX
.500 MIN
.100 (NOTE 2)
SEATING PLANE
3 LEADS .017 +.002 −.001 (NOTE 1)
EMITTER . E
BASE ONE...B1
BASE TWO. B2
LEAD 1
E
B2
LEAD 4
B1
LEAD 2
2
4
1
CONNECTED INTERNALLY TO HEADER
.046
.036
.048
.028
(NOTE 3)
45°
ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

electrical characteristics: (25°C)

		MIN.	TYP.	MAX.	
Intrinsic Standoff Ratio ($V_{BB} = 10V$) (Note 4)	η	.68		.82	
Interbase Resistance ($V_{BB} = 3V, I_E = 0$)	R_{BBO}	4.7		9.1	KΩ
Emitter Saturation Voltage ($V_{BB} = 10V, I_E = 50$ ma)	$V_{E(SAT)}$		2		Volts
Modulated Interbase Current ($V_{BB} = 10V, I_E = 50$ ma)	$I_{B2(MOD)}$		12		mA
Emitter Reverse Current ($V_{B2E} = 30V, I_{B1} = 0$)	I_{EO}			.5	μA
Peak Point Emitter Current ($V_{BB} = 25V$)	I_P			2	μA
Valley Point Current ($V_{BB} = 20V, R_{B2} = 100\ \Omega$)	I_V	8			mA
Base-One Peak Pulse Voltage (Note 3)	V_{OB1}	6			Volts

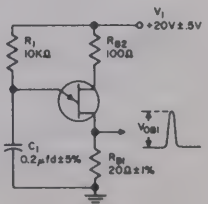
NOTES:

1. Derate 3.0 MW/°C increase in ambient temperature. The total power dissipation (available power to Emitter and Base-Two) must be limited by the external circuitry.
2. Capacitor discharge — 10μF or less, 30 volts or less.
3. The Base-One Peak Pulse Voltage is measured in the circuit below. This specification on the D5E45 is used to ensure a minimum pulse amplitude for applications in SCR firing circuits and other types of pulse circuits.
4. The intrinsic standoff ratio η, is essentially constant with interbase voltage. η is defined by the equation:

$$V_P = \eta V_{BB} + V_D$$

Where V_P = Peak Point Emitter Voltage
V_{BB} = Interbase Voltage
V_D = Junction Diode Drop (Approx. .5V)

FIGURE 1

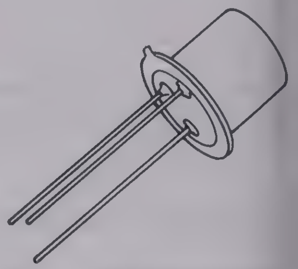

V_1
+20V±.5V
R_1
10KΩ
R_{B2}
100Ω
V_{OB1}
C_1
0.2μfd±5%
R_{B1}
20Ω±1%

N P

D5K1

COMPLEMENTARY UNIJUNCTION

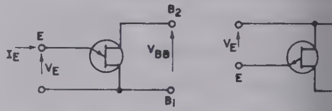
The General Electric D5K1 Complementary Unijunction Transistor is a silicon planar, monolithic integrated circuit. It has unijunction characteristics with superior stability, a much tighter intrinsic-standoff ratio distribution and lower saturation voltage.



FEATURES

- Guaranteed stability of better than .6% from −15°C to +65°C and better than 1.0% from −55°C to +150°C
- Low leakage current: less than 10nA
- Ability to temperature compensate and calibrate at room temperature
- Up to 100 kHz operation

WHAT IS A COMPLEMENTARY UNIJUNCTION TRANSISTOR?



Standard Unijunction   **Complement Unijunctio**

The General Electric D5K is a silicon planar passivated semiconductor device with characteristics like those of a standard unijunction transistor except that the currents and voltages applied to it are of opposite polarity.

We have chosen to use this polarity so that standard NPN planar passivated transistor processing techniqu can be used. This results in a unijunction having superior stability and better uniformity than any unijunctio previously available. The much tighter spread of intrinsic-standoff ratio now available is a significant advantag For most applications, the polarity is not important.

WHAT CAN THE D5K DO?

The General Electric D5K can be used in most applications now using standard type unijunctions. Its uniqu stability and uniform properties make it ideal for stable oscillators, timers, and frequency dividers.

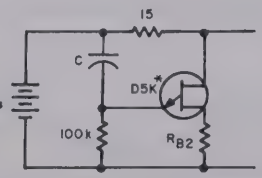
The key advantage of the D5K over conventional UJT's is its predictability over the specified temperature rang This allows an engineer to use design curves to select the correct R_{B2} compensating resistor instead of having perform expensive temperature testing on individual devices.

The D5K1 has been characterized especially for applications requiring the best possible stability over the extrem temperature range specified. For most applications, because of the tight R_{BBO} and η spread, the D5K1 can compensated in a given circuit with one resistor value by selecting the proper R_{B2} from Figure 2. For even bett stability, a designer only has to measure the R_{BBO} of a device at room temperature, determine the prop R_{BBO}/R_{B2} ratio from Figure 3, and insert the correct R_{B2}. Using this method, oscillators and timers can be bui offering 0.5% stability over most temperature ranges used.

Frequency dividers can be built with larger countdown ratios and drastically lower capacitor sizes due to th stability and low charge to trigger value (Q_t). Another product advantage, low base 1 to emitter voltage drop high current, allows generation of high outputpulses with *low* base to base voltages.

For further application information, refer to Application Note 90.72.

FIGURE 1



TEST CIRCUIT
*CUJT ONLY SUBJECTED TO
TEMPERATURE CHANGE
ALL RESISTORS 1%

FIGURE 2

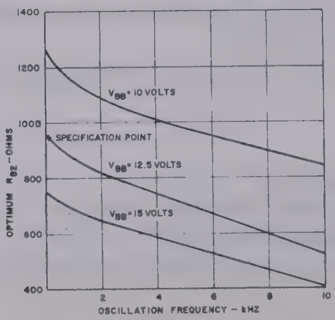
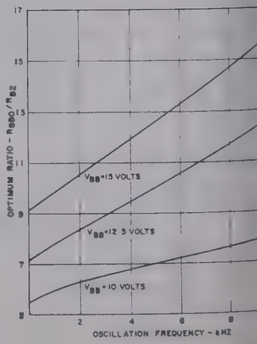


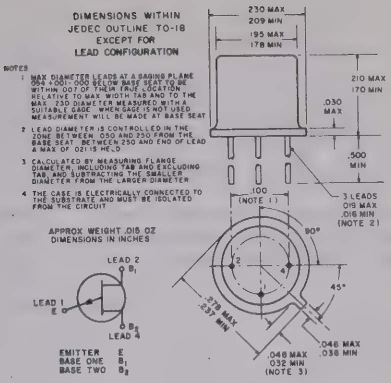
FIGURE 3



5K1

absolute maximum ratings: (25° C free air)

	D5K1	
Voltage		
Interbase Voltage	30	V
Current (Note 2)		
Average Emitter (Forward)	150	mA
Peak Emitter (Forward) (Note 1)	2	A
Peak Reverse Emitter	15	mA
Power		
Average Total (Note 2)	300	mW
Temperature		
Operating	−55 to +150	°C
Storage	−55 to +200	°C



DIMENSIONS WITHIN JEDEC OUTLINE TO-18 EXCEPT FOR LEAD CONFIGURATION

NOTES

1. MAX DIAMETER LEADS AT A GAGING PLANE .054 +.001 -.000 BELOW BASE SEAT TO BE WITHIN .007 OF THEIR TRUE LOCATION RELATIVE TO MAX WIDTH TAB AND TO THE MAX .230 DIAMETER MEASURED WITH A SUITABLE GAGE. WHEN GAGE IS NOT USED MEASUREMENT WILL BE MADE AT BASE SEAT
2. LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND .250 FROM THE BASE SEAT. BETWEEN .250 AND END OF LEAD A MAX OF .021 IS HELD
3. CALCULATED BY MEASURING FLANGE DIAMETER, INCLUDING TAB AND EXCLUDING TAB, AND SUBTRACTING THE SMALLER DIAMETER FROM THE LARGER DIAMETER
4. THE CASE IS ELECTRICALLY CONNECTED TO THE SUBSTRATE AND MUST BE ISOLATED FROM THE CIRCUIT

APPROX WEIGHT .018 OZ
DIMENSIONS IN INCHES

---

electrical characteristics: (25° C free air)

		Min.	Typ.	Max.	
Intrinsic Standoff Ratio (Note 3)	η	0.58	0.60	0.62	
Peak Point Voltage					
($V_{BB} = 5V$)	V_P	3.2	3.45	3.7	Volts
($V_{BB} = 10V$)	V_P	6.1	6.45	6.8	Volts
Interbase Resistance ($I_{BB} = 0.1mA$)	R_{BBO}	5.5	6.8	8.2	kohms
Emitter Breakdown Voltage ($I_{EB1} = 10\mu A$)	V_{EB1O}	8.0	9.5		Volts
Peak Point Current ($V_{BB} = 10V$)	I_P			5	μA
Valley Point Current ($V_{BB} = 10V$)	I_V	1	2		mA
Emitter Reverse Current ($V_{EB1} = 5V$)	I_{EB1O}		0.1	10	nA
Emitter Saturation Voltage ($I_E = 50mA, V_{BB} = 10V$)	$V_{E(sat)}$		1.1	1.5	Volts
Modulated Interbase Current ($I_E = 50mA, V_{BB} = 10V$)	$I_{B2(mod)}$		4	10	mA
Peak Pulse Voltage (Note 4)	V_{OUT}	3.5	4.5		Volts
Diode Voltage Drop (Note 3)	V_D	.30	.45	.60	Volts
Minimum Charge to Trigger ($V_{BB} = 10V$)	Q_t		50		pC
Turn-on Time (See Figure 7)	t_{on}			1	μsec.
Recovery Time (See Figure 7)	t_{rec}			10	μsec.
Relaxation Oscillator Frequency Shift from 25°C Value (See Figure 1, $C = 0.1\mu F, R_{B2} = 950\Omega, V_S = 12.5V$)					
−15°C to +65°C			0.2	0.6	%
−55°C to +150°C			0.4	1.0	%

Notes:

1. For capacitor discharge, resistor current limiting is required for capacitors greater than 5 μF and recommended for all cases. (A minimum of 15 ohms is required for good temperature stability.)
2. Derate power and currents linearly to zero at maximum operating temperature.
3. The intrinsic-standoff ratio (η) is essentially constant with temperature and interbase voltage. It and the associated diode drop of peak point voltage are defined by the equations:

$$\eta = \frac{V_{P1} - V_{P2}}{V_{BB1} - V_{BB2}} \qquad V_D = V_{P2} - \eta V_{BB2} \qquad \text{Where: } V_{BB1} = 10V \pm .001V,\; V_{BB2} = 5V \pm .001V$$

4. The Base-One Peak Pulse Voltage is measured in the circuit shown in Figure 4. This specification is used to insure a minimum pulse amplitude for applications in SCR firing circuits and other types of firing circuits.

FIGURE 4

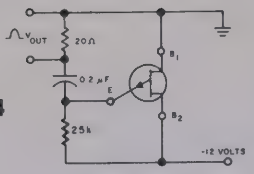
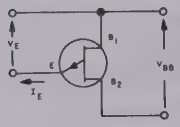

V_{OUT}
20Ω
0.2 µF
E
B_1
B_2
25k
-12 VOLTS

FIGURE 5


V_E
I_E
E
B_1
B_2
V_{BB}

Complementary Unijunction Transistor symbol with nomenclature used for voltage and currents.

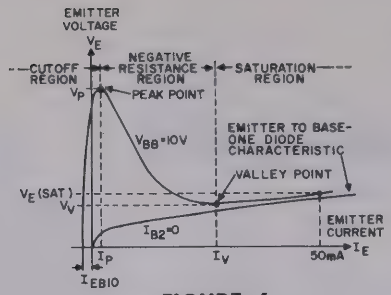


FIGURE 6

Static Emitter Characteristics curves showing important parameters and measurement points (exaggerated to show details).

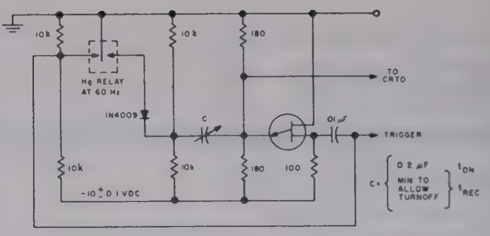
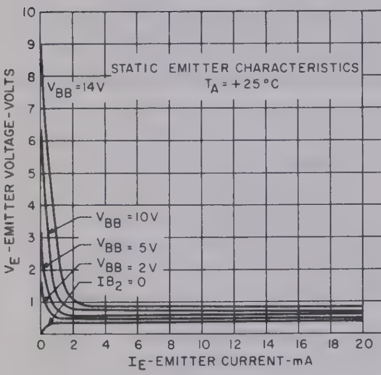
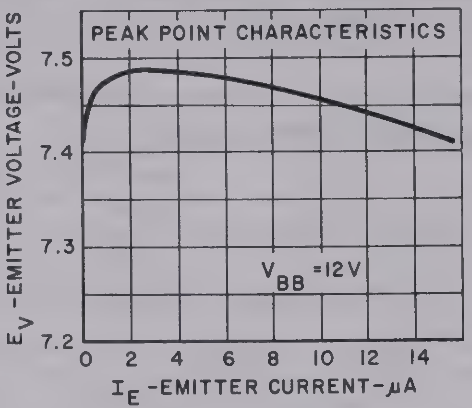
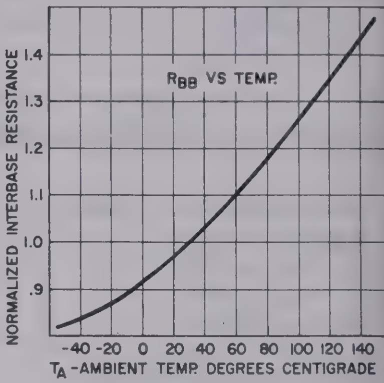

10k
Hg RELAY AT 60 Hz
10k
180
TO CRTO
1N4009
C
.01 µF
TRIGGER
10k
10k
180
100
-10 ± 0.1 VDC
C = 0.2 µF t_{ON}
MIN TO ALLOW TURNOFF t_{REC}

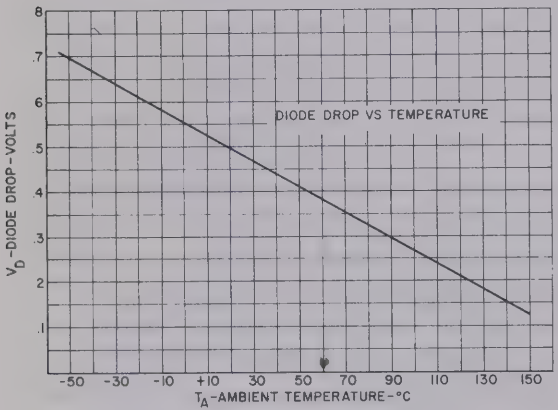
FIGURE 7

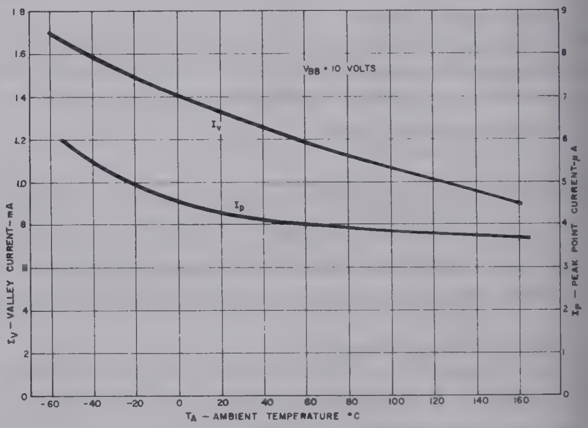
TYPICAL CHARACTERISTICS

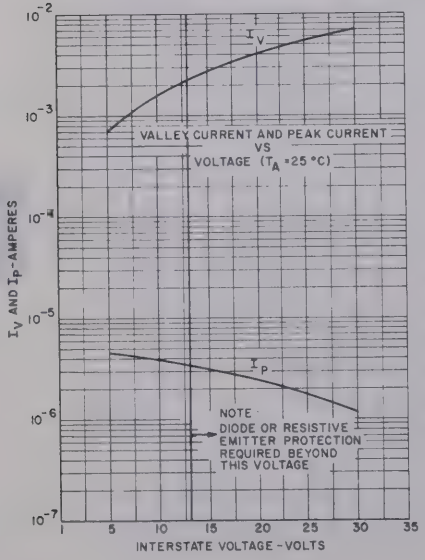


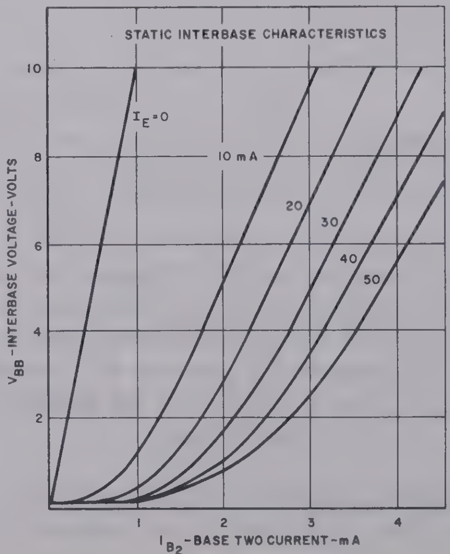


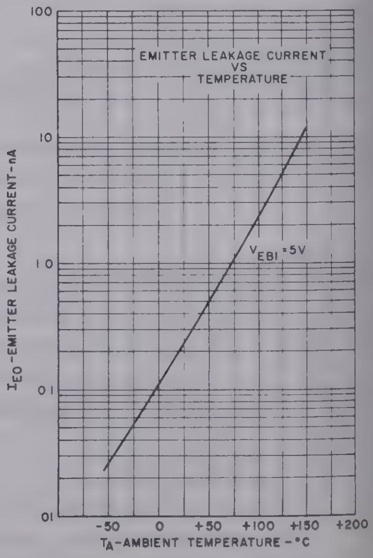










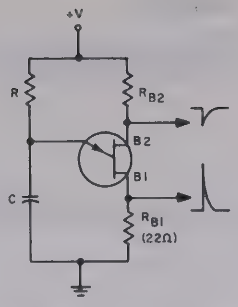


5K1

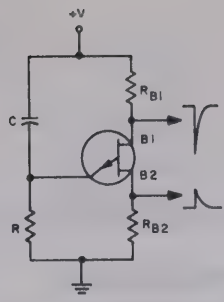
PPLICATIONS

TYPICAL CIRCUITS

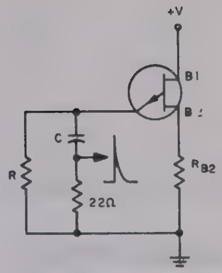
Since the CUJT has opposite polarities from standard UJT's, its oscillator circuit Figure (b)is“inverted.” Figure (a) shows a positive, high energy pulse, while Figure (b) shows a negative. Circuit in Figure (c) results in positive pulses for SCR triggering.


+V
R
R_{B2}
B2
B1
C
R_{B1}
(22Ω)

(a)
STANDARD
CIRCUIT


+V
C
R_{B1}
B1
B2
R
R_{B2}

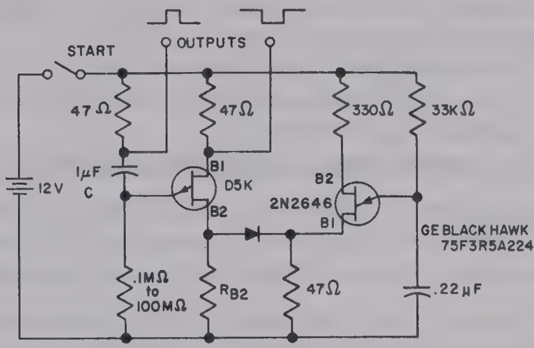
(b)
COMPLEMENTARY
CIRCUIT


+V
B1
B2
C
R
22Ω
R_{B2}

(c)
CUJT CIRCUIT
FOR HIGH ENERGY
TRIGGER PULSES

0.1 TO 90 SECOND TIMER

Timer interval starts when power is applied to circuit, terminates when voltage is applied to load. 2N2646 is used in oscillator which pulses base 2 of D5K. This reduces effective I_P of D5K and allows much larger timing resistor and smaller timing capacitor to be used than would otherwise be possible.

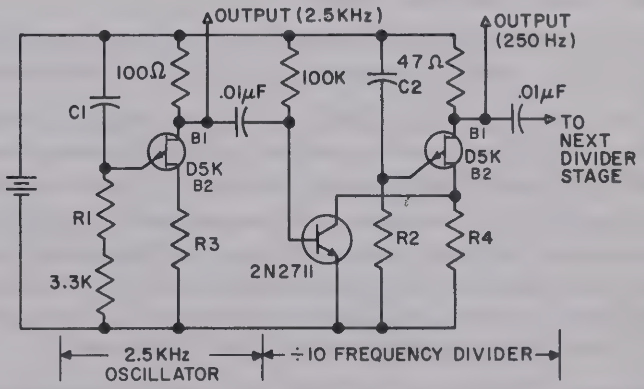

OUTPUTS
START
47Ω
47Ω
330Ω
33KΩ
12V
1μF
C
B1
D5K
B2
B2
2N2646
B1
GE BLACK HAWK
75F3R5A224
.1MΩ
to
100MΩ
R_{B2}
47Ω
.22μF

C=GE BLUE JAY AA18A105C

DECADE FREQUENCY DIVIDER

In next stage, product of R2 and C2 should be 10 × that of preceding stage (±2%). R2 should be between 27kΩ and 10 meg Ω.

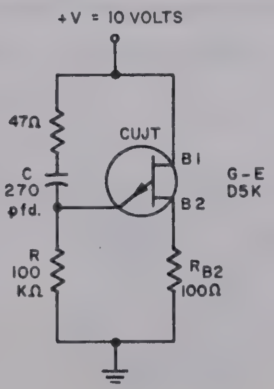
C1 & C2—.0047 μF (±1%)
R1—100k Ω (±1%)
R2—1M Ω (±1%)
R3—R4—1k Ω (may need to be adjusted for variation of R_{BB} of CUJT)


OUTPUT (2.5KHz)
OUTPUT
(250 Hz)
100Ω
.01μF
100K
47Ω
C2
.01μF
C1
B1
D5K
B2
B1
D5K
B2
TO
NEXT
DIVIDER
STAGE
R1
R3
2N2711
R2
R4
3.3K
2.5KHz
OSCILLATOR
÷10 FREQUENCY DIVIDER

---

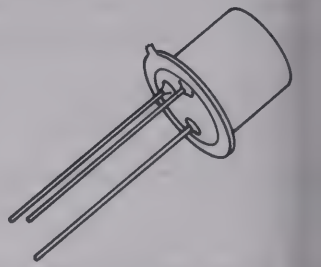
50 kHz OSCILLATOR

Higher frequency (stable) oscillators are now possible. Here are typical components for a 50 kHz circuit. This is possible because of the more nearly ideal characteristics of the D5K (over conventional UJT's). One application for higher frequency is TV horizontal oscillators. Note the low R_{B2}.


+V = 10 VOLTS
47Ω
CUJT
B1
G-E
D5K
C
270
pfd.
B2
R
100
KΩ
R_{B2}
100Ω

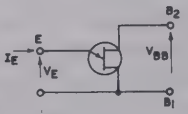
COMPLEMENTARY UNIJUNCTION

The General Electric D5K2 Complementary Unijunction Transistor is a silicon planar, monolithic integrated circuit. It has unijunction characteristics with superior stability, a much tighter intrinsic-standoff ratio distribution and lower saturation voltage.

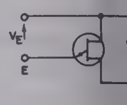


FEATURES

- Guaranteed stability of better than 1.0% from −15°C to +65°C and better than 2.0% from −55°C to +100°C
- Low leakage current: less than 100 nA
- Ability to temperature compensate and calibrate at room temperature
- Up to 100 kHz operation



Standard Unijunction



Complement Unijunctio

WHAT IS A COMPLEMENTARY UNIJUNCTION TRANSISTOR?

The General Electric D5K is a silicon planar passivated semiconductor device with characteristics like those of a standard unijunction transistor except that the currents and voltages applied to it are of opposite polarity.

We have chosen to use this polarity so that standard NPN planar passivated transistor processing technique can be used. This results in a unijunction having superior stability and better uniformity than any unijunctio previously available. The much tighter spread of intrinsic-standoff ratio now available is a significant advantage For most applications, the polarity is not important.

WHAT CAN THE D5K DO?

The General Electric D5K can be used in most applications now using standard type unijunctions. Its uniqu stability and uniform properties make it ideal for stable oscillators, timers, and frequency dividers.

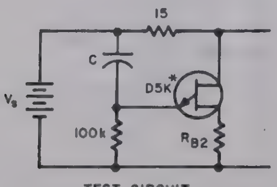
The key advantage of the D5K over conventional UJT's is its predictability over the specified temperature rang This allows an engineer to use design curves to select the correct R_{B2} compensating resistor instead of having t perform expensive temperature testing on individual devices.

For most applications now using conventional UJT's, the entire D5K2 population can be compensated in a give circuit with one resistor value by selecting the proper R_{B2} compensating resistor from Figure 2. For even bette stability, a designer only has to measure the R_{BBO} of a device at room temperature, determine the proper R_{BBO}/R ratio from Figure 3, and insert the correct R_{B2}. Using this method, oscillators and timers can be built offerin 1.0% stability over most temperature ranges used.

Frequency dividers can be built with larger countdown ratios and drastically lower capacitor sizes due to th stability and low charge to trigger value (Q_t). Another product advantage, low base 1 to emitter voltage drop high current, allows generation of high outputpulses with *low* base to base voltages.

For further application information, refer to Application Note 90.72.

FIGURE 1



TEST CIRCUIT
*CUJT ONLY SUBJECTED TO TEMPERATURE CHANGE
ALL RESISTORS 1%

FIGURE 2

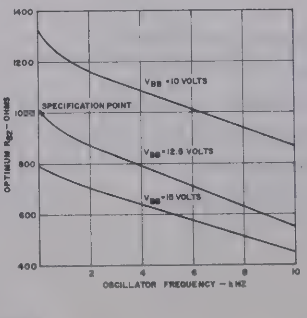
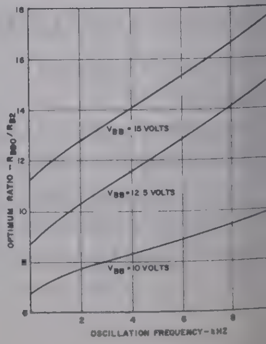
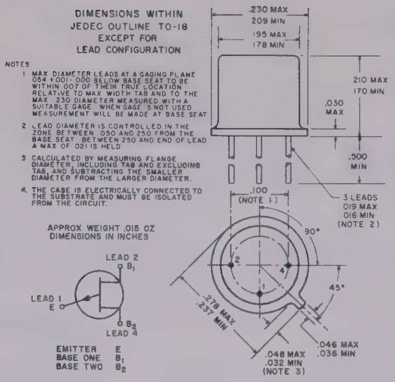


FIGURE 3



absolute maximum ratings: (25° C free air)

	D5K2	
Voltage		
Interbase Voltage	20	V
Current (Note 2)		
Average Emitter (Forward)	150	mA
Peak Emitter (Forward) (Note 1)	2	A
Peak Reverse Emitter	15	mA
Power		
Average Total (Note 2)	200	mW
Temperature		
Operating	−55 to +100	°C
Storage	−55 to +150	°C



DIMENSIONS WITHIN JEDEC OUTLINE TO-18 EXCEPT FOR LEAD CONFIGURATION

NOTES

1. MAX DIAMETER LEADS AT A GAGING PLANE 054 +001- 000 BELOW BASE SEAT TO BE WITHIN 007 OF THEIR TRUE LOCATION RELATIVE TO MAX WIDTH TAB AND TO THE MAX 230 DIAMETER MEASURED WITH A SUITABLE GAGE WHEN GAGE S NOT USED MEASUREMENT WILL BE MADE AT BASE SEAT
2. LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN 050 AND 250 FROM THE BASE SEAT BETWEEN 250 AND END OF LEAD A MAX OF 021 IS HELD
3. CALCULATED BY MEASURING FLANGE DIAMETER, INCLUDING TAB AND EXCLUDING TAB, AND SUBTRACTING THE SMALLER DIAMETER FROM THE LARGER DIAMETER.
4. THE CASE IS ELECTRICALLY CONNECTED TO THE SUBSTRATE AND MUST BE ISOLATED FROM THE CIRCUIT.

APPROX WEIGHT .015 OZ
DIMENSIONS IN INCHES

electrical characteristics: (25° C free air)

		Min.	Typ.	Max.	
Intrinsic Standoff Ratio (Note 3)	η	0.58	0.60	0.62	
Peak Point Voltage					
($V_{BB} = 5V$)	V_P	3.2	3.45	3.7	Volts
($V_{BB} = 10V$)	V_P	6.1	6.45	6.8	Volts
Interbase Resistance					
($I_{BB} = 0.1mA$)	R_{BBO}	5	8	15	kohms
Emitter Breakdown Voltage					
($I_{EB1} = 10\mu A$)	V_{EB1O}	8.0	9.5		Volts
Peak Point Current					
($V_{BB} = 10V$)	I_P			15	μA
Valley Point Current					
($V_{BB} = 10V$)	I_V	1	2		mA
Emitter Reverse Current					
($V_{EB1} = 5V$)	I_{EB1O}		0.1	10	nA
Emitter Saturation Voltage					
($I_E = 50mA, V_{BB} = 10V$)	$V_{E(sat)}$		1.1	1.5	Volts
Modulated Interbase Current					
($I_E = 50mA, V_{BB} = 10V$)	$I_{B2(mod)}$		4	10	mA
Peak Pulse Voltage					
(Note 4)	V_{OUT}	3.5	4.5		Volts
Diode Voltage Drop					
(Note 3)	V_D	.30	.45	.60	Volts
Minimum Charge to Trigger					
($V_{BB} = 10V$)	Q_t		50		pC
Turn-on Time (See Figure 7)	t_{on}			1	μsec.
Recovery Time (See Figure 7)	t_{rec}			10	μsec.
Relaxation Oscillator Frequency Shift from 25°C Value (See Figure 1, $C = 0.1\mu F, R_{B2} = 1k\Omega, V_S = 12.5V$)					
−15°C to +65°C			0.3	1.0	%
−55°C to +100°C			0.5	2.0	%

Notes:

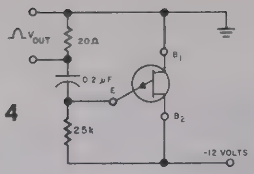
1. For capacitor discharge, resistor current limiting is required for capacitors greater than 5 μF and recommended for all cases. (A minimum of 15 ohms is required for good temperature stability.)
2. Derate power and currents linearly to zero at maximum operating temperature.
3. The intrinsic-standoff ratio (η) is essentially constant with temperature and interbase voltage. It and the associated diode drop of peak point voltage are defined by the equations:

$$\eta = \frac{V_{P1} - V_{P2}}{V_{BB1} - V_{BB2}} \qquad V_D = V_{P2} - \eta V_{BB2} \qquad \text{Where: } V_{BB1} = 10V \pm .001V, \quad V_{BB2} = 5V \pm .001V$$

4. The Base-One Peak Pulse Voltage is measured in the circuit shown in Figure 4. This specification is used to insure a minimum pulse amplitude for applications in SCR firing circuits and other types of firing circuits.

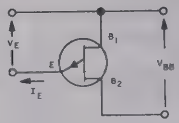
D5K2

FIGURE 4



V_{OUT}
20 Ω
0.2 μF
E
B1
B2
25k
-12 VOLTS

FIGURE 5



VE
E
IE
B1
B2
VBB

Complementary Unijunction Transistor symbol with nomenclature used for voltage and currents.

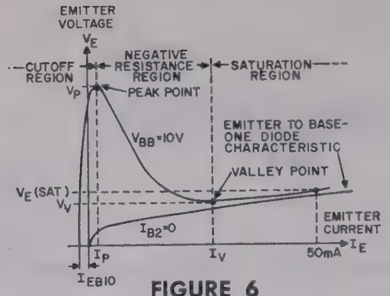
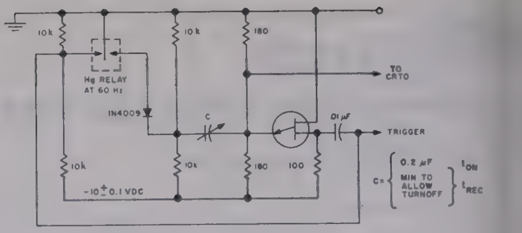


FIGURE 6

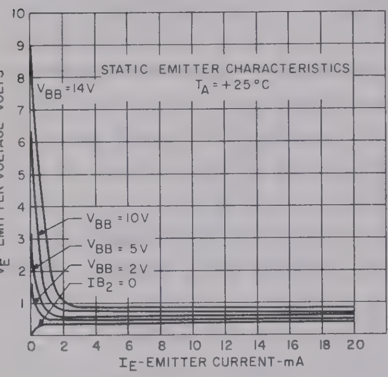
Static Emitter Characteristics curves showing important parameters and measurement points (exaggerated to show details).

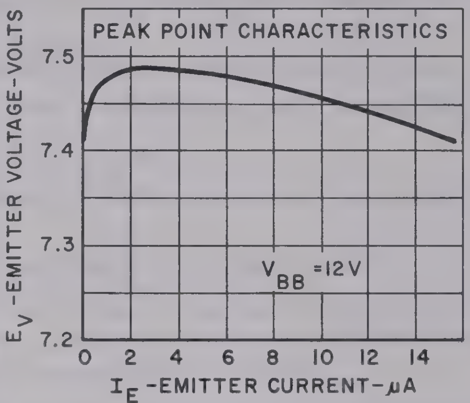


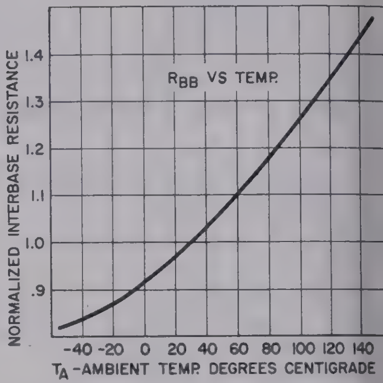
10k
Hg RELAY AT 60 Hz
10k
180
TO CRTO
1N4009
C
.01 μF
TRIGGER
10k
10k
180
100
-10 ± 0.1 VDC
C = 0.2 μF tON
MIN TO ALLOW TURNOFF tREC

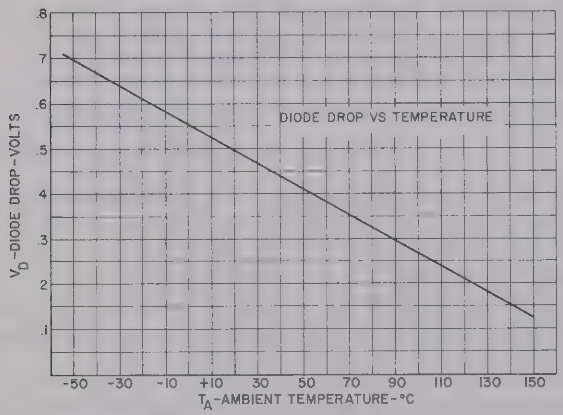
FIGURE 7

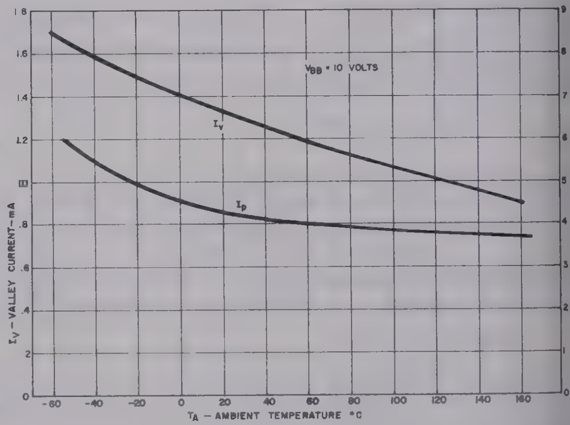
TYPICAL CHARACTERISTICS

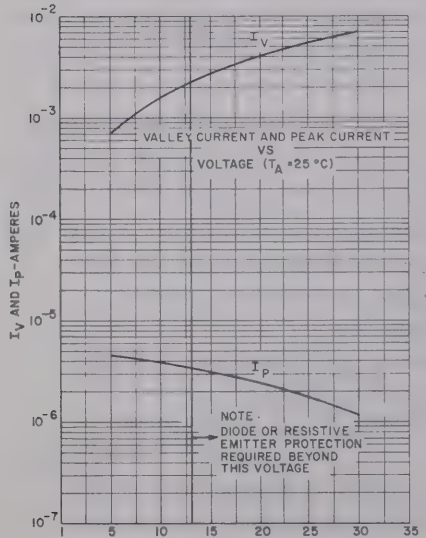


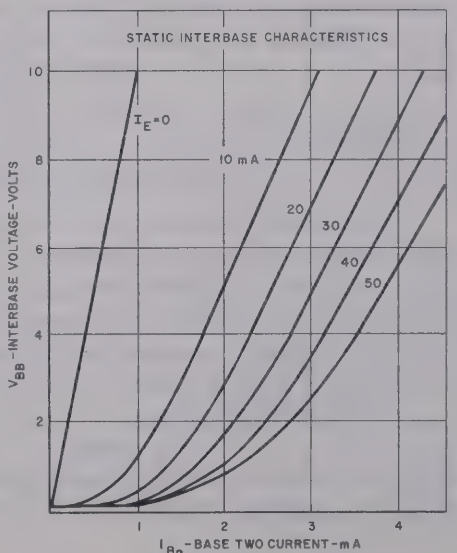


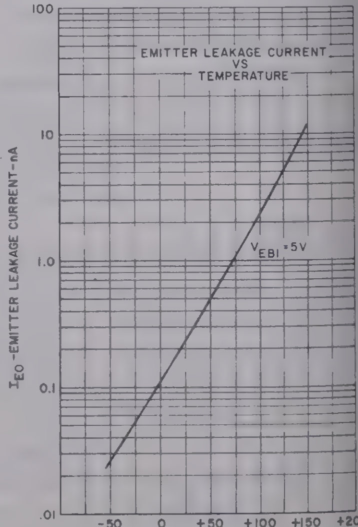








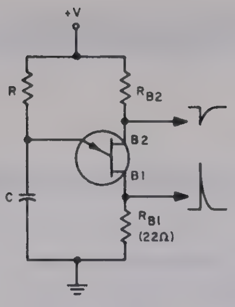




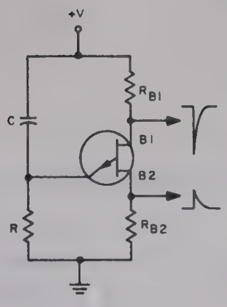
APPLICATIONS

TYPICAL CIRCUITS

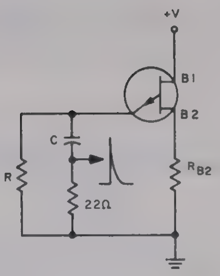
Since the CUJT has opposite polarities from standard UJT's, its oscillator circuit Figure (b) is "inverted." Figure (a) shows a positive, high energy pulse, while Figure (b) shows a negative. Circuit in Figure (c) results in positive pulses for SCR triggering.


+V
R
C
R_{B2}
B2
B1
R_{B1} (22Ω)

(a)
STANDARD CIRCUIT


+V
C
R
R_{B1}
B1
B2
R_{B2}

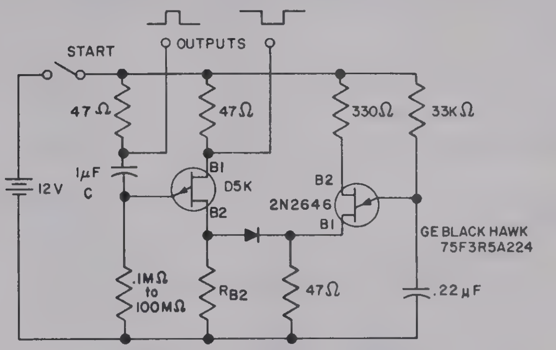
(b)
COMPLEMENTARY CIRCUIT


+V
B1
B2
C
R
22Ω
R_{B2}

(c)
CUJT CIRCUIT FOR HIGH ENERGY TRIGGER PULSES

0.1 TO 90 SECOND TIMER

Timer interval starts when power is applied to circuit, terminates when voltage is applied to load. 2N2646 is used in oscillator which pulses base 2 of D5K. This reduces effective I_P of D5K and allows much larger timing resistor and smaller timing capacitor to be used than would otherwise be possible.

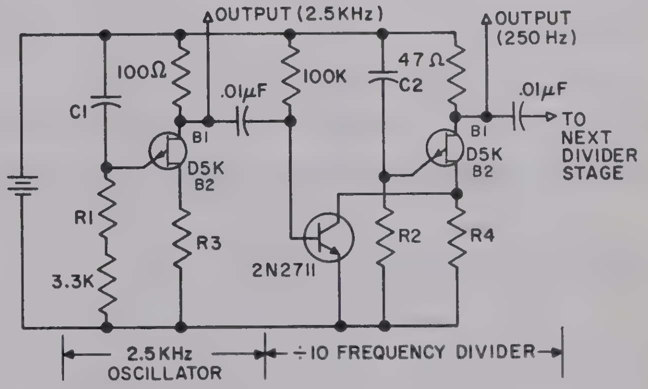

OUTPUTS
START
47Ω
47Ω
330Ω
33KΩ
12V
1μF C
B1
D5K
B2
B2
2N2646
B1
GE BLACK HAWK 75F3R5A224
.1MΩ to 100MΩ
R_{B2}
47Ω
.22μF

C=GE BLUE JAY AA18A105C

DECADE FREQUENCY DIVIDER

In next stage, product of R2 and C2 should be 10 × that of preceding stage (±2%). R2 should be between 27kΩ and 10 meg Ω.

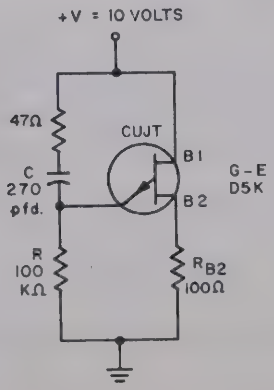
C1 & C2—.0047 μF (±1%)
R1—100k Ω (±1%)
R2—1M Ω (±1%)
R3—R4—1k Ω (may need to be adjusted for variation of R_{BB} of CUJT)


OUTPUT (2.5KHz)
OUTPUT (250 Hz)
100Ω
.01μF
100K
47Ω
C2
.01μF
C1
B1
D5K
B2
B1
D5K
B2
TO NEXT DIVIDER STAGE
R1
3.3K
R3
2N2711
R2
R4
2.5KHz OSCILLATOR
÷10 FREQUENCY DIVIDER

---

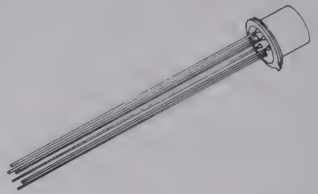
50 kHz OSCILLATOR

Higher frequency (stable) oscillators are now possible. Here are typical components for a 50 kHz circuit. This is possible because of the more nearly ideal characteristics of the D5K (over conventional UJT's). One application for higher frequency is TV horizontal oscillators. Note the low R_{B2}.


+V = 10 VOLTS
47Ω
CUJT
B1
G-E D5K
C 270 pfd.
B2
R 100 KΩ
R_{B2} 100Ω

NPN
12A8

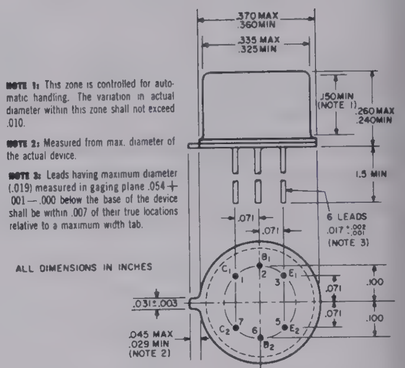
The General Electric type 12A8 is a 6 terminal device containing two completely isolated silicon planar transistors in a hermetically sealed package of TO-5 size. The 12A8 is particularly advantageous when used as a differential amplifier where matched VBE over a temperature range is of prime importance. This device is designed for power supplies and other industrial equipment where economy is of prime importance.



absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages		
Collector to Base	V_{CBO}	50 volts
Collector to Emitter	V_{CEO}	30 volts
Emitter to Base	V_{EBO}	5 volts
Dissipation*		
Each Transistor (Free Air at 25°C)	P_T	250 mw
Each Transistor (Case Temperature 25°C)	P_T	500 mw
Both Sides (Free Air at 25°C)	P_T	500 mw
Both Sides (Case Temperature 25°C)	P_T	1000 mw
Temperatures		
Storage	T_{STG}	-65 to 200°C
Operating Junction	T_J	-65 to 200°C

*Derate linearly to 200°C for operation above 25°C.



NOTE 1: This zone is controlled for automatic handling. The variation in actual diameter within this zone shall not exceed .010.

NOTE 2: Measured from max. diameter of the actual device.

NOTE 3: Leads having maximum diameter (.019) measured in gaging plane .054 + 001 — .000 below the base of the device shall be within .007 of their true locations relative to a maximum width tab.

ALL DIMENSIONS IN INCHES

electrical characteristics: (25°C) (unless otherwise specified)

Collector Base Voltage (I_C =50mua)	V_{CBO}	50		volts
Collector to Emitter Voltage (I_C =20ma)	V_{CEO}**	30		volts
Collector Leakage Current (V_{CB} =30V)	I_{CBO}		25	mua
Collector Leakage Current (V_{CB} =30V, T_A =150°C)	I_{CBO}		20	ua
Emitter Base Leakage Current (V_{EB} =5V)	I_{EBO}		100	mua
Forward Current Transfer Ratio (I_C =1ma, V_{CE} =5V)	h_{FE}	30		
Forward Current Transfer Ratio (I_C =100ua, V_{CE} =5V)	h_{FE}	20		
DC Beta Ratio (V_{CE} =5V) (I_C =100ua) Note 1)	h_{FE1} h_{FE2}	0.6	1.0	
Collector Saturation Voltage (I_C =50ma, I_B =5ma)	$V_{CE(SAT)}$**		3.0	volts
Base Saturation Voltage (I_C =50ma, I_B =5ma)	$V_{BE(SAT)}$**		1.0	volts
Voltage Differential (V_{CE} =5V, I_C =100ua)	V_{BE1} - V_{BE2}		15	mv
Collector Capacity (V_{CB} =10V, I_E =0, f=1mc)	C_{ob}		25	uuf
Current Transfer Ratio (I_C =50ma, V_{CE} =10V, f=20mc)	h_{fe}	2.5		

**Pulse width 300usec, Duty Cycle 2%.

Note 1: Lowest of two hFE readings is taken as hFE1 for the purposes of this ratio.

Silicon
Differential Amplifier

NPN

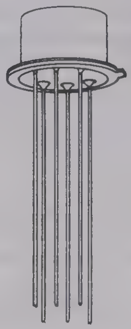
D12E026,126

The General Electric D12E026 and D12E126 are NPN planar passivated ifferential amplifiers in hermetically sealed, 6 terminal, TO-5 or TO-18 size packges featuring ceramic "fixed-bed" construction. These devices are designed for ıdustrial equipment where economy is of prime importance.

absolute maximum ratings: (25°C)

	SYMBOL	D12E026 D12E126	
Voltages			
Collector to Base	BV_{CBO}	45	V
Collector to Emitter	BV_{CEO}	30	V
Emitter to Base	BV_{EBO}	5	V
Current			
Collector	I_C	30	mA

		D12E026 (TO-5)	D12E126 (TO-18)	
Dissipation				
Free Air @ 25°C	P_T			
Each Transistor		300	200	mW
Derate		2.0	1.33	mW/°C
Both Transistors		600	300	mW
Derate		4.0	2.0	mW/°C
Case Temperature @ 25°C	P_T			
Each Transistor		600	500	mW
Derate		4.0	3.33	mW/°C
Both Transistors		1200	750	mW
Derate		8.0	5.0	mW/°C
Temperature				
Storage	T_{STG}	−65 to +200°C		
Operating	T_J	+175°C		



D12E026

(TO-5)

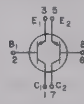
DIMENSIONS WITHIN JEDEC OUTLINE TO-5 EXCEPT FOR LEAD CONFIGURATION

NOTE 1: Lead diameter is controlled in the zone between 050 and 250 from the seating plane Between 250 and end of lead a max of 021 is held

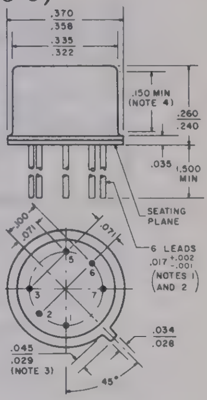
NOTE 2: Leads having maximum diameter (.019) measured in gaging plane .054 + 001 .000 below the seating plane of the device shall be within 007 of true position relative to a maximum width tab.

NOTE 3: Measured from max. diameter of the actual device

NOTE 4: This zone is controlled for automatic handling. The variation in actual diameter within this zone shall not exceed .010.



ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED



D12E126

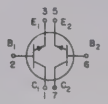
(TO-18)

DIMENSIONS WITHIN JEDEC OUTLINE TO-18 EXCEPT FOR LEAD CONFIGURATION

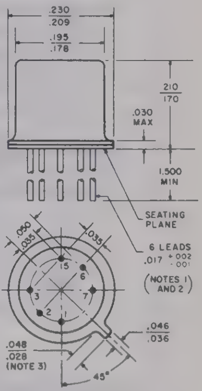
NOTE 1: Lead diameter is controlled in the zone between .050 and .250 from the seating plane Between .250 and end of lead a max. of .021 is held.

NOTE 2: Leads having maximum diameter (.019) measured in gaging plane 054 + 001 .000 below the seating plane of the device shall be within 007 of true position relative to a maximum width tab.

NOTE 3: Measured from max diameter of the actual device.



ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED



electrical characteristics: (25°C) (unless otherwise noted)

	Symbol	Min.	Max.	
Collector Base Voltage ($I_C = 10\,\mu A$, $I_E = 0$)	BV_{CBO}	45		V
Collector Emitter Voltage ($I_C = 10$ mA, $I_B = 0$, Pulse)	BV_{CEO}*	30		V
Emitter Base Voltage ($I_E = 10\,\mu A$, $I_C = 0$)	BV_{EBO}	5		V
Emitter Leakage Current ($V_{EB} = 5V$, $I_C = 0$)	I_{EBO}		25	μA
Collector Leakage Current ($V_{CB} = 20V$, $I_E = 0$, $T_A = 150°C$)	I_{CBO}		25	μA
Collector Saturation Voltage ($I_C = 1$ mA, $I_B = 0.1$ mA)	$V_{CE(sat)}$		0.6	V
Base Saturation Voltage ($I_C = 0.1$ mA, $V_{CE} = 5V$)	$V_{BE(on)}$		1.0	V
Forward Current Transfer Ratio ($I_C = 0.1$ mA, $V_{CE} = 5V$)	h_{FE}	40		
Forward Current Transfer Ratio ($I_C = 1$ mA, $V_{CE} = 5V$)	h_{FE}	60		
MATCHING CHARACTERISTICS				
DC Beta Match ($I_C = 0.1$ mA, $V_{CE} = 5V$)	h_{FE1}/h_{FE2}**	0.6	1.0	
Voltage Differential ($I_C = 0.1$ mA, $V_{CE} = 5V$)	V_{BE1}/V_{BE2}		15	mV
HIGH FREQUENCY CHARACTERISTICS				
Collector Capacitance ($V_{CB} = 10V$, $I_E = 0$, f = 1 mHz)	C_{ob}		8	pF
Current Transfer Ratio ($I_C = 1$ mA, $V_{CE} = 5v$, f = 20 mHz)	h_{fe}	1.5		

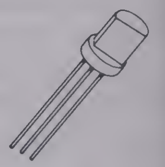
*Pulse width = 300 μ sec, Duty Cycle = 2%

**Lowest of the two h_{FE} readings is taken as h_{FE1} for purpose of this ratio.

Silicon
Asymmetrical Switch
(SAS)

D13H1

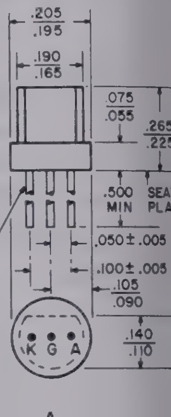
The General Electric SAS is a TO-98 epoxy packaged,silicon planar,monolithic integrated circuit having bilateral, asymmetrical voltage threshold, thyristor electrical characteristics. The voltage threshold is closely controlled and specified with both low switching current and low temperature coefficient. A gate lead is provided to eliminate rate effect, allow gate triggering and provide a saturating output to the cathode.



DIMENSIONS WITHIN
JEDEC OUTLINE TO-98

NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

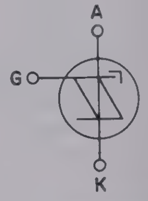


APPLICATIONS INCLUDE:
- Lamp Drivers with Memory
- Overvoltage Crowbar Circuits
- SCR Triggers
- Pulse Discriminators
- Tachometers

absolute maximum ratings: (25°C) (unless otherwise specified)

Power Dissipation	350	mW
Anode Current		
Forward Peak, 10 μsec	1	Amp
Reverse Peak, 10 μsec	0.5	Amp
Gate to Cathode Current		
On State	50	mA
Off State	1	mA
Gate to Anode Current	1	mA
Temperature, Operating	-55 to +125	°C
Storage	-55 to +150	°C
Leads (1/16", 10 sec max)	260	°C

*Derate 3.5 mW/°C above 25°C ambient



electrical characteristics: (25°C) (unless otherwise specified)

PARAMETER	SYMBOL	MIN.	MAX.	UNITS
Switching Voltage, Forward	V_{SF}	7.0	9.0	Volts
Switching Voltage, Reverse	V_{SR}	14.0	18.0	Volts
Switching Current, Both Directions	I_S		100	μA
Gate Trigger Current, V_{AK} = 5V, R_K = 200Ω	I_{GT}		−70	μA
Gate Saturation Voltage, I_A = 2mA, I_G = 20mA	$V_{GK(SAT)}$		1.0	Volts
Anode Saturation Voltage, I_A = 200mA, I_G = 0	$V_{AK(SAT)}$		2.0	Volts
Switching Voltage Temperature Coefficient	T. C.		0.05	%/°C
Holding Current, $R_A = 1K\Omega$, $I_G = 0$	I_H		250	μA
Leakage Current, V_{AK} = 5V	I_{AKO}		100	nA
Leakage Current, V_{KA} = 10V	I_{KAO}		100	nA
Peak Pulse Amplitude, Fig. 2, R = 20 Ω, C = 0.1 μF	V_O	3.5		Volts

SAS EQUIVALENT CIRCUIT

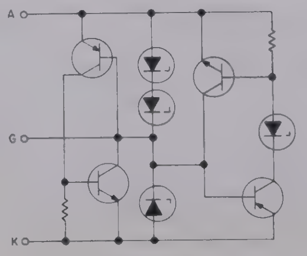


FIGURE 1

PEAK PULSE AMPLITUDE TEST CIRCUIT

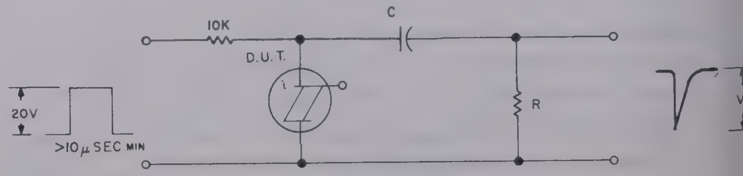
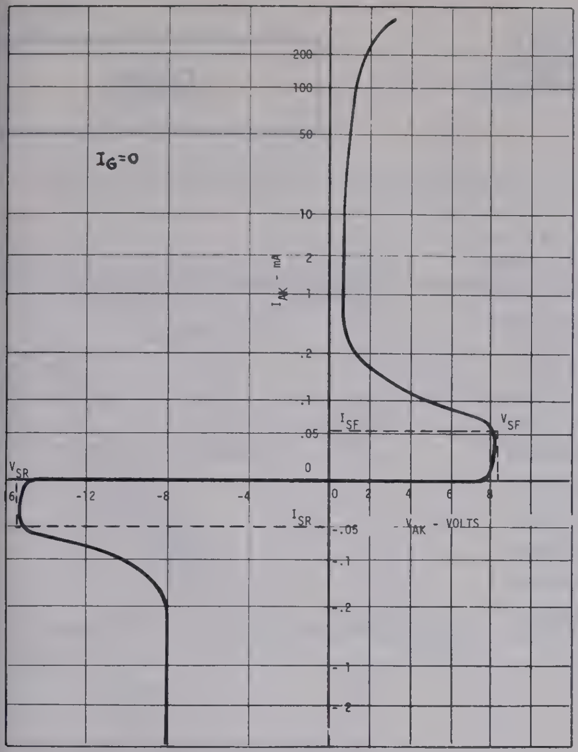
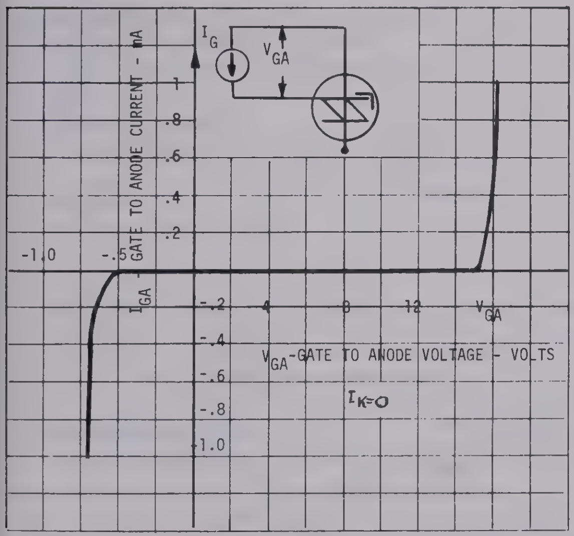


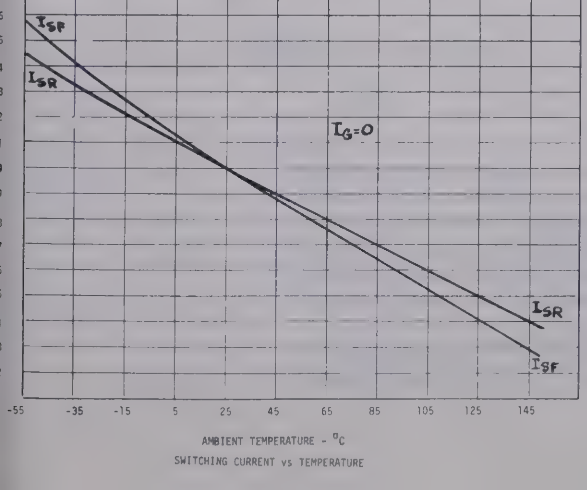
FIGURE 2



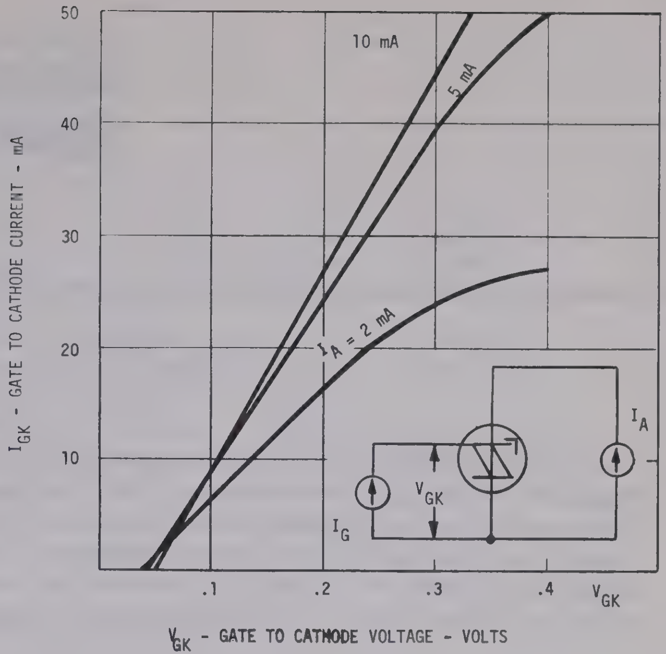
ANODE CATHODE CHARACTERISTICS GATE OPEN



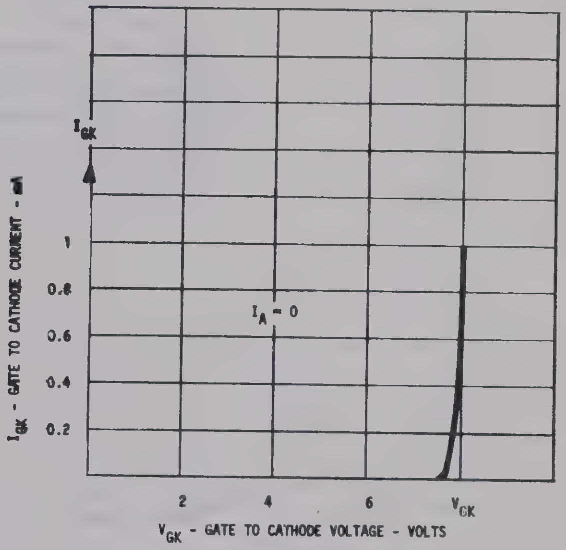
GATE - ANODE CHARACTERISTICS



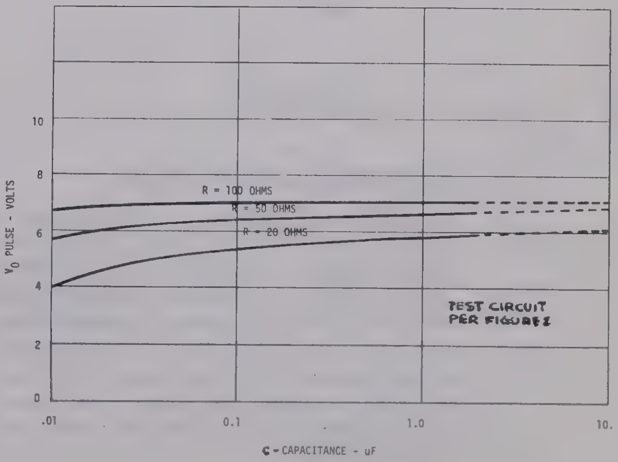
SWITCHING CURRENT vs TEMPERATURE



GATE CATHODE CHARACTERISTICS ON STATE



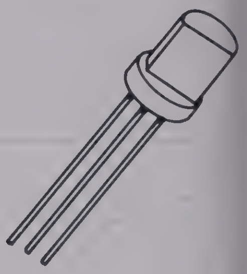
GATE CATHODE CHARACTERISTICS



V_0 PULSE AS A FUNCTION OF LOAD RESISTANCE
AND CHARGING CAPACITANCE

Integrated Voltage Regulator

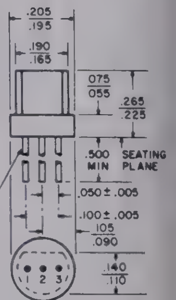
D13V



The General Electric IVR (D13V) is a monolithic integrated voltage regulator circuit in a standard epoxy TO-98 package. Designed for use as a shunt voltage regulating element, it can be utilized over wide voltage and current ranges. It also features a specified voltage temperature coefficient. It can also serve as an excellent reference amplifier for use in high precision, high power regulation systems.

FEATURES

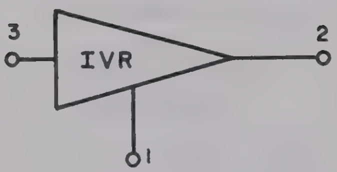
- Wide voltage range
- Simple resistor programming
- High gain
- Low temperature coefficient
- Epoxy transistor package
- High pulse current
- Low dynamic impedance
- Programmable "zener"



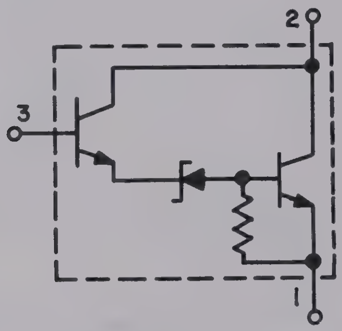
NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

DIMENSIONS WITHIN JEDEC OUTLINE TO-98



SYMBOL



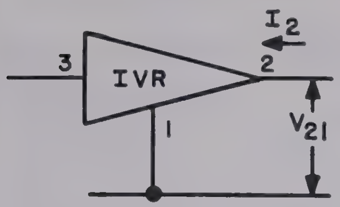
IVR CIRCUIT DIAGRAM

IVR Application And Operation

The IVR may be utilized as a shunt voltage regulator or as the voltage reference/error amplifier (reference amplifier) portion of a series pass voltage regulator. As a shunt voltage regulator a resistive voltage divider provides voltage feedback from the regulated voltage output to the IVR input (see Circuit 2). The output voltage is regulated to the value of the IVR Thevenin reference voltage times the inverse of the voltage divider ratio ($V_{21} = V_{21T} (R_1 + R_2)/R_2$). Operation of the IVR as a reference amplifier is similar in that the resistive divider to the IVR input monitors output voltage. The IVR output is now used to regulate the drive to the series pass element. Note that characterization of the IVR with respect to the Thevenin equivalent input circuit simplifies the regulator design procedure.

PERFORMANCE DATA

absolute maximum ratings: (25°C, refer to Circuit 1)



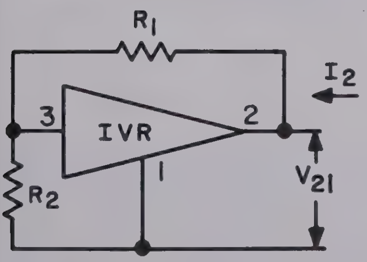
CIRCUIT 1

Total Average Power*	400	mW
Voltage, V_{21}	40	Volts
D.C. Current, I_2	40	mA
Peak Current, I_2		
(10 μsec pulse width, 1% duty cycle)	1	Amps
(50 msec pulse width, 10% duty cycle)	100	mA
Current, I_3	5	mA
Operating Temperature Range, T_J	–15°C to +125°C	
Storage Temperature Range, T_{STJ}	–55°C to +150°C	

electrical characteristics: (25°C, unless otherwise specified)

		Min.	Typ.	Max.	Units
Regulated Voltage Range $I_2 = 10$ mA, $R_{TH} = 50K\ \Omega$ (Circuit 2)	V_{21}	10	—	40	Volts
***Temperature Coefficient of Regulated Voltage** –15°C to +125°C $I_2 = 10$ mA, $R_{TH} = 50K\ \Omega$ (Circuit 2)	T.C.	—	.03	0.1	%/°C
Thevenin Impedance $I_2 = 10$mA, $R_{TH} = 50K\ \Omega$ (Circuit 3)	r_{21T}	—	10	50	Ohms
Leakage Current $V_{21} = 25$V (Circuit 1)	I_2	—	5	100	nanoamps.
Leakage Current $V_{21} = 5$V, $R_{TH} = 50K$ (Circuit 3)	I_2	—	1	100	nanoamps.
Capacitance $V_{23} = 10$V, f = 1 mHz	C_{23}	—	—	10	pF
Thevenin Reference Voltage $I_2 = 10$ mA, $R_{TH} = 50K$ (Circuit 3)	V_{21T}	—	8.5	10	Volts

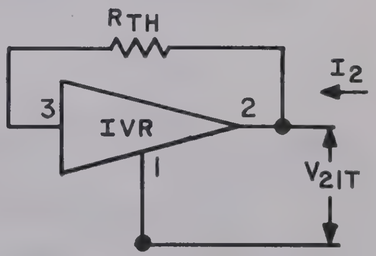
***Note:** Temperature coefficient holds for any divider with 50K Thevenin impedance.



CIRCUIT 2

Circuit 3 is the Thevenin equivalent of Circuit 2, with respect to the input of the IVR. The value of R_{TH}, the Thevenin input resistance, is

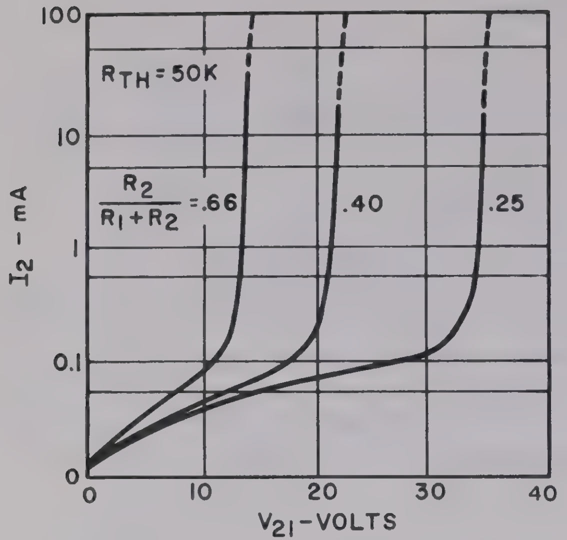
$$R_{TH} = \frac{R_1 R_2}{R_1 + R_2}.$$



CIRCUIT 3

TYPICAL SHUNT REGULATOR CHARACTERISTICS

I_2 VS. V_{21}

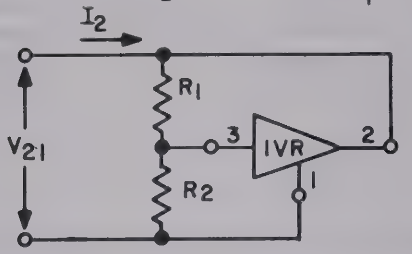


PROGRAMMING

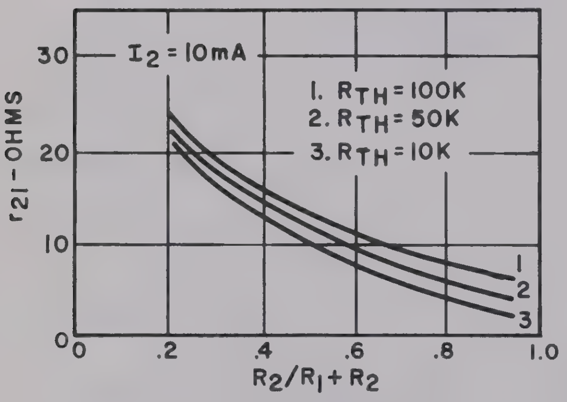
$V_{21} \cong V_{21T} \frac{R_1+R_2}{R_2}$

$r_{21} \cong r_{21T} \frac{R_1+R_2}{R_2}$

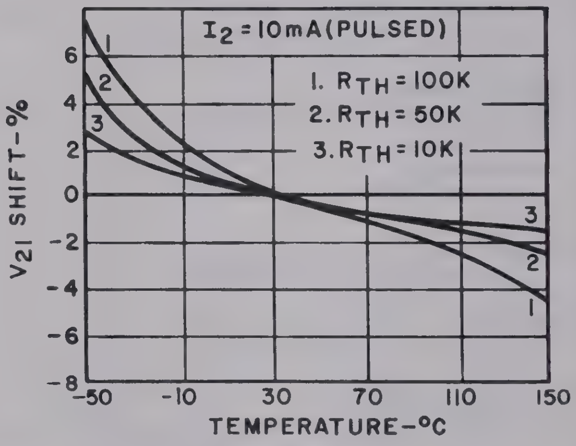
R_{TH}, THE THEVENIN INPUT RESISTANCE IS $R_{TH} = \frac{R_1 R_2}{R_1+R_2}$



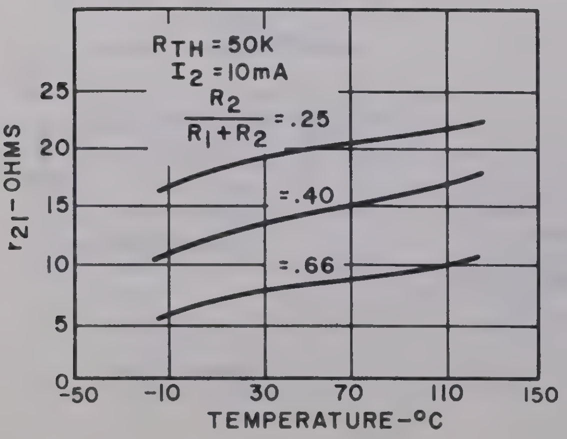
IMPEDANCE VS. RESISTOR RATIO



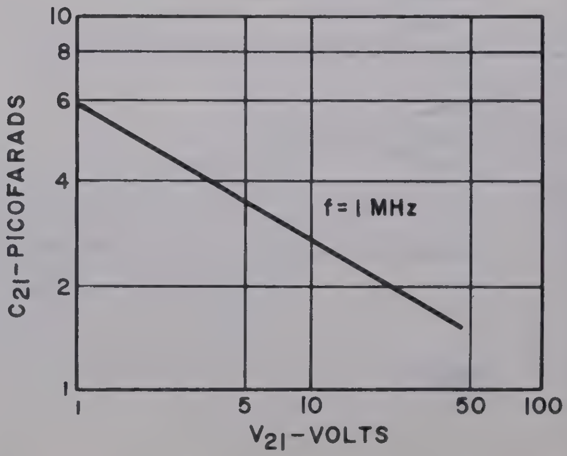
V_{21} SHIFT VS. TEMPERATURE



IMPEDANCE VS. TEMPERATURE



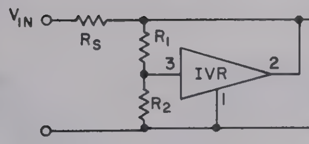
CAPACITANCE VS. VOLTAGE



APPLICATIONS

TYPICAL CIRCUITS

IVR Shunt Regulator


VIN
RS
R1
3
IVR
2
1
R2
VOUT

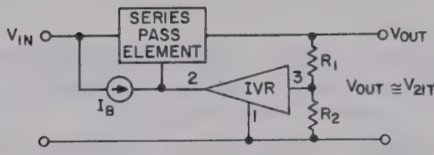
$$V_{OUT} = V_{21T}\left(\frac{R_1+R_2}{R_2}\right)$$

WHERE $\frac{\Delta V_{OUT}}{\Delta I_{OUT}} \cong r_{21T}\left(\frac{R_1+R_2}{R_2}\right);\ \frac{\Delta V_{OUT}}{\Delta V_{IN}} \cong \frac{r_{21T}}{R_S+r_{21T}}\left(\frac{R_1+R_2}{R_2}\right)$

AND MINIMUM $R_S \cong \frac{V_{OUT}}{0.4}\left(V_{IN}-V_{OUT}\right)$

The IVR (D13V) is used in this circuit as a simple shunt regulator, or "Programmable Zener." V_{IN}, unregulated DC, is supplied through current limiting resistor R_S. Line and load regulations equations are shown, also the determination of the minimum value of R_S.

IVR Reference Amplifier


VIN
SERIES PASS ELEMENT
IB
2
IVR
3
1
R1
R2
VOUT

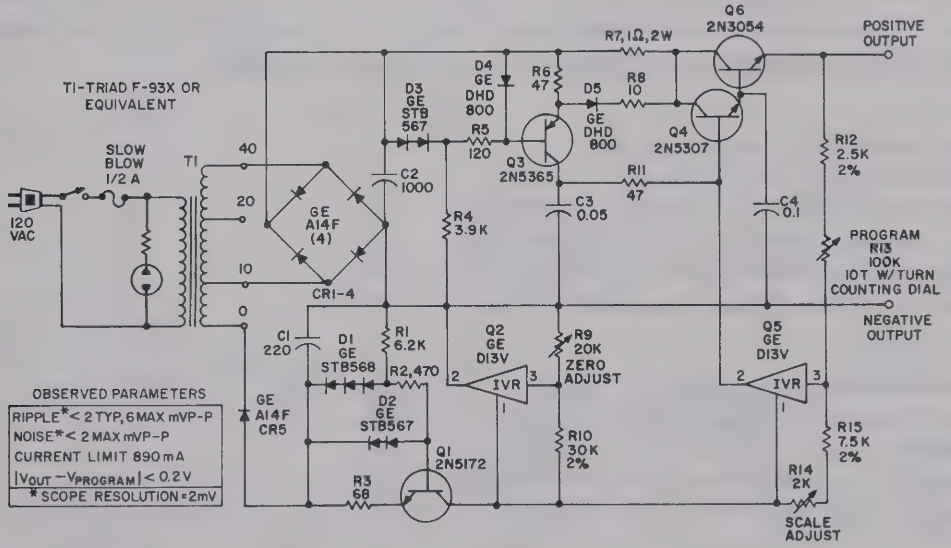
$$V_{OUT} \cong V_{21T}\frac{R_1+R_2}{R_2}$$

WHERE $\frac{\Delta V_{OUT}}{\Delta I_{OUT}} \cong \frac{r_{21T}}{\beta_S}\cdot\frac{R_1+R_2}{R_2}$ AND $\frac{\Delta V_{OUT}}{\Delta V_{IN}} \cong r_{21T}\cdot\frac{R_1+R_2}{R_2}\left(\frac{1}{r_S\cdot\beta_S}+\frac{1}{r_{IB}}\right)$

The use of the IVR (D13V) is illustrated in this circuit as a voltage reference/error amplifier element in a series pass power supply. Output voltage of the supply is feed back to the IVR which controls the drive current to the series pass element. Line and load regulation equations are given; where, β_S is the series pass element current gain, r_S is the shunt conductance of the series pass element current gain, and r_{IB} is the shunt conductance of the bias current source, I_B.

Digitally Programmed Precision Power Supply

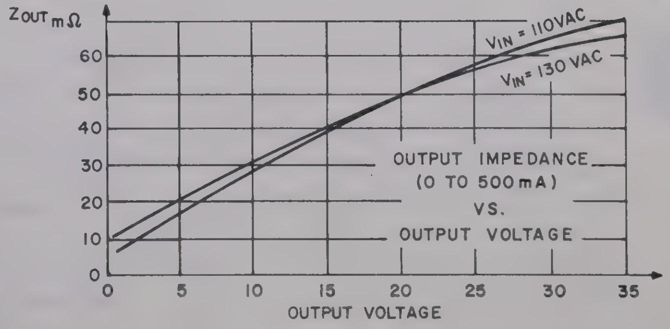
(0-35 Vdc, 0-500 mA, constant current limiting)


TI-TRIAD F-93X OR EQUIVALENT
SLOW BLOW 1/2 A
120 VAC
T1
40
20
10
0
GE A14F (4)
CR1-4
D3 GE STB 567
D4 GE DHD 800
R6 47
R5 120
C2 1000
R4 3.9K
Q3 2N5365
D5 GE DHD 800
R7, 1Ω, 2W
R8 10
Q6 2N3054
Q4 2N5307
R11 47
C3 0.05
C4 0.1
POSITIVE OUTPUT
R12 2.5K 2%
PROGRAM R13 100K 10T W/TURN COUNTING DIAL
NEGATIVE OUTPUT
C1 220
D1 GE STB568
R1 6.2K
R2, 470
D2 GE STB567
Q2 GE D13V
IVR
R9 20K ZERO ADJUST
R10 30K 2%
GE A14F CR5
Q1 2N5172
R3 68
Q5 GE D13V
R15 7.5K 2%
R14 2K
SCALE ADJUST

OBSERVED PARAMETERS
RIPPLE* < 2 TYP, 6 MAX mVP-P
NOISE* < 2 MAX mVP-P
CURRENT LIMIT 890 mA
$|V_{OUT} - V_{PROGRAM}| < 0.2V$
*SCOPE RESOLUTION = 2mV

ALL RESISTORS 5%, 1/2W UNLESS NOTED, ALL CAPACITORS IN µF. USE LOW TEMPERATURE COEFFICENT RESISTORS FOR 2% TOLERANCE AND VARIABLE RESISTORS.

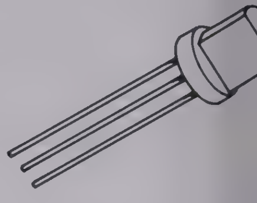
Circuit illustrates the high degree of regulation available at low cost using the IVR (D13V). Operation of the circuit is as follows: A multiple transistor (Q4, Q6) series pass element is biased by the Q3 current source and is controlled by an IVR reference amplifier, Q5. This reference amplifier is biased by an offset supply, consisting of the IVR shunt regulator Q2, and the Q1 current source, which allows programming to zero output voltage. Output voltage is digitally programmed by the turns counting dial on R12. Constant current limiting is provided by R7 voltage drop shutting down the current source through D5. Total parts cost (as of March 1970) of this power supply, at single component distributor prices, is less than $40.00 (less than 20% of this cost involves semiconductor devices).

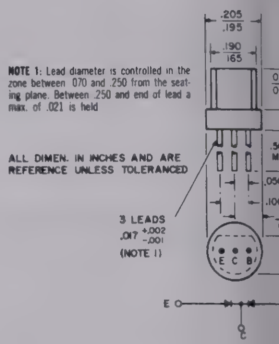


Silicon
Transistors

D16G6

The General Electric D16G6 is an NPN silicon planar epitaxial passivated transistor designed specifically for high frequency applications. The unit is suitable for use as a UHF television tuner oscillator.





NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

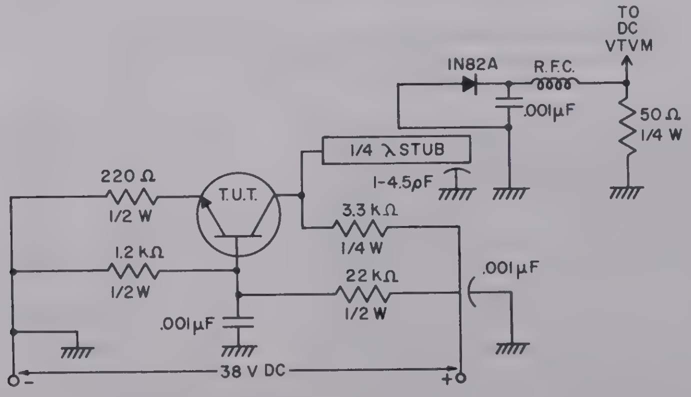
absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to base	V_{CBO}	30	V
Emitter to base	V_{EBO}	3	V
Collector to emitter	V_{CEO}	12	V
Current			
Collector (steady state)*	I_C	25	mA
Dissipation			
Total Power (free air @ 25°C amb.)*	P_T	200	mW
Total Power (free air @ 55°C amb.)*	P_T	120	mW
Temperature			
Storage temperature	T_{stg}	−55 to +125	°C
Soldering temperature 10 sec. 1/16 ± 1/32″ from case		260	°C
Operating junction temperature	T_J	100	°C

* Derate 2.67 mW/°C for ambient above 25°C.

electrical characteristics: (25°C) (unless otherwise specified)

	Symbol	Min	Typ	Max
Static				
Collector cutoff current ($V_{CB} = 30$ V, $I_E = 0$)	I_{CBO}			0.5
Emitter cutoff current ($V_{EB} = 3$ V, $I_C = 0$)	I_{EBO}			0.5
Forward current transfer ratio ($I_C = 5$ mA, $V_{CE} = 10$V)	h_{FE}	20		
Collector-base breakdown voltage ($I_E = 0$, $I_C = 100\ \mu$A)	BV_{CBO}	30		
Emitter-base breakdown voltage ($I_C = 0$, $I_E = 100\ \mu$A)	BV_{EBO}	3		
Collector-emitter breakdown voltage ($I_B = 0$, $I_C = 3$ mA)	BV_{CEO}	12		35
Dynamic				
Gain bandwidth product ($V_{CE} = 10$V, $I_C = 5$ mA)	f_T	500		
Collector base time constant ($V_{CE} = 10$V, $I_C = 5$ mA)	$r'_b C_c$			20
Output capacitance ($V_{CB} = 10$V, $I_E = 0$, f = 1 MHz)	C_{cbo}		1.2	1.5
Oscillator output ($V_{CC} = 38$V, $I_C \approx 5$ mA, f ≈ 940 MHz) (See Figure 1)	V_o	2.5		



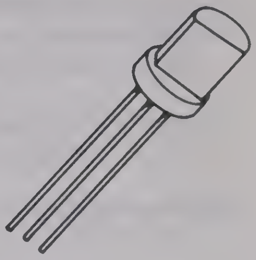
940 MHz Oscillator Test Circuit
Figure 1

Silicon
Transistor

NPN

D16P1

The General Electric D16P1 is a planar epitaxial passivated NPN silicon Darlington monolithic amplifier. It is ideal for preamplifier input impedances of several megohms.



absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to base	V_{CBO}	18	V
Collector to emitter	V_{CEO}	12	V
Collector to emitter	V_{CES}	18	V
Emitter to base	V_{EBO}	12	V
Current			
Collector (Pulsed)*	I_C	500	mA
Collector (steady state)	I_C	200	mA
Base (steady state)	I_B	20	mA
Dissipation			
Total power (free air @ 25°C)**	P_T	400	mW
Temperature			
Storage	T_S	−65 to +150	°C
Operating	T_J	−65 to +125	°C
Lead 1/16″ ± 1/32″ from case for 10 seconds maximum	T_L	260	°C

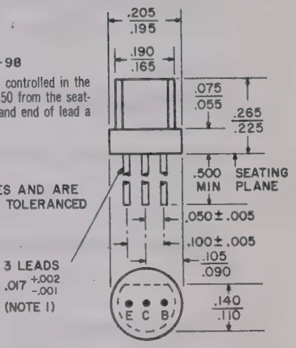
*Pulse Conditions: 300 μsec. pulse width, 2% duty cycle

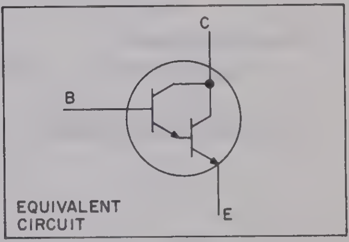
**Derate 4.0 mW/°C for increase in ambient temperature between 25 and 125°C

DIMENSIONS WITHIN JEDEC OUTLINE TO-98

NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED





EQUIVALENT CIRCUIT

electrical characteristics: (25°C) (unless otherwise specified)

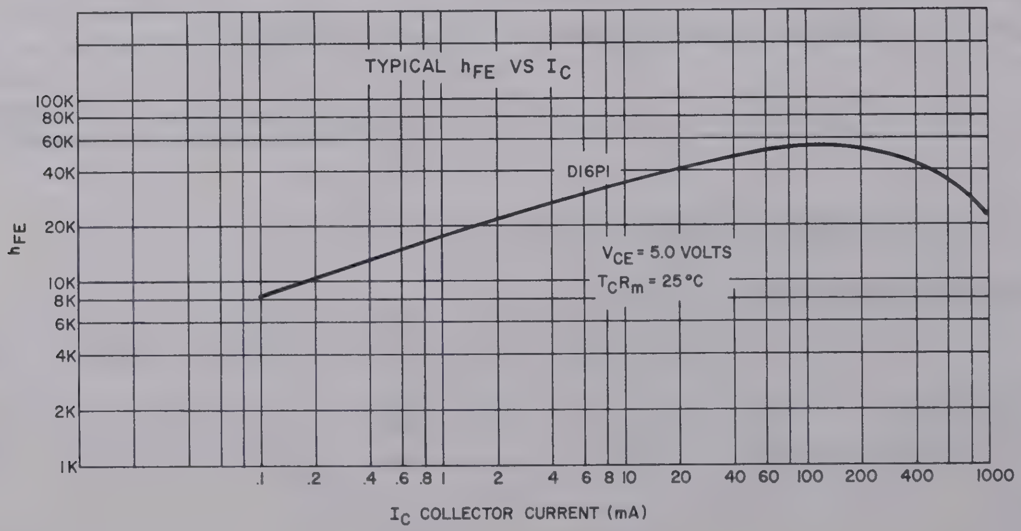
STATIC CHARACTERISTICS

		Min.	Typ.	Max.	
Collector cutoff current					
(V_{CB} = 18V, I_E = 0)	I_{CBO}			100	nA
(V_{CB} = 18V, I_E = 0, T_A = 100°C)	I_{CBO}			20	μA
Emitter cutoff current					
(V_{EB} = 12V)	I_{EBO}			100	nA

electrical characteristics: 25°C (unless otherwise specified) (cont'd)

		Min.	Typ.	Max.	
Collector emitter breakdown voltage ($I_C = 10$ mA, $I_B = 0$)	$V_{(BR)CEO}$	12			V
Forward current transfer ratio ($I_C = 2$ mA, $V_{CE} = 5V$) ($I_C = 100$ mA, $V_{CE} = 5V$)	h_{FE} h_{FE}†	2,000 6,000			
Collector emitter saturation voltage ($I_C = 200$ mA, $I_B = 0.2$ mA)	$V_{CE(SAT)}$†			1.4	V
Base emitter saturation voltage ($I_C = 200$ mA, $I_B = 0.2$ mA)	$V_{BE(SAT)}$†			1.6	V
Base emitter drive voltage ($I_C = 200$ mA, $V_{CE} = 5V$)	V_{BE}†			1.5	V
DYNAMIC CHARACTERISTICS					
Forward current transfer ratio ($I_C = 2$ mA, $V_{CE} = 5V$, f — 1 kHz)	h_{fe}	2,000			
Forward current transfer ratio ($I_C = 2$ mA, $V_{CE} = 5V$, f = 20 MHz)	$\|h_{fe}\|$	3			
Output capacitance ($V_{CB} = 10V$, f = 1 MHz)	C_{ob}		7.6	10	pF
Input capacitance ($V_{EB} = 0.5V$, f = 1 MHz)	C_{eb}		10.5		pF

†Pulsed Measurement: Pulse width $\leqq 300\ \mu$sec., Duty cycle $\leqq 2\%$

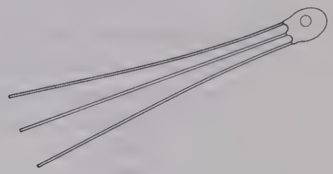


Microtab Transistors

NPN

D26C1,2,3,4,5

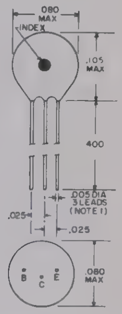
The General Electric D26C series are NPN microminiature silicon, planar, epitaxial, passivated transistors similar to the 2N2217 through 2N2222 series. These devices are designed for fast switching over a wide range of currents. The series forms the NPN complement to the D30A PNP series.



Features:

- High Gain
- Low Leakage Currents
- Low Collector Saturation Voltage
- Epoxy Encapsulation with Field Proven Reliability

NOTES:
1 LEAD DIAMETER IS NOT CONTROLLED WITHIN .020 OF THE BODY



ALL DIMENSIONS ARE IN INCHES AND ARE REFERENCED UNLESS TOLERANCED

absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	25	Volts
Emitter to Base	V_{EBO}	5	Volts
Collector to Base	V_{CBO}	25	Volts
Dissipation			
Total Power (Free air at 25°C)*	P_T	90	mW
Temperature			
Storage	T_{STG}	−55°C to +125	°C
Operating	T_J	−55°C to +100	°C
Soldering (10 sec, 1/16″ body body)	T_L	+260	°C

*Derate above 25°C, 1.20 mW/°C.

electrical characteristics: (25°C) (unless otherwise specified)

	Symbol	Min.	Max.	
Collector-Emitter Breakdown Voltage ($I_C = 1$ mA)	$V_{(BR)CEO}$*	25	—	Volts
Collector-Base Breakdown Voltage ($I_C = 100\ \mu A$)	$V_{(BR)CBO}$	25	—	Volts
Emitter-Base Breakdown Voltage ($I_E = 100\ \mu A$)	$V_{(BR)EBO}$	5	—	Volts
Collector-Emitter Cutoff Current ($V_{CE} = 18$ V)	I_{CES}	—	25	nA
Collector-Base Cutoff Current ($V_{CB} = 18$ V)	I_{CBO}	—	25	nA

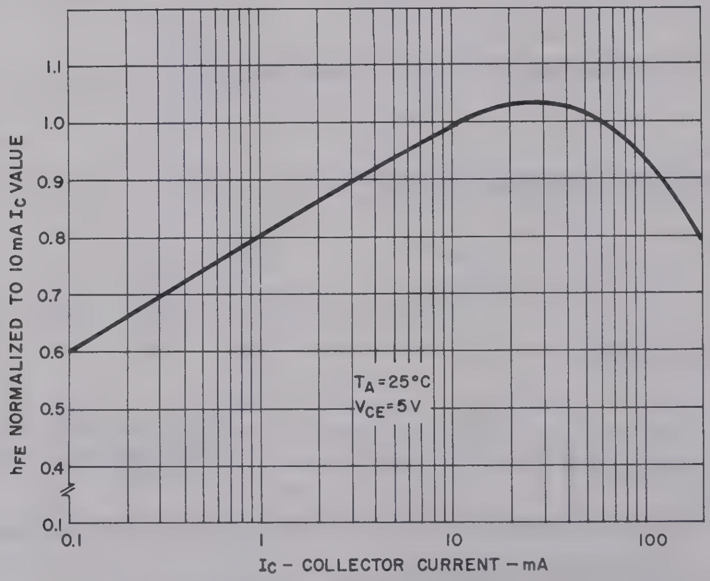
*Pulse width $\leq 300\ \mu$sec, duty cycle $\leq 2\%$.

D26C1,2,3,4,5

electrical characteristics: (cont.)

	Symbol	Min.	Max.	
Emitter-Base Cutoff Current ($V_{EB} = 4$ V)	I_{EBO}	—	100	nA
Collector-Emitter Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)	$V_{CE(SAT)}$	—	0.25	Volts
Emitter-Base Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)	$V_{BE(SAT)}$	—	0.80	Volts
Forward Current Transfer Ratio ($I_C = 10$ mA, $V_{CE} = 5$ V)				
D26C1	h_{FE}*	30	90	
D26C2	h_{FE}*	60	180	
D26C3	h_{FE}*	140	300	
D26C4	h_{FE}*	250	500	
D26C5	h_{FE}*	400	800	
Output Capacitance, Common Base ($V_{CB} = 10$ V, f = 1 MHz, emitter connected to guard terminal on three terminal bridge)	C_{cb}	—	8	pF

*Pulse width ≤300 μsec, duty cycle ≤2%.

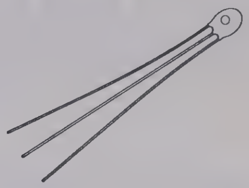


Normalized h_{FE} vs. I_C

Microtab
TRANSISTOR

NPN

D26E-1



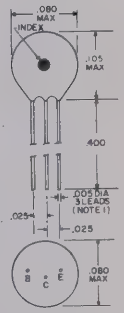
The General Electric D26E-1 is a NPN silicon, planar, epitaxial, passivated transistor, similar to types 2N930, 2N2484. It is well suited as a high voltage, high gain amplifier and switch. Useful applications include drivers for audio output stages, high level video amplifiers and output stages of operational amplifiers.

absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages		
Collector to Emitter	V_{CEO}	45 volts
Emitter to Base	V_{EBO}	5 volts
Collector to Base	V_{CBO}	45 volts
Dissipation		
Total Power (Free air at 25°C)*	P_T	90 mW
Temperature		
Storage	T_{STG}	−55 to +125°C
Operating	T_J	−55 +100°C
Soldering (10 sec, 1/32″ from body)	T_L	+260° C

*Derate above 25°C, 1.20 mW/°C.

NOTES:
1 LEAD DIAMETER IS NOT CONTROLLED WITHIN .020 OF THE BODY



ALL DIMENSIONS ARE IN INCHES AND ARE REFERENCED UNLESS TOLERANCED

electrical characteristics: (25°C)

		Min.	Max.	
DC CHARACTERISTICS				
Collector Cut Off Current ($V_{CB} = 45V$)	I_{CBO}		10	nA
Emitter Cut Off Current ($V_{EB} = 5V$)	I_{EBO}		10	nA
Collector Leakage Current ($V_{CE} = 5V$)	I_{CEO}		2	nA
Collector-Emitter Breakdown Voltage ($I_C = 10$ mA)	$V_{(BR)CEO}$*	45		V
Emitter-Base Breakdown Voltage ($I_E = 10$ nA)	$V_{(BR)EBO}$	5		V
Collector-Emitter Saturation Voltage ($I_C = 10$ mA, $I_B = 0.5$ mA)	$V_{CE(SAT)}$		1	V
Emitter-Base Saturation Voltage ($I_C = 10$ mA, $I_B = 0.5$ mA)	$V_{BE(SAT)}$	.6	1	V
Forward Current Transfer Ratio ($I_C = 10\ \mu A$, $V_{CE} = 5V$)	h_{FE}	100	300	
($I_C = 500\ \mu A$, $V_{CE} = 5V$)	h_{FE}	150		
($I_C = 10$ mA, $V_{CE} = 5V$)	h_{FE}		600	
SMALL SIGNAL CHARACTERISTICS				
Current Transfer Ratio ($I_C = 0.5$ mA, $V_{CE} = 5V$, f = 20 MHz)	$\lvert h_{fe} \rvert$	4.0		
($I_C = 1$ mA, $V_{CE} = 5V$, f = 1 kHz)	h_{fe}	150	600	
Input Resistance ($I_E = 1$ mA, $V_{CB} = 5V$, f = 1 kHz)	h_{ib}	25	32	ohms
Voltage Feedback Ratio ($I_E = 1$ mA, f = 1 kHz, $V_{CE} = 5V$)	h_{rb}		600	x10^{-6}
Output Conductance ($I_E = 1$ mA, $V_{CE} = 5V$, f = 1 kHz)	h_{ob}		1	μmhos
HIGH FREQUENCY CHARACTERISTICS				
Collector Capacitance ($V_{CB} = 5V$, f = 1MHz)	C_{cb}		8	pF
Noise Figure ($R_g = 10K\Omega$, BW = 15 Hz to 10 kHz, $I_C = 10\ \mu A$, $V_{CE} = 5V$, Equivalent Noise Bandwidth = 15.7 kHz)	NF		3	dB

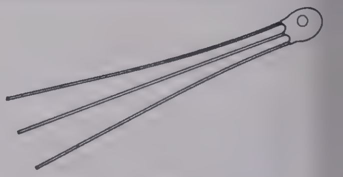
*Pulse width ≤300 μsec, duty cycle ≤2%.

Microtab
Transistors

NPN

D26E-2,3,4,5,6

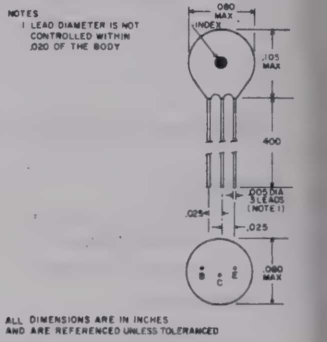
The General Electric D26E series are NPN microminiature silicon, planar, epitaxial, passivated transistors. They are well suited as high voltage, high gain amplifiers and switches. Useful applications include drivers for audio output stages, high level video amplifiers and output stages of operational amplifiers.



absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages		
Collector to Emitter	V_{CEO}	40 volts
Emitter to Base	V_{EBO}	5 volts
Collector to Base	V_{CBO}	40 volts
Dissipation		
Total Power (Free air at 25°C)*	P_T	90 mW
Temperature		
Storage	T_{STG}	−55 to +125°C
Operating	T_J	−55 to +100°C
Soldering (10 sec, 1/16″ from body)	T_L	

*Derate above 25°C, 1.20 mW/°C.


NOTES
1 LEAD DIAMETER IS NOT CONTROLLED WITHIN .020 OF THE BODY
.080 MAX
INDEX
.105 MAX
400
.005 DIA 3 LEADS (NOTE 1)
.025
.025
B
C
E
.080 MAX
ALL DIMENSIONS ARE IN INCHES AND ARE REFERENCED UNLESS TOLERANCED

electrical characteristics: (25°C) (unless otherwise specified)

DC CHARACTERISTICS		Min.	Max.	
Collector Cut Off Current ($V_{CB} = 30V$)	I_{CBO}		25	nA
Emitter Cut Off Current ($V_{EB} = 5V$)	I_{EBO}		50	nA
Collector-Base Breakdown Voltage ($I_C = 100\ \mu A$)	$V_{(BR)CBO}$ *	40		V
Collector-Emitter Breakdown Voltage ($I_C = 1$ mA)	$V_{(BR)CEO}$	40		V
Emitter-Base Breakdown Voltage ($I_E = 100\ \mu A$)	$V_{(BR)EBO}$	5		V
Collector-Emitter Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)	$V_{CE(SAT)}$		.25	V
Forward Current Transfer Ratio ($I_C = 100\ \mu A$, $V_{CE} = 2.5V$)				
D26E-2	h_{FE}	40	90	
D26E-3	h_{FE}	70	145	
D26E-4	h_{FE}	115	220	
D26E-5	h_{FE}	180	330	
D26E-6	h_{FE}	40	330	
Collector Capacitance ($V_{CB} = 10V$, f = 1 MHz)	C_{cb}		4	pF
Noise Figure ($I_C = 10\ \mu A$, $V_{CE} = 5V$, $R_g = 10\ K\Omega$, BW = 15 Hz to 10 kHz, Equivalent Noise Bandwidth = 15.7 kHz)				
D26E-2	NF		6	dB
D26E-3	NF		5	dB
D26E-4	NF		4	dB
D26E-5	NF		3	dB
D26E-6	NF		6	dB

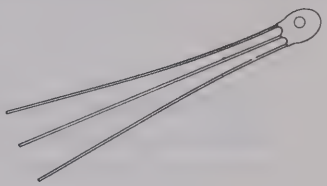
*Pulse width ≤300 μsec, duty cycle ≤2%.

Microtab
Transistor

NPN

D26G-1

The General Electric D26G-1 is a microminiature NPN silicon, planar, epitaxial, passivated transistor similar to 2N918 types designed specifically for high frequency applications. The units are suitable for use as oscillators in UHF television tuners, etc.

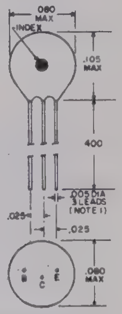


absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages		
Collector to Emitter	V_{CEO}	15 volts
Emitter to Base	V_{EBO}	3 volts
Collector to Base	V_{CBO}	30 volts
Dissipation		
Total Power (Free air at 25°C)*	P_T	90 mW
Temperature		
Storage	T_{STG}	−55 to +125°C
Operating	T_J	−55 to +100°C
Soldering (10 sec, 1/16″ from body)	T_L	+260° C

*Derate above 25°C, 1.20 mW/°C.

NOTES:
1 LEAD DIAMETER IS NOT CONTROLLED WITHIN .020 OF THE BODY



ALL DIMENSIONS ARE IN INCHES AND ARE REFERENCED UNLESS TOLERANCED

electrical characteristics: (25°C) (unless otherwise specified)

DC CHARACTERISTICS		Min.	Max.	
Collector Cut Off Current ($V_{CE} = 15V$)	I_{CES}		10	nA
Emitter Cut Off Current ($V_{EB} = 2V$)	I_{EBO}		100	nA
Collector-Base Breakdown Voltage ($I_C = 100\ \mu A$)	$V_{(BR)CBO}$	30		V
Collector-Emitter Breakdown Voltage ($I_C = 3\ mA$)	$V_{(BR)CEO}$*	15		V
Emitter-Base Breakdown Voltage ($I_E = 100\ \mu A$)	$V_{(BR)EBO}$	3		V
Collector-Emitter Saturation Voltage ($I_C = 10\ mA, I_B = 1.0\ mA$)	$V_{CE(SAT)}$		0.4	V
Emitter-Base Saturation Voltage ($I_C = 10\ mA, I_B = 1.0\ mA$)	$V_{BE(SAT)}$		1.0	V
Forward Current Transfer Ratio ($I_C = 3\ mA, V_{CE} = 1V$)	h_{FE}	20		
SMALL SIGNAL CHARACTERISTICS				
Current Transfer Ratio ($I_C = 4\ mA, f = 100MHz, V_{CE} = 10V$)	$\lvert h_{fe} \rvert$	6		
HIGH FREQUENCY CHARACTERISTICS				
Input Capacitance ($V_{EB} = 0.5V, f = 1MHz$)	C_{eb}		1.6	pF
Collector Capacitance ($V_{CB} = 0, f = 1MHz$)	C_{cb}		3	pF
($V_{CB} = 10V, f = 1MHz$)	C_{cb}		1.7	pF
Noise Figure ($I_C = 1\ mA, V_{CE} = 6V,$ $R_g = 400\Omega, f = 60MHz$)	NF		6	dB
Power Gain ($V_{CB} = 12V, I_C = 6\ mA, f = 200MHz$)	G_{PE}	15		dB

*Pulse width ≤300 μsec, duty cycle ≤2%.

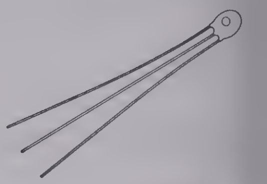
Microtab
Silicon Monolithic
Darlington Amplifiers

PLANAR EPITAXIAL PASSIVATED

NPN

D26P1

The General Electric D26P1 is a planar epitaxial passivated NPN silicon Darlington monolithic amplifier. It is ideal for preamplifier input impedances of several megohms.



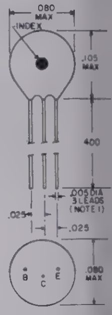
absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to base	V_{CBO}	18	V
Collector to emitter	V_{CEO}	12	V
Collector to emitter	V_{CES}	18	V
Emitter to base	V_{EBO}	12	V
Dissipation			
Total power (free air @ 25°C)**	P_T	90	mW
Temperature			
Storage	T_S	−55 to +125	°C
Operating	T_J	−55 to +100	°C
Lead 1/16″ ± 1/32″ from case for 10 seconds maximum	T_L	+260	°C

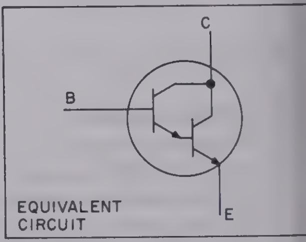
*Pulse Conditions: 300 μsec. pulse width, 2% duty cycle

**Derate 1.2 mW/°C for increase in ambient temperature between 25 and 100°C

NOTES.
1 LEAD DIAMETER IS NOT CONTROLLED WITHIN .020 OF THE BODY



ALL DIMENSIONS ARE IN INCHES AND ARE REFERENCED UNLESS TOLERANCED



EQUIVALENT CIRCUIT

electrical characteristics: (25°C) (unless otherwise specified)

STATIC CHARACTERISTICS

		Min.	Typ.	Max.	
Collector cutoff current					
(V_{CB} = 18V, I_E = 0)	I_{CBO}			100	nA
(V_{CB} = 18V, I_E = 0, T_A = 100°C)	I_{CBO}			20	μA
Emitter cutoff current					
(V_{EB} = 12V)	I_{EBO}			100	nA

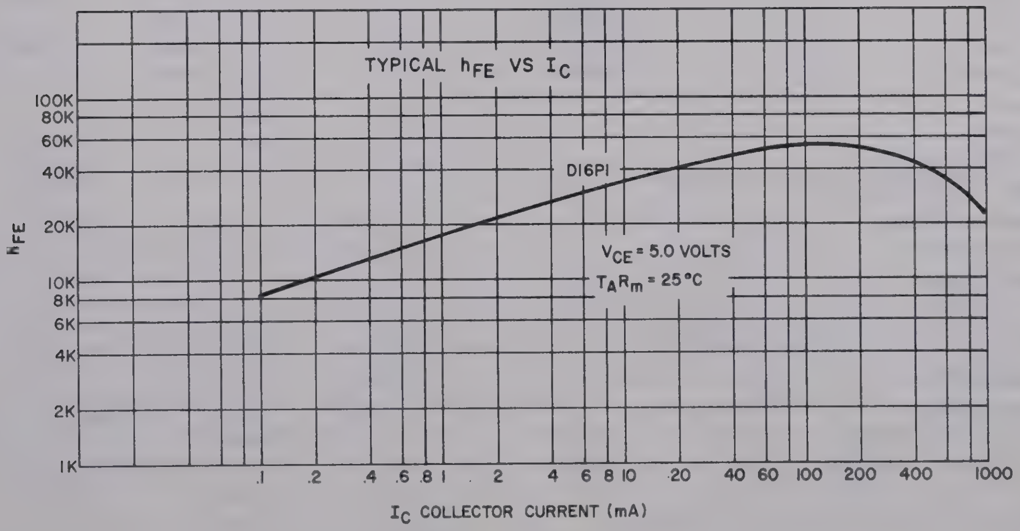
electrical characteristics: 25°C (unless otherwise specified) (cont'd)

		Min.	Typ.	Max.	
Collector emitter breakdown voltage (I_C = 10 mA, I_B = 0)	$V_{(BR)CEO}$	12			V
Forward current transfer ratio (I_C = 2 mA, V_{CE} = 5V)	h_{FE}	2,000			
(I_C = 100 mA, V_{CE} = 5V)	h_{FE}†	6,000			
Collector emitter saturation voltage (I_C = 200 mA, I_B = 0.2 mA)	$V_{CE(SAT)}$†			1.4	V
Base emitter saturation voltage (I_C = 200 mA, I_B = 0.2 mA)	$V_{BE(SAT)}$†			1.6	V
Base emitter drive voltage (I_C = 200 mA, V_{CE} = 5V)	V_{BE}†			1.5	V

DYNAMIC CHARACTERISTICS

		Min.	Typ.	Max.	
Forward current transfer ratio (I_C = 2 mA, V_{CE} = 5V, f — 1 kHz)	h_{fe}	2,000			
Forward current transfer ratio (I_C = 2 mA, V_{CE} = 5V, f = 20 MHz)	$\lvert h_{fe} \rvert$	3			
Output capacitance (V_{CB} = 10V, f = 1 MHz)	C_{cb}		7.6	10	pF
Input capacitance (V_{EB} = 0.5V, f = 1 MHz)	C_{eb}		10.5		pF

†Pulsed Measurement: Pulse width ≦ 300 μsec., Duty cycle ≦ 2%



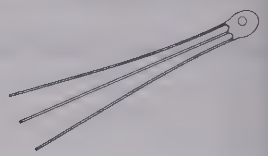
Microtab
Silicon Monolithic
Darlington Amplifiers

PLANAR EPITAXIAL PASSIVATED

NPN

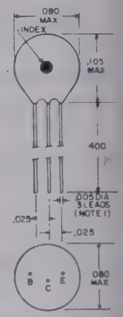
D26P2

D26P3



The General Electric D26P2 and D26P3 are NPN, silicon, planar, epitaxial, passivated Darlington monolithic amplifiers. These devices are especially suited for preamplifier input stages requiring input impedances of several megohms or extremely low level, high gain, low noise amplifier applications. Additional applications include medium speed switching circuits in consumer and industrial control applications.

NOTES
1 LEAD DIAMETER IS NOT CONTROLLED WITHIN .020 OF THE BODY

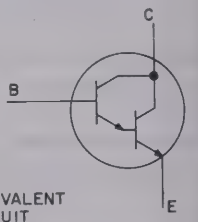


ALL DIMENSIONS ARE IN INCHES AND ARE REFERENCED UNLESS TOLERANCED

absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Base	V_{CBO}	25	Volts
Collector to Emitter	V_{CEO}	25	Volts
Emitter to Base	V_{EBO}	12	Volts
Dissipation			
Total Power ($T_A \leqq 25°$ C)†	P_T	90	mW
Temperature			
Storage	T_{stg}	−55 to +125	°C
Operating	T_J	−55 to +100	°C
Lead, 1/16″ ± 1/32″ from case for 10 sec. max.	T_L	+260	°C

†Derate 1.2 mW/°C for increase in ambient temperature above 25°C.



EQUIVALENT CIRCUIT

STATIC CHARACTERISTICS			Min.	Max.	
Collector to Base Breakdown Voltage ($I_C = 0.1\ \mu A, I_C = 0$)		$V_{(BR)CBO}$	25		Volts
Collector to Emitter Breakdown Voltage ($I_C = 10mA, I_B = 0$)		$V_{(BR)CEO}$	25		Volts
Emitter to Base Breakdown Voltage ($I_E = 0.1\mu A, I_E = 0$)		$V_{(BR)EBO}$	12		Volts
Forward Current Transfer Ratio					
($V_{CE} = 5V, I_C = 2mA$)	D26P2	h_{FE}	2000	20000	
($V_{CE} = 5V, I_C = 100mA$)*	D26P2	h_{FE}	6000		
($V_{CE} = 5V, I_C = 2mA$)	D26P3	h_{FE}	7000	70000	
($V_{CE} = 5V, I_C = 100mA$)*	D26P3	h_{FE}	20000		
Collector Cutoff Current					
($V_{CB} = 25V, I_E = 0$)		I_{CBO}		100	nA
($V_{CB} = 25V, I_E = 0, T_A = 100°$ C)		I_{CBO}		20	µA
Emitter Cutoff Current ($V_{EB} = 12V, I_C = 0$)		I_{EBO}		100	nA
Collector Emitter Saturation Voltage					
($I_C = 200mA, I_B = 0.2mA$)*		$V_{CE(SAT)}$		1.4	Volts
Base Emitter Saturation Voltage					
($I_C = 200mA, I_B = 0.2mA$)*		$V_{BE(SAT)}$		1.6	Volts
Base Emitter Voltage ($V_{CE} = 5V, I_C = 200mA$)*		V_{BE}		1.5	Volts

DYNAMIC CHARACTERISTICS						
Forward Current Transfer Ratio			Min.	Typ.	Max.	
($V_{CE} = 5V, I_C = 2mA, f = 1kHz$)	D26P2	h_{fe}	2000			
($V_{CE} = 5V, I_C = 2mA, f = 1kHz$)	D26P3	h_{fe}	7000			
($V_{CE} = 5V, I_C = 2mA, f = 10$ MHz)		$\lvert h_{fe} \rvert$	15.6			dB
Gain Bandwidth Product ($V_{CE} = 5V, I_C = 2mA, f = 10$ MHz)		f_T	60			MHz
Input Impedance ($V_{CE} = 5V, I_C = 2mA, f = 1$ kHz)		h_{ie}		650		kohms
Collector Base Capacitance ($V_{CB} = 10V, f = 1$ MHz)		C_{cb}		7.6	10	pF
Emitter Capacitance ($V_{EB} = 0.5V, f = 1$ MHz)		C_{eb}		10.5		pF

3

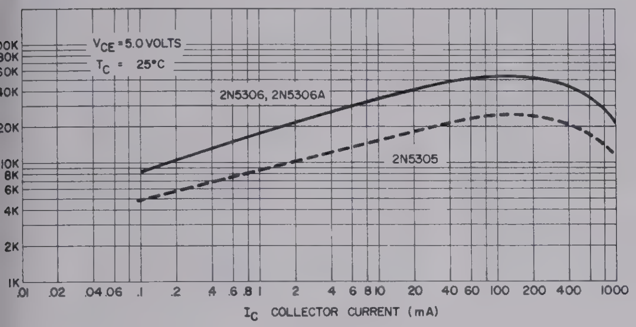
			Min.	Typ.	Max.	Units
Voltage	($I_C = 0.6$ mA, $V_{CE} = 5$V, $R_G = 160$kΩ f = 10 Hz to 10kHz, B.W. = 15.7 kHz)	e_n		195		n V/$\sqrt{\text{Hz}}$

: As measured on a Quan-Tech Model 2283/2181M test set with 10 Hz filter modified by Quan-Tech to a wideband (f = 10 Hz to 10 kHz, B.W. = 15.7 kHz) filter.

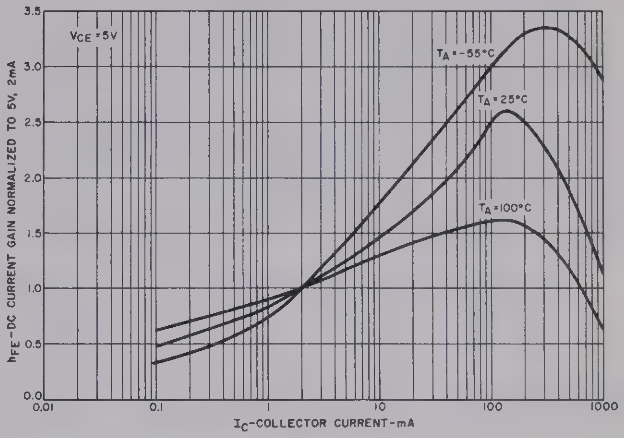
d Measurement: Pulse width ≦ 300 μsec., Duty Cycle ≦ 2%

Typical Curves

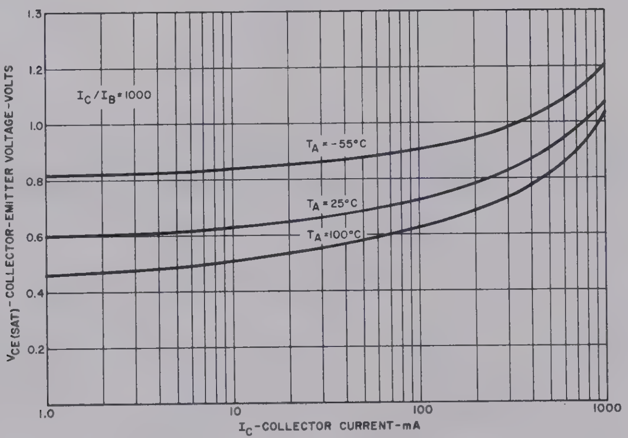
Typical h_{FE} vs. I_C



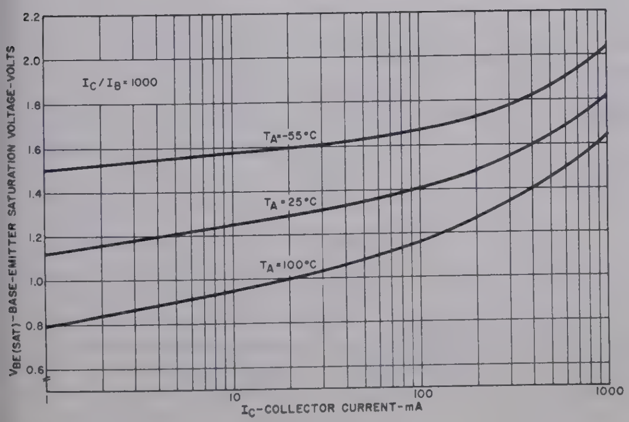
Normalized h_{FE} vs. I_C



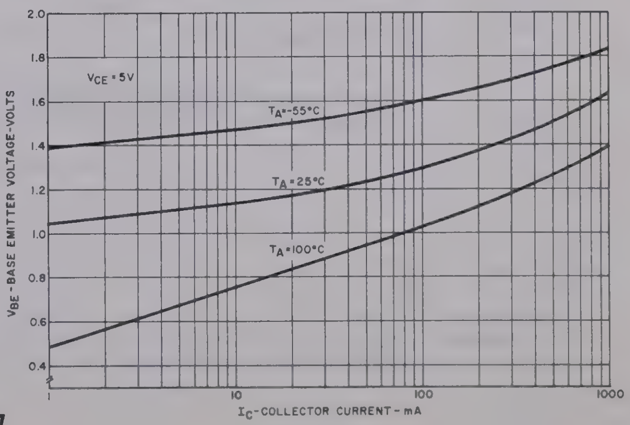
V_{CE} vs. I_C

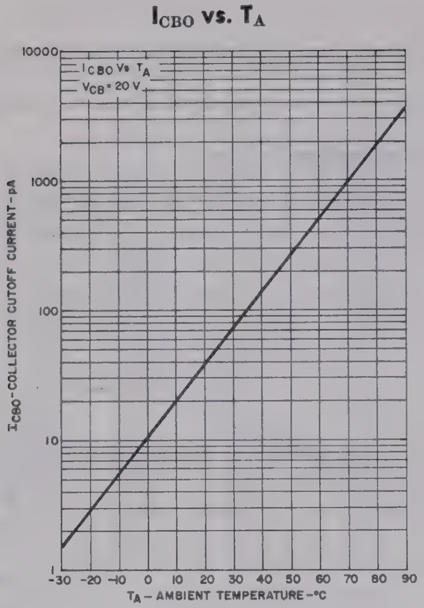


$V_{BE(SAT)}$ vs. I_C

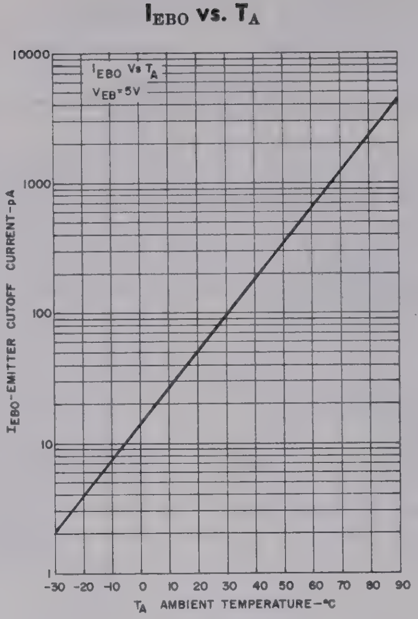


Transconductance Characteristic, V_{BE} vs. I_C

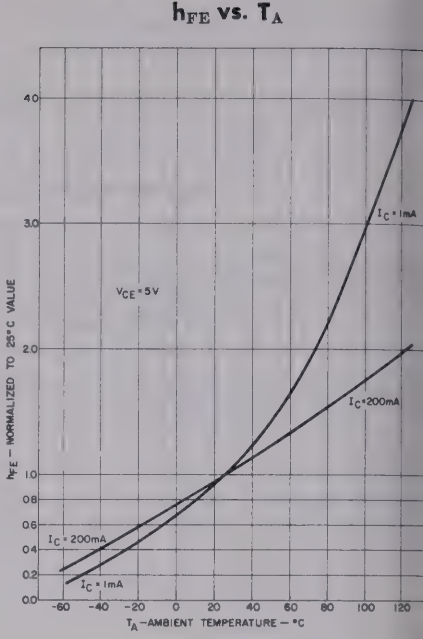




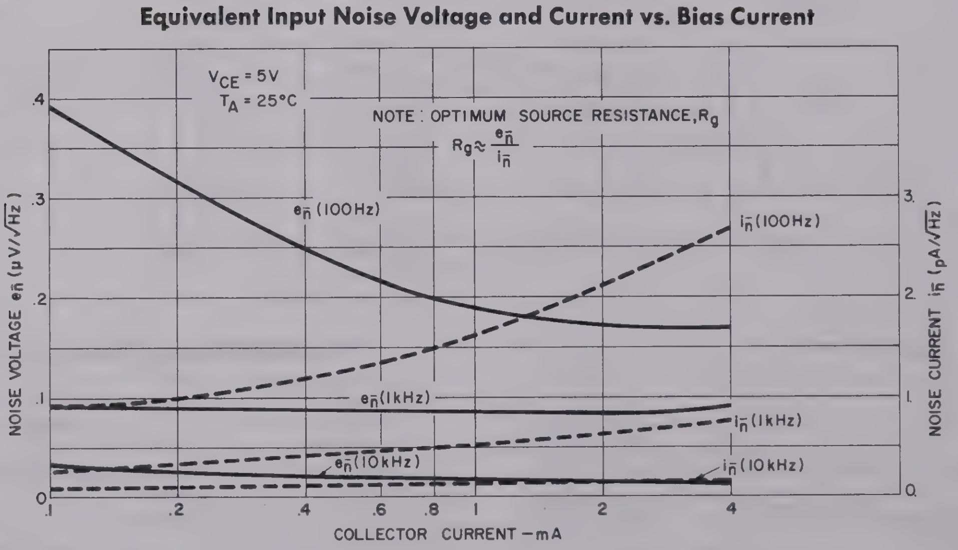
I_{CBO} vs. T_A



I_{EBO} vs. T_A



h_{FE} vs. T_A



Equivalent Input Noise Voltage and Current vs. Bias Current

NOTE: Due to the noise characteristics of this device versus frequency, calculation of noise figure (N.F.) from $e_{\bar n}$, $i_{\bar n}$ values is not accurate [as is the case with field effect transistors (F.E.T.'s)].

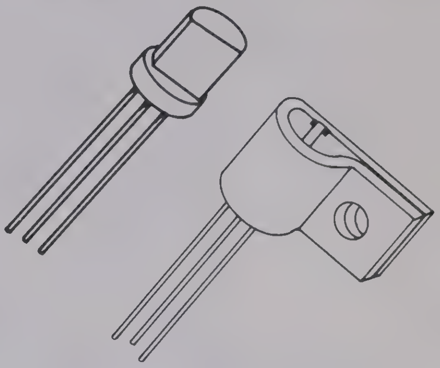
Silicon
Transistors

PNP	NPN
D29E1	D33D21
D29E2	D33D22
D29E1J1	D33D21J1
D29E2J1	D33D22J1

The PNP D29E1, 2 series and the NPN D33D21, 22 series are silicon, planar, passivated, epitaxial transistors intended for general purpose applications. These complementary pairs are especially suited for the output stage of push-pull audio amplifiers, the drive stage of power amplifiers, or for control and television circuitry.

FEATURES: • Low Collector Saturation Voltage • Excellent Beta Linearity Over a Wide Current Range • Heatsinking Available on All Units

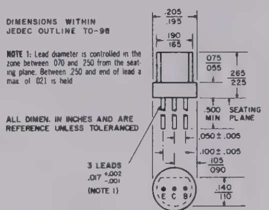
NOTE: Observe proper polarity on biases for PNP's and NPN's.

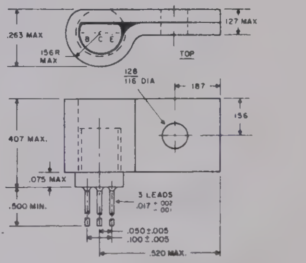


absolute maximum ratings: (25°C unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	25	Volts
Emitter to Base	V_{EBO}	5	Volts
Collector to Base	V_{CBO}	35	Volts
Collector to Emitter	V_{CES}	35	Volts
Current			
Collector (Continuous)	I_C	750	mA
Collector (Pulsed, 300 μsec. pulse width, ≤ 2% duty cycle)	I_{CM}	1000	mA
Dissipation			
Total Power (Free Air, $T_A \leq 25°C$) *	P_T	500	mW
Total Power with J1 Heatsink (Free Air, $T_A \leq 25°C$) **	P_T	700	mW
Total Power with J1 Heatsink (Case Temp., $T_C \leq 25°C$) ***	P_T	1000	mW
Temperature			
Storage	T_{STG}	−65 to +150	°C
Operating	T_J	−65 to +150	°C
Lead soldering (1/16" ± 1/32" from case for 10 sec. max.)	T_L	+260	°C

*Derate 4.0 mW/°C increase in ambient temperature above 25°C. **Derate 5.6 mW/°C increase in ambient temperature above 25°C. ***Derate 8.0 mW/°C increase in case temperature above 25°C.


DIMENSIONS WITHIN JEDEC OUTLINE TO-98
NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max of .021 is held
ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED
.205/.195
.190/.165
.075/.055
.265/.225
.500 MIN
SEATING PLANE
.050 ± .005
.100 ± .005
.105/.090
.140/.110
3 LEADS .017 +.002 −.001 (NOTE 1)
E C B


.263 MAX
.127 MAX
B C E
.156R MAX
TOP
.128/.116 DIA
.187
.156
.407 MAX.
.075 MAX
.500 MIN.
3 LEADS .017 +.002 −.001
.050 ± .005
.100 ± .005
.520 MAX.
ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED
WITH J1 HEATSINK

electrical characteristics: (25°C unless otherwise specified)

NOTE: Characteristics apply to both heatsinked and non-heatsinked devices.

STATIC CHARACTERISTICS		Min.	Max.	
Collector Cutoff Current (V_{CE} = 25V)	I_{CES}	—	100	nA
(V_{CE} = 25V, T_A = 100°C)	I_{CES}	—	15	μA
Forward Current Transfer Ratio				
(I_C = 2 mA, V_{CE} = 2V)				
D29E1/D33D21	h_{FE}	60	200	
D29E2/D33D22	h_{FE}	150	500	
(I_C = 500 mA, V_{CE} = 2V)				
D29E1/D33D21	h_{FE}	45	—	
D29E2/D33D22	h_{FE}	60	—	
Collector Emitter Breakdown Voltage				
(I_C = 10 mA)	$V_{(BR)CEO}$	25	—	Volts
(I_C = 10 μA)	$V_{(BR)CES}$	35	—	Volts
Emitter Base Breakdown Voltage				
(I_E = 10 μA)	$V_{(BR)EBO}$	5	—	Volts
Collector Saturation Voltage				
(I_C = 500 mA, I_B = 50 mA)	$V_{CE(SAT)}$	—	0.75	Volts
Base Saturation Voltage				
(I_C = 500 mA, I_B = 50 mA)	$V_{BE(SAT)}$	—	1.2	Volts
DYNAMIC CHARACTERISTICS				
Output Capacitance, Common Base				
(V_{CB} = 10V, f = 1 MHz)	C_{cb}	—	15	pF
Input Capacitance, Common Base				
(V_{EB} = 0.5V, f = 1 MHz)	C_{eb}	—	55	pF
Gain Bandwidth Product				
(I_C = 50 mA, V_{CE} = 2V, f = 20 MHz)				
D29E1/D33D21	f_t	100	—	MHz
D29E2/D33D22	f_t	135	—	MHz

TYPICAL h_{FE} VS. I_C

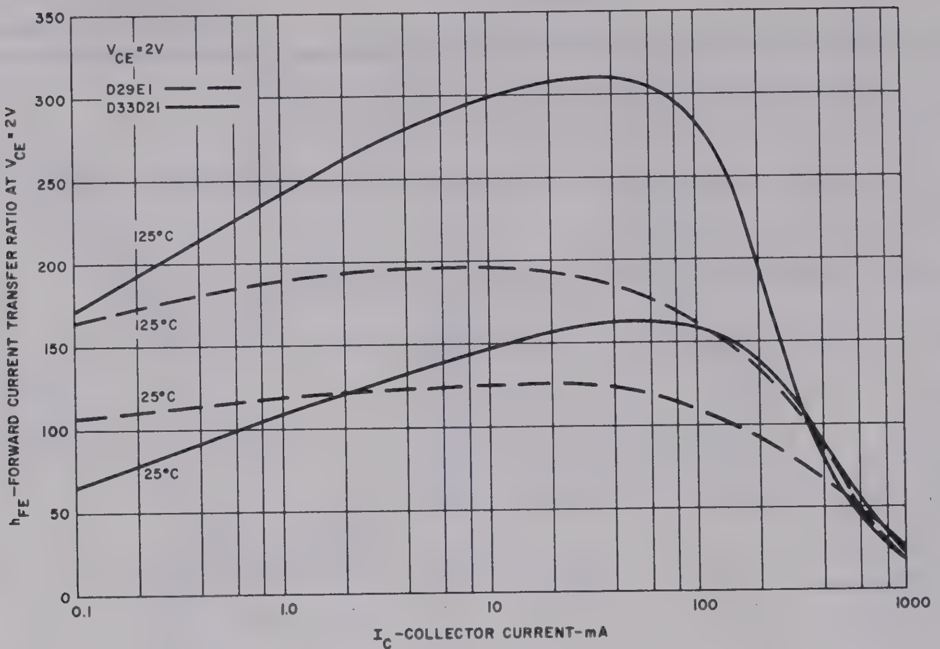


FIGURE 1

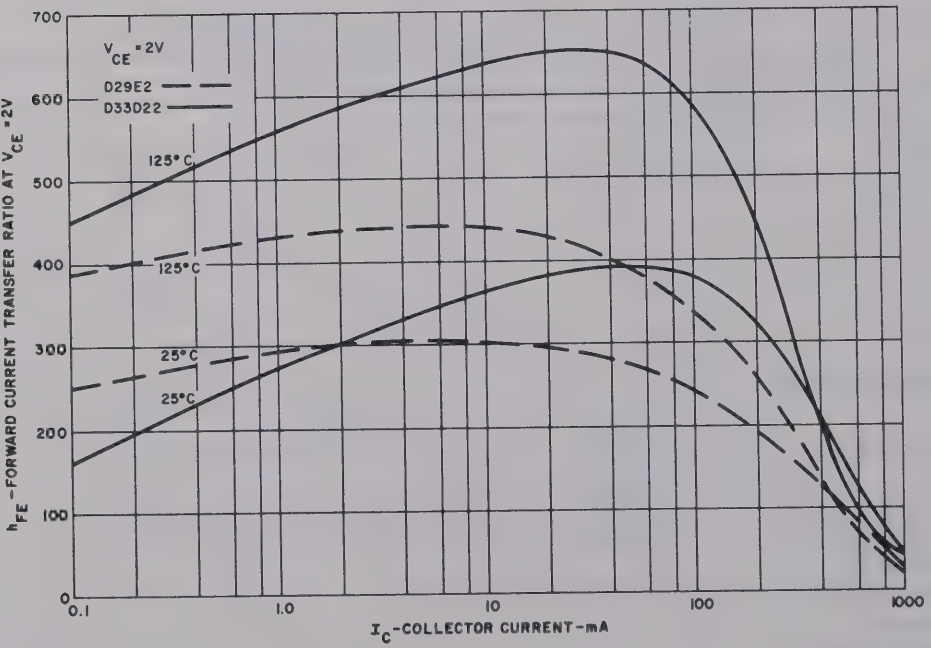


FIGURE 2

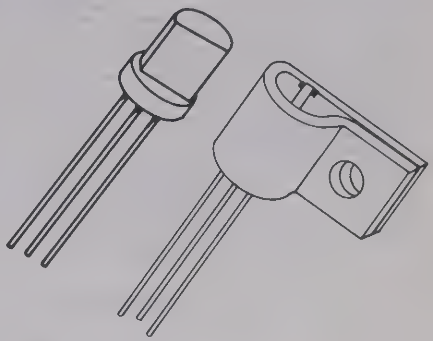
Silicon Transistors

PNP	NPN
D29E4-7	D33D24-27
D29E4J1-7J1	D33D24J1-27J1

The PNP D29E4-7 series and the NPN D33D24-27 series are silicon, planar, passivated, epitaxial transistore intended for general purpose applications. These complementary pairs are especially suited for the drive stage in high power amplifiers, and for control and television circuitry.

FEATURES: • Low Collector Saturation Voltage • Excellent Beta Linearity Over A Wide Current Range • Heatsinking Available On All Units

NOTE: Observe proper polarity on biases for PNP's and NPN's



absolute maximum ratings: (25°C) (unless otherwise specified)

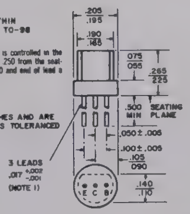
Voltage			
Collector to Emitter	V_{CEO}	40	Volts
Emitter to Base	V_{EBO}	5	Volts
Collector to Base	V_{CBO}	50	Volts
Collector to Emitter	V_{CES}	50	Volts
Current			
Collector (Continuous)	I_C	750	mA
Collector (Pulsed, 300 μsec. pulse width, ≦ 2% duty cycle)	I_{CM}	1000	mA
Dissipation			
Total Power (Free Air, $T_A \leqq 25°C$)*	P_T	500	mW
Total Power with J1 Heatsink (Free Air, $T_A \leqq 25°C$)**	P_T	700	mW
Total Power with J1 Heatsink (Case Temp., $T_C \leqq 25°C$)***	P_T	1000	mW
Temperature			
Storage	T_{STG}	−65 to +150	°C
Operating	T_J	−65 to +150	°C
Lead soldering (1/16" ± 1/32" from case for 10 sec. max.)	T_L	+260	°C

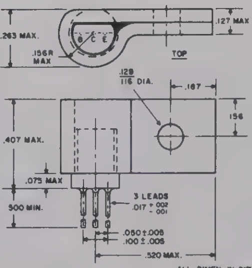
*Derate 4.0 mW/°C increase in ambient temperature above 25°C. **Derate 5.6 mW/°C increase in ambient temperature above 25°C. ***Derate 8.0 mW/°C increase in case temperature above 25°C.

DIMENSIONS WITHIN JEDEC OUTLINE TO-98

NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED





ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED WITH J1 HEATSINK

electrical characteristics: (25°C) (unless otherwise specified)

NOTE: Characteristics apply to both heatsinked and non-heatsinked devices.

		Min.	Max.	
STATIC CHARACTERISTICS				
Collector Cutoff Current (V_{CE} = 25V)	I_{CES}	—	100	nA
(V_{CE} = 25V, T_A = 100°C)	I_{CES}	—	15	μA
Forward Current Transfer Ratio				
(I_C = 2 mA, V_{CE} = 2V)				
D29E4/D33D24	h_{FE}	60	120	
D29E5/D33D25	h_{FE}	100	200	
D29E6/D33D26	h_{FE}	150	300	
D29E7/D33D27	h_{FE}	250	500	
(I_C = 500 mA, V_{CE} = 2V)				
D29E4/D33D24	h_{FE}	20	—	
D29E5/D33D25	h_{FE}	25	—	
D29E6/D33D26	h_{FE}	25	—	
D29E7/D33D27	h_{FE}	25	—	
Collector Emitter Breakdown Voltage				
(I_C = 10 mA)	$V_{(BR)CEO}$	40	—	Volts
(I_C = 10 μA)	$V_{(BR)CES}$	50	—	Volts
Emitter Base Breakdown Voltage				
(I_E = 10 μA)	$V_{(BR)EBO}$	5	—	Volts
Collector Saturation Voltage				
(I_C = 500 mA, I_B = 50 mA)	$V_{CE(SAT)}$	—	0.75	Volts
Base Saturation Voltage				
(I_C = 500 mA, I_B = 50 mA)	$V_{BE(SAT)}$	—	1.2	Volts
DYNAMIC CHARACTERISTICS				
Output Capacitance, Common Base				
(V_{CB} = 10V, f = 1 MHz)	C_{cb}	—	15	pF
Input Capacitance, Common Base				
(V_{EB} = 0.5V, f = 1 MHz)	C_{eb}	—	55	pF
Gain Bandwidth Product				
(I_C = 50 mA, V_{CE} = 2V, f = 20 MHz)				
D29E4/D33D24	f_t	80	—	MHz
D29E5/D33D25	f_t	120	—	MHz
D29E6/D33D26	f_t	135	—	MHz
D29E7/D33D27	f_t	150	—	MHz

TYPICAL h_{FE} VS. I_C

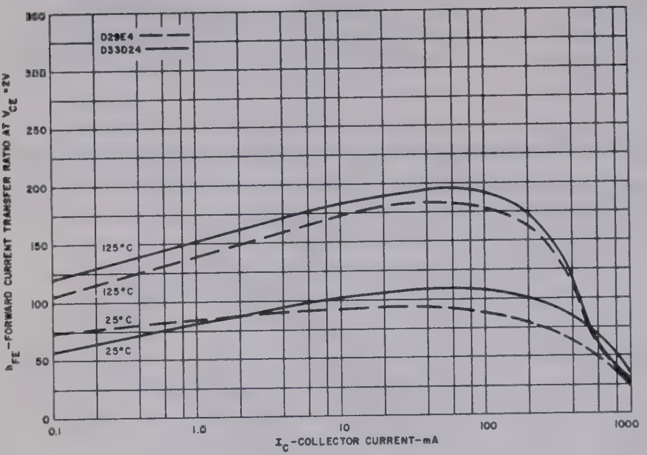


FIGURE 1

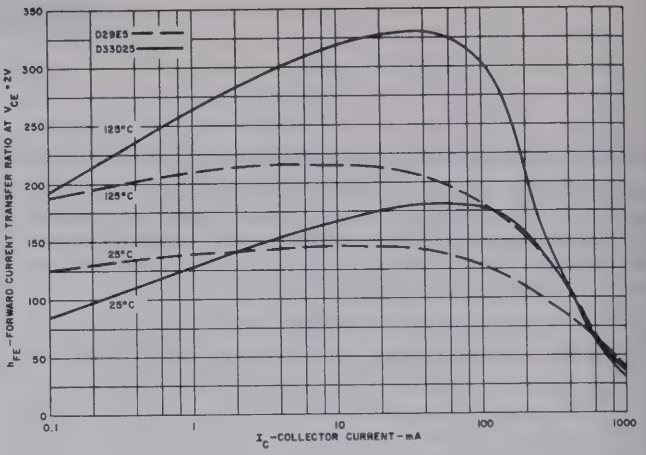


FIGURE 2

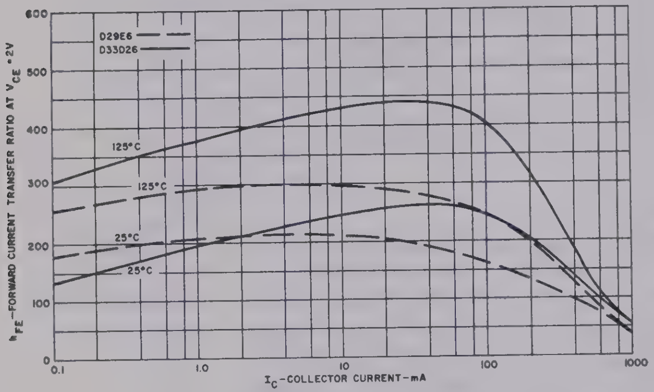


FIGURE 3

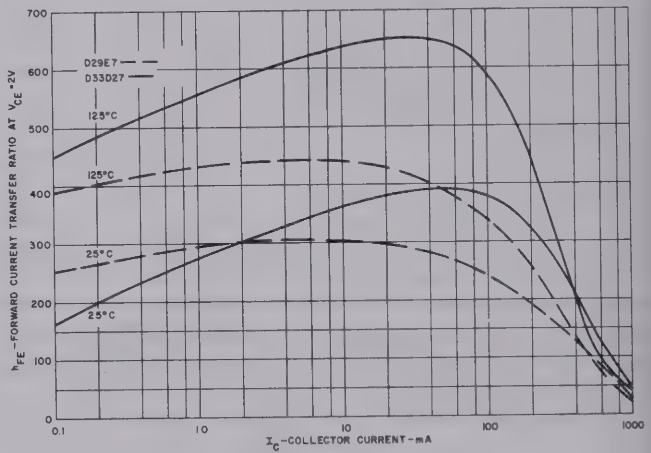


FIGURE 4

TYPICAL $V_{CE\,(SAT)}$ VS. I_C, $I_B = I_C/20$

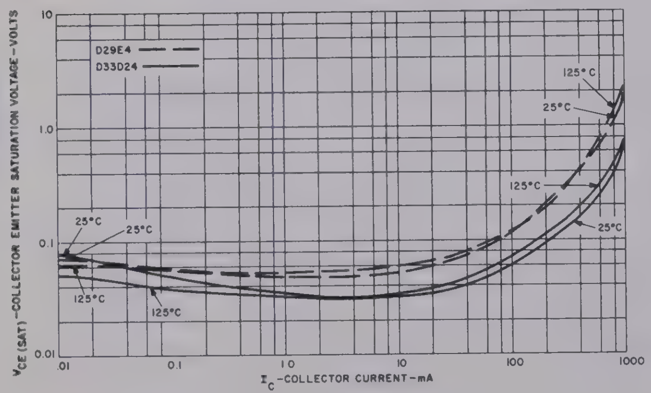


FIGURE 5

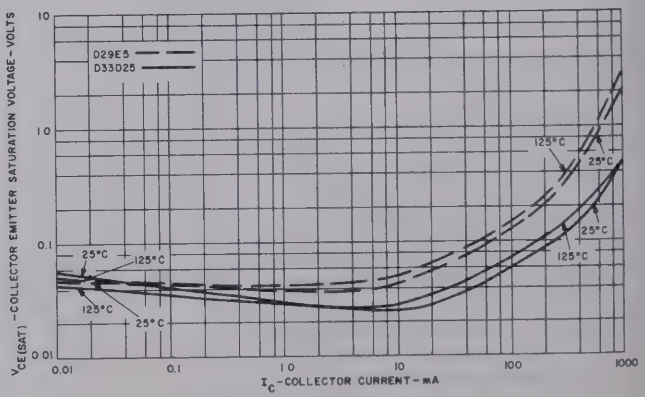


FIGURE 6

TYPICAL $V_{CE\,(SAT)}$ VS. I_C, $I_B = I_C/20$ (continued)

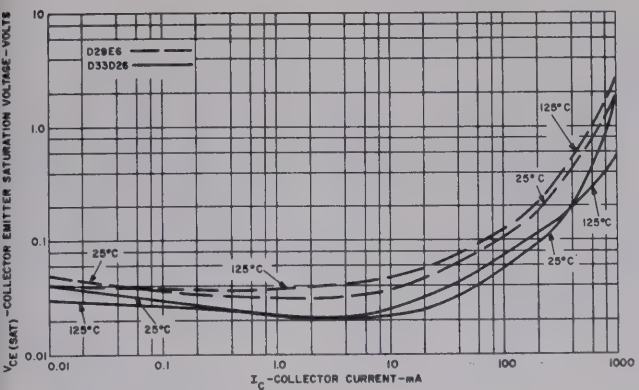


FIGURE 7

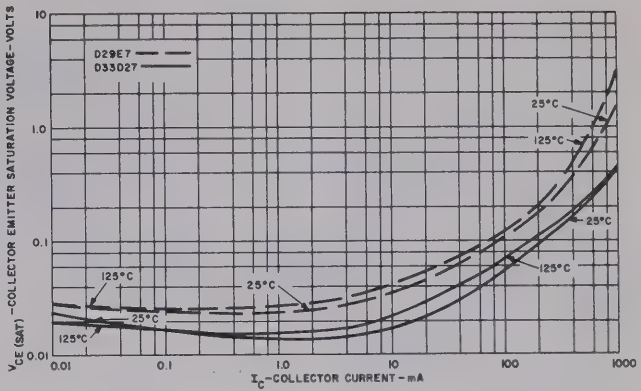


FIGURE 8

TYPICAL $V_{CE\,(SAT)}$ VS. I_C, $I_B = I_C/10$

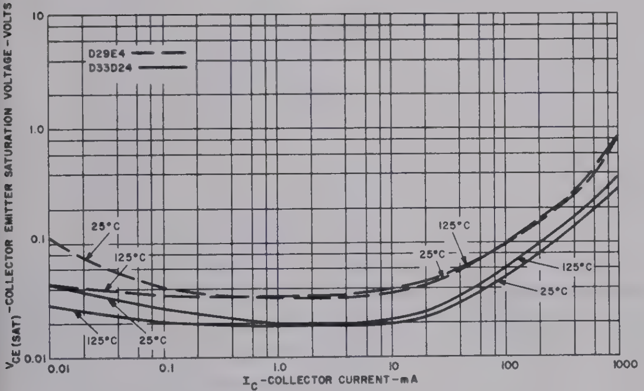


FIGURE 9

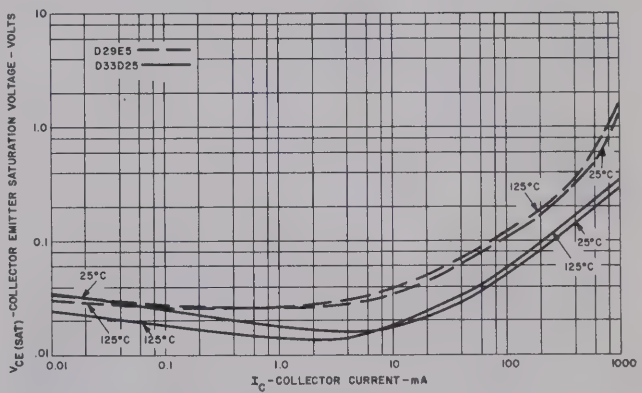


FIGURE 10

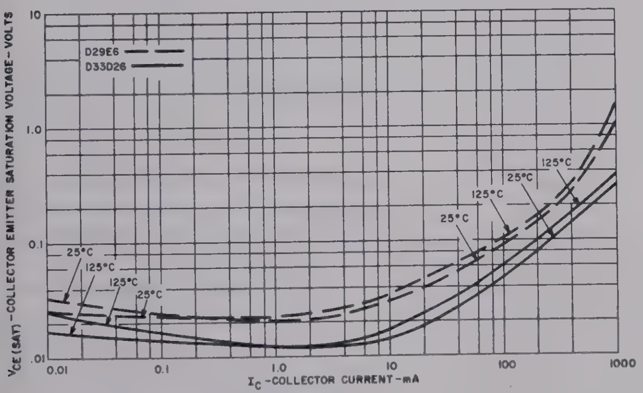


FIGURE 11

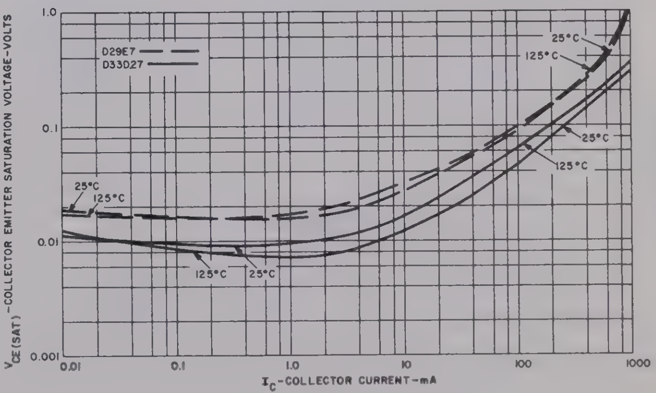


FIGURE 12

TYPICAL V_{BE} VS. I_C

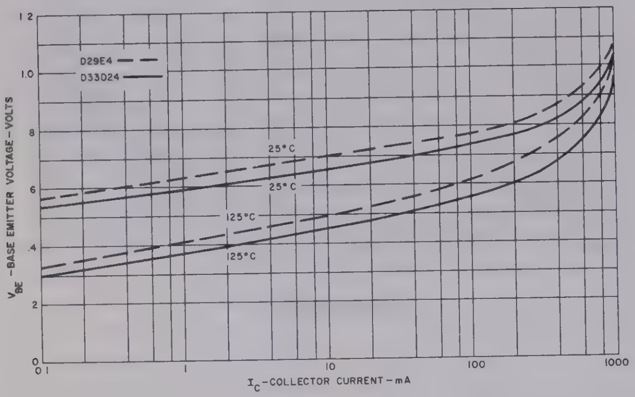


FIGURE 13

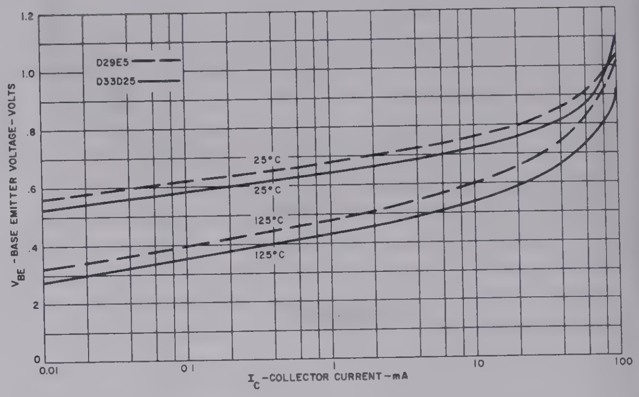


FIGURE 14

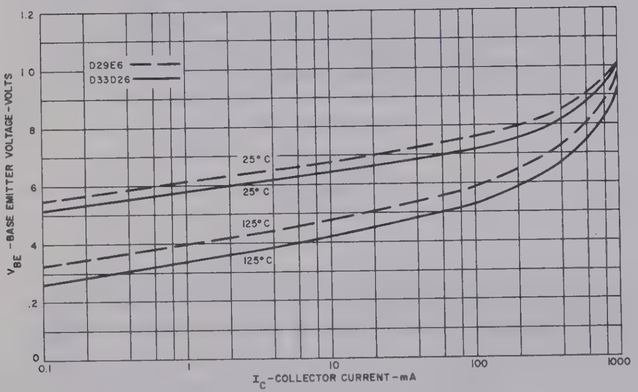


FIGURE 15

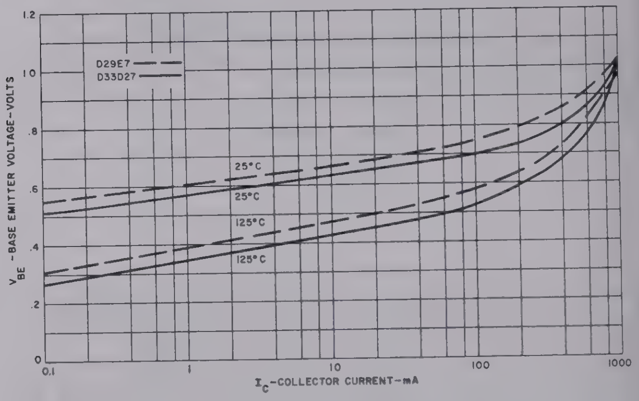
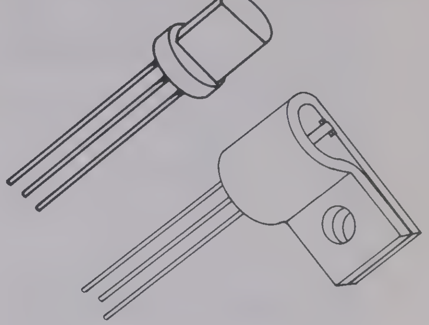


FIGURE 16

Silicon
Transistors

PNP	NPN
D29E9-10	D33D29-30
D29E9J1-10J1	D33D29J1-30J1

The PNP D29E9-10 series and the NPN D33D29-30 series are silicon, lanar, passivated, epitaxial transistors intended for general purpose appliations. These complementary pairs are especially suited for the drive stage n high power amplifiers, and for control and television circuitry.



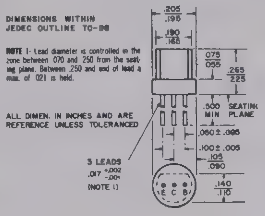
FEATURES: • Low Collector Saturation Voltage • Excellent Beta Linearity over a Wide Current Range • Heatsinking Available on All Units

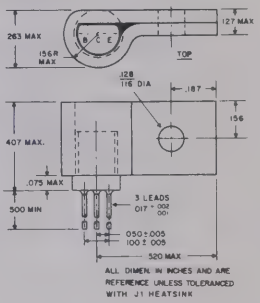
OTE: Observe proper polarity on biases for PNP's and NPN's.

absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	60	Volts
Emmitter to Base	V_{EBO}	5	Volts
Collector to Base	V_{CBO}	70	Volts
Collector to Emitter	V_{CES}	70	Volts
Current			
Collector (Continuous)	I_C	750	mA
Collector (Pulsed, 300 μsec., pulse width, ≦ 2% duty cycle)	I_{CM}	1000	mA
Dissipation			
Total Power (Free Air, $T_A \leqq 25°C$)*	P_T	500	mW
Total Power with J1 Heatsink (Free Air, $T_A \leqq 25°C$)**	P_T	700	mW
Total Power with J1 Heatsink (Case Temp., $T_C \leqq 25°C$)***	P_T	1000	mW
Temperature			
Storage	T_{STG}	−65 to +150	°C
Operating	T_J	−65 to +150	°C
Lead soldering (1/16" ± 1/32" from case for 10 sec. max.)	T_L	+260	°C

*Derate 4.0 mW/°C increase in ambient temperature above 25°C. **Derate 5.6 mW/°C increase in ambient temperature above 25°C. ***Derate 8.0 mW/°C increase in case temperature above 25°C.


DIMENSIONS WITHIN JEDEC OUTLINE TO-98
NOTE 1- Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.
ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED
.205
.195
.190
.168
.075
.055
.265
.225
.500 MIN
SEATING PLANE
.050±.005
.100±.005
.105
.090
.140
.110
3 LEADS
.017 +.002 -.001
(NOTE 1)
E
C
B

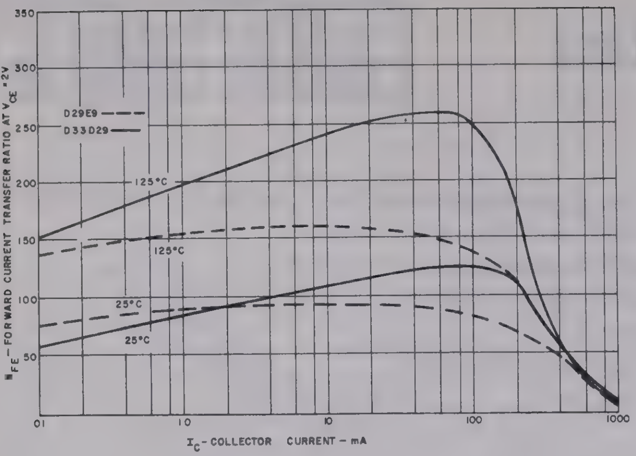

263 MAX
.156R MAX
B
C
E
.127 MAX
TOP
.128
.116 DIA
.187
.156
.407 MAX.
.075 MAX
.500 MIN
3 LEADS
.017 +.002 .001
.050±.005
.100±.005
.520 MAX
ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED
WITH J1 HEATSINK

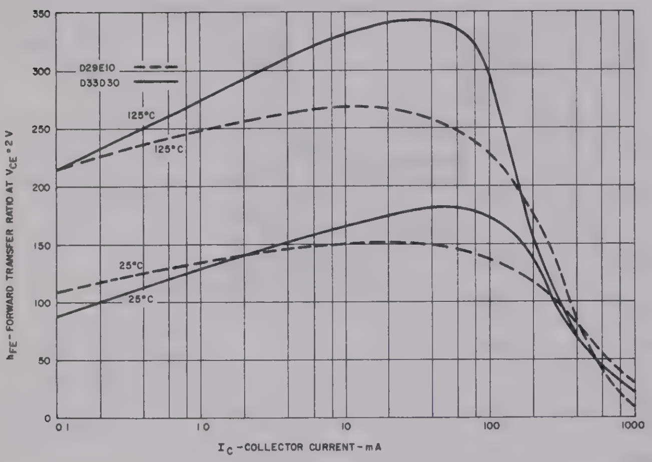
electrical characteristics: (25°C) (unless otherwise specified)

OTE: Characteristics apply to both heatsinked and non-heatsinked devices.

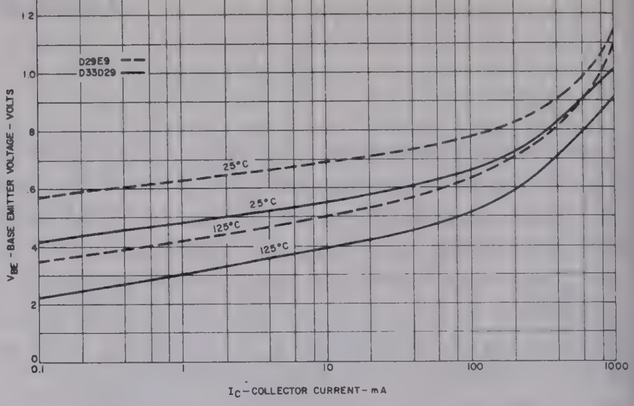
STATIC CHARACTERISTICS		Min.	Max.	
Collector Cutoff Current ($V_{CE} = 25V$)	I_{CES}	—	100	nA
($V_{CE} = 25V$, $T_A = 100°C$)	I_{CES}	—	15	μA
Forward Current Transfer Ratio				
($I_C = 2$ mA, $V_{CE} = 2V$)				
D29E9/D33D29	h_{FE}	60	120	
D29E10/D33D30	h_{FE}	100	200	
($I_C = 500$ mA, $V_{CE} = 2V$)				
D29E9/D33D29	h_{FE}	20	—	
D29E10/D33D30	h_{FE}	25	—	
Collector Emitter Breakdown Voltage				
($I_C = 10$ mA)	$V_{(BR)CEO}$	60	—	Volts
($I_C = 10$ μA)	$V_{(BR)CES}$	70	—	Volts
Emitter Base Breakdown Voltage				
($I_E = 10$ μA)	$V_{(BR)EBO}$	5	—	Volts
Collector Saturation Voltage				
($I_C = 500$ mA, $I_B = 50$ mA)	$V_{CE(SAT)}$	—	0.75	Volts
Base Saturation Voltage				
($I_C = 500$ mA, $I_B = 50$ mA)	$V_{BE(SAT)}$	—	1.2	Volts
DYNAMIC CHARACTERISTICS				
Output Capacitance, Common Base				
($V_{CB} = 10V$, f = 1 MHz)	C_{cb}	—	15	pF
Input Capacitance, Common Base				
($V_{EB} = 0.5V$, f = 1 MHz)	C_{eb}	—	55	pF
Gain Bandwidth Product				
($I_C = 50$ mA, $V_{CE} = 2V$, f = 20 MHz)				
D29E9/D33D29	f_t	80	—	MHz
D29E10/D33D30	f_t	120	—	MHz

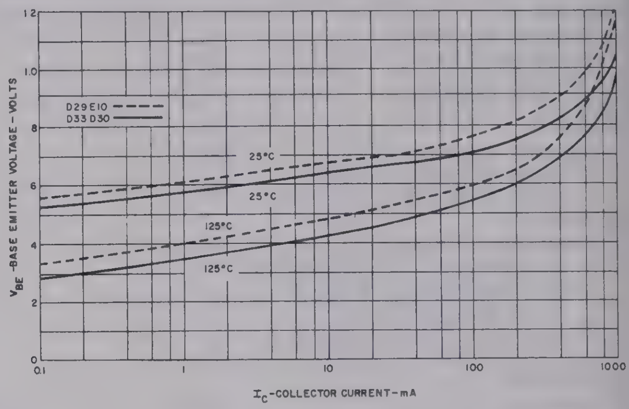
TYPICAL h_{FE} VS. I_C



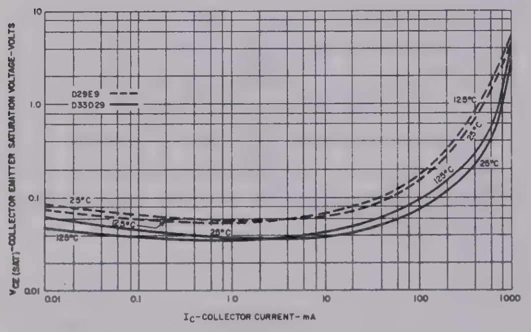


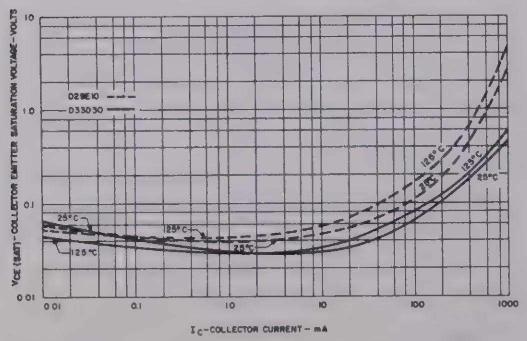
TYPICAL $V_{BE\ on}$ VS. I_C



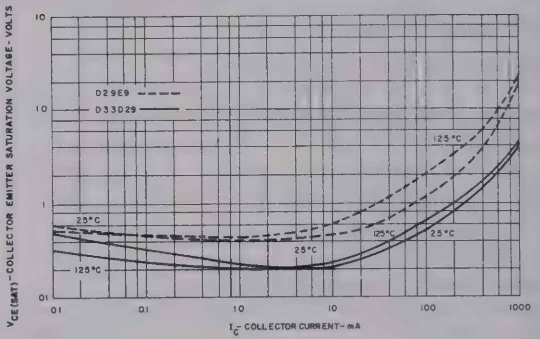


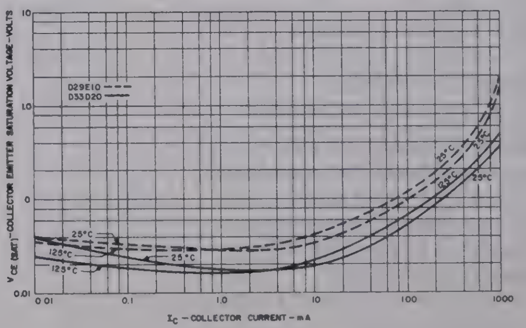
TYPICAL V_{CE}(SAT) VS. I_C
$I_B = I_C/20$





TYPICAL V_{CE}(SAT) VS. I_C
$I_B = I_C/10$





Silicon Transistors

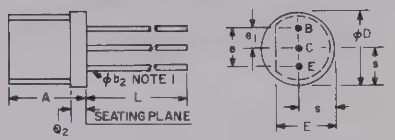
Consumer/Industrial

PLANAR EPITAXIAL PASSIVATED

PNP

D29F1-7

his series of transistors are PNP silicon, planar, epitaxial, passivated devices. These units ature low collector saturation voltage, low capacitance, high voltage and low noise. ossible applications include video drivers, FM decoder, chroma processing, and wherever signal PNP transistor is required.



SYMBOL	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	.170	.265	4.32	6.73
ϕb_2	.016	.019	.406	.483
ϕD	.165	.205	4.19	5.21
E	.110	.155	2.79	3.94
e	.095	.105	2.41	2.67
e_1	.045	.055	1.14	1.40
L	.500		12.70	
Q_2	.055	.075	1.40	1.90
s	.080	.115	2.03	2.92

NOTE I: LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .070 AND .250 FROM THE SEATING PLANE. BETWEEN .250 AND END OF LEAD A MAX OF .021 IS HELD.

bsolute maximum ratings: (25°C) (unless otherwise specified)

		D29F1-4	D29F5-7
oltages			
Collector to emitter	V_{CEO}	-40	-60 volts
Emitter to base	V_{EBO}	- 4	- 4 volts
Collector to base	V_{CBO}	-40	-60 volts
urrent			
Collector (continuous)	I_C	-100ma	
issipation			
Total Power (Free air @ 25°C)*	P_T	360mw	
emperature			
Storage	T_{stg}	-65 to +150°C	
Operating	T_j	-65 to +125°C	
Lead temperature, 1/16" ± 1/32" from case for 10 sec. max.	T_L	+260°C	

Derate 3.6mw/°C increase in ambient temperature above 25°C

(Complementary to NPN)
types: 2N3858, A
2N3859, A
2N3860
2N5232

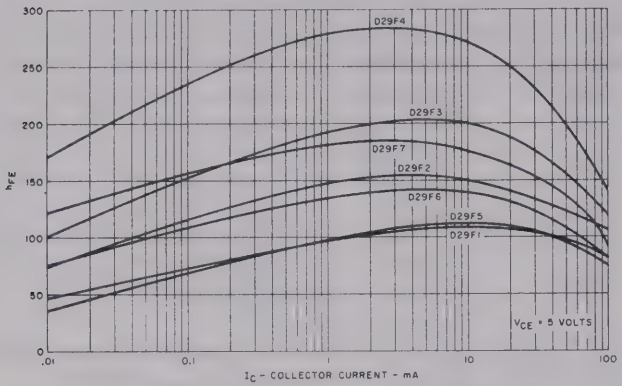
lectrical characteristics: (25°C) (unless otherwise specified)

TATIC CHARACTERISTICS

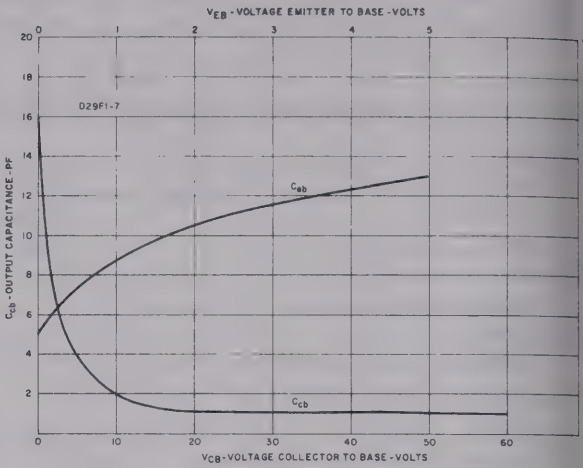
			Min.	Max.	Units
ollector Cutoff Current					
(V_{CB} = -40V)	D29F1-4	I_{CBO}		- 50	nA
(V_{CB} = -40V, T_A = 100°C)	D29F1-4	I_{CBO}		- 10	μA
(V_{CB} = -40V)	D29F5-7	I_{CBO}		- 50	nA
(V_{CB} = -40V, T_A = 100°C)	D29F5-7	I_{CBO}		- 10	μA
mitter Cutoff Current					
(V_{EB} = -3V)		I_{EBO}		-100	nA
ollector Emitter Breakdown Voltage					
(I_C = –10ma)	D29F1-4	$V_{(BR)CEO}$	-40		V
ollector Emitter Breakdown Voltage					
(I_C = –10ma)	D29F5-7	$V_{(BR)CEO}$	-60		V
mitter Base Breakdown Voltage					
(I_E = -10μA)		$V_{(BR)EBO}$	- 4		V
ollector Saturation Voltage					
(I_C = -10ma, I_B = -1ma)		$V_{CE(sat)}$		-0.25	V
ase Saturation Voltage					
(I_C = -10ma, I_B = -1ma)		$V_{BE(sat)}$		-0.85	V
orward Current Transfer Ratio					
(V_{CE} = -5V, I_C = -2ma)					
	D29F1	h_{FE}	60	120	
	D29F2	h_{FE}	100	200	
	D29F3	h_{FE}	150	300	
	D29F4	h_{FE}	250	500	
	D29F5	h_{FE}	60	120	
	D29F6	h_{FE}	100	200	
	D29F7	h_{FE}	150	300	

electrical characteristics: (25°C) (unless otherwise specified)(continued)

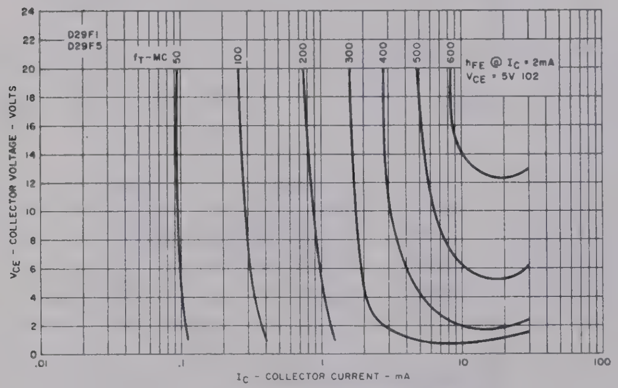
DYNAMIC CHARACTERISTICS		Min.	Max.	Units
Gain Bandwidth Product (V_{CE} = -10V, I_C = -2ma, f = 10MHz)	f_t	90		MHz
Output Capacitance, Common Base (V_{CB} = -10V, f = 1MHz)	C_{cb}		4	pF



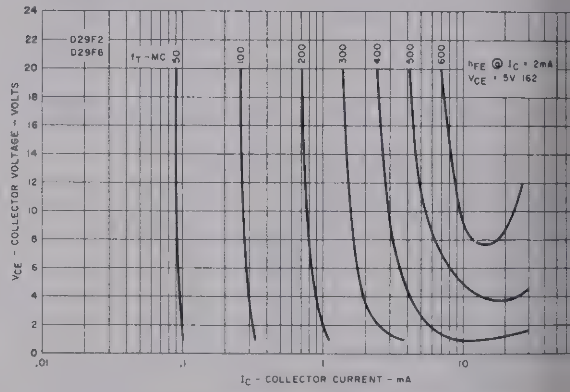
FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT



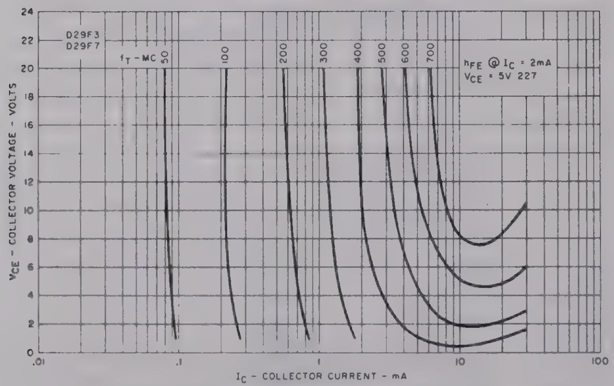
INPUT AND OUTPUT CAPACITANCE VS. VOLTAGE



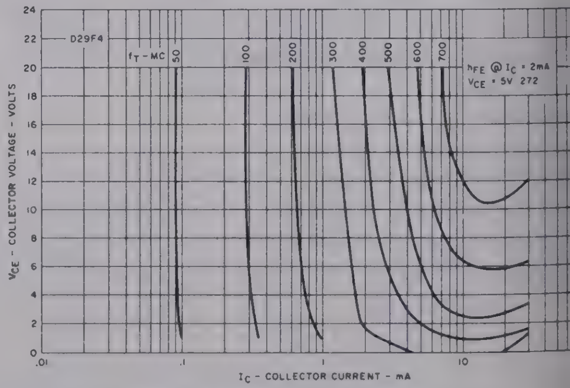
GAIN BANDWIDTH PRODUCT VS. COLLECTOR CURRENT



GAIN BANDWIDTH PRODUCT VS. COLLECTOR CURRENT



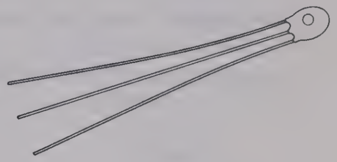
GAIN BANDWIDTH PRODUCT VS. COLLECTOR CURRENT



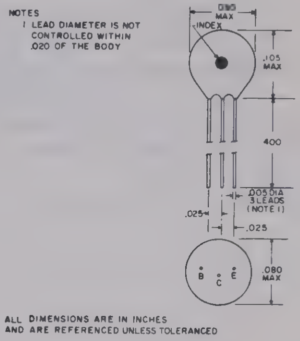
GAIN BANDWIDTH PRODUCT VS. COLLECTOR CURRENT

Microtab
Transistors

PNP
D30A1,2,3,4,5



The General Electric D30A series are PNP microminiature silicon, planar, epitaxial, passivated transistors similar to the 2N2907 series. The D30A forms the PNP complement to the D26C NPN microminiature transistors. These devices may be used for amplifier, driver and general purpose switching applications.


NOTES
1 LEAD DIAMETER IS NOT CONTROLLED WITHIN .020 OF THE BODY
090 MAX
INDEX
.105 MAX
400
.005 DIA 3 LEADS (NOTE 1)
.025
.025
B
C
E
.080 MAX
ALL DIMENSIONS ARE IN INCHES AND ARE REFERENCED UNLESS TOLERANCED

Features:

- High Gain
- Low Leakage Currents
- Low Collector Saturation Voltage
- Epoxy Encapsulation with Field Proven Reliability

absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	−25	Volts
Emitter to Base	V_{EBO}	−4	Volts
Collector to Base	V_{CBO}	−25	Volts
Dissipation			
Total Power (Free air at 25°C)*	P_T	90	mW
Temperature			
Storage	T_{STG}	−55°C to +125	°C
Operating	T_J	−55°C to +100	°C
Soldering (10 sec, 1/16″ from body)	T_L	+260	°C

*Derate above 25°C, 1.20 mW/°C.

electrical characteristics: (25°C) (unless otherwise specified)

	Symbol	Min.	Max.	
Collector-Emitter Breakdown Voltage ($I_C = -1$ mA)	$V_{(BR)CEO}$*	−25	—	Volts
Collector-Base Breakdown Voltage ($I_C = -100\ \mu A$)	$V_{(BR)CBO}$	−25	—	Volts
Emitter-Base Breakdown Voltage ($I_E = -100\ \mu A$)	$V_{(BR)EBO}$	−4	—	Volts
Collector-Emitter Cutoff Current ($V_{CE} = -18$ V)	I_{CES}	—	−25	nA
Collector-Base Cutoff Current ($V_{CB} = -18$ V)	I_{CBO}	—	−25	nA

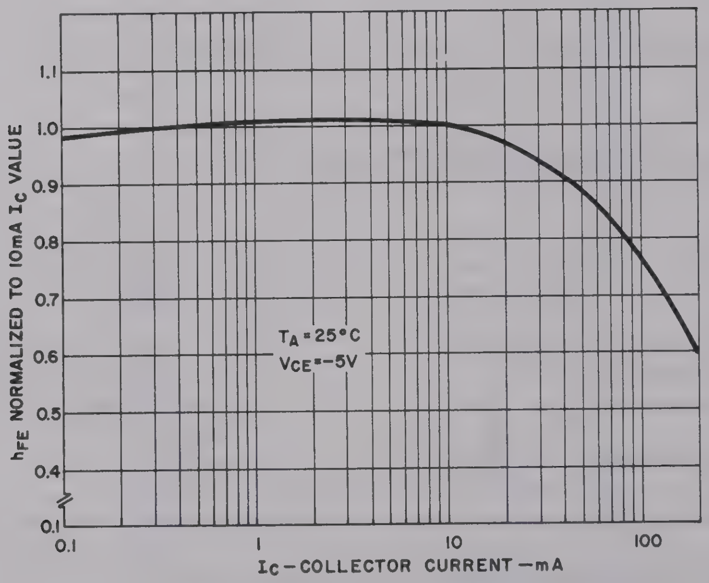
*Pulse width ≤300 μsec, duty cycle ≤2%.

D30A1,2,3,4,5

electrical characteristics: (cont.)

	Symbol	Min.	Max.	
Emitter-Base Cutoff Current ($V_{EB} = -3$ V)	I_{EBO}	—	−100	nA
Collector-Emitter Saturation Voltage ($I_C = -10$ mA, $I_B = -1$ mA)	$V_{CE(SAT)}$	—	−0.25	Volts
Emitter-Base Saturation Voltage ($I_C = -10$ mA, $I_B = -1$ mA)	$V_{BE(SAT)}$	−0.6	−0.80	Volts
Forward Current Transfer Ratio ($I_C = -10$ mA, $V_{CE} = -5$ V)				
D30A1	h_{FE}*	30	90	
D30A2	h_{FE}*	60	180	
D30A3	h_{FE}*	140	300	
D30A4	h_{FE}*	250	500	
D30A5	h_{FE}*	400	800	
Output Capacitance, Common Base ($V_{CB} = -10$ V, f = 1 MHz, emitter connected to guard terminal on three terminal bridge)	C_{cb}	—	8	pF

*Pulse width ≦300 μsec, duty cycle ≦2%.



Normalized h_{FE} vs. I_C

Silicon
Transistors

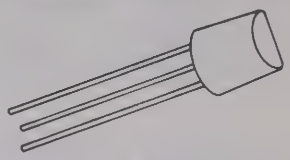
NPN

D32K1

D32K2

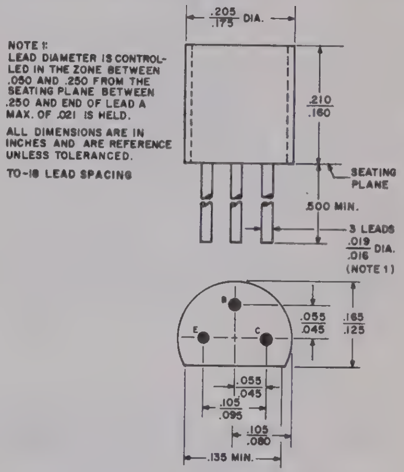
The General Electric D32K1 and D32K2 are planar epitaxial passivated NPN Silicon transistors. They are intended for high current, high speed switching applications in core driver, power and audio output stages.

FEATURES:
- Epoxy encapsulation
- Performance comparable to hermetic units—excellent characteristic stability under environmental stresses –85°C –85% relative humidity
- Ultra fast high current switching



absolute maximum ratings: (T_A = 25°C unless otherwise specified)

		D32K1	D32K2	
VOLTAGES				
Collector to Emitter	V_{CEO}	25	40	Volts
Collector to Base	V_{CBO}	30	50	Volts
Emitter to Base	V_{EBO}	4	4	Volts
CURRENT				
Collector	I_c	750	750	mA
Collector (pulsed, 300 usec, ≤ 2% duty cycle)	I_c	1500	1500	mA
DISSIPATION				
Total Power ($T_A \leq 25°C$)	P_T	500	500	mW
Total Power ($T_C \leq 25°C$)	P_T	1000	1000	mW
Derate Factor ($T_A > 25°C$)		4	4	mW/°C
Derate Factor ($T_C > 25°C$)		8	8	mW/°C
TEMPERATURE				
Storage	Tstg	–65°C to +150°C		
Operating	Tj	–65°C to +150°C		
Lead Soldering (1/16" ± 1/32" from case for 10 seconds max.)	T_L	+260°C		

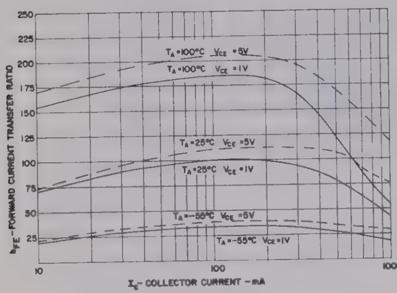

.205
.175 DIA.
NOTE 1:
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND .250 FROM THE SEATING PLANE BETWEEN .250 AND END OF LEAD A MAX. OF .021 IS HELD.
ALL DIMENSIONS ARE IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.
TO-18 LEAD SPACING
.210
.160
SEATING PLANE
.500 MIN.
3 LEADS
.019
.016 DIA.
(NOTE 1)
B
E
C
.055
.045
.165
.125
.055
.045
.105
.095
.105
.080
.135 MIN.

electrical characteristics: (T_A = 25°C unless otherwise specified)

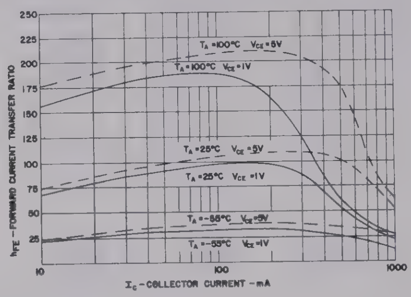
		D32K1		D32K2		
		MIN.	MAX.	MIN.	MAX.	
STATIC						
Collector-Base Breakdown Voltage (I_c = 10 uA, I_E = 0)	$V_{(BR)CBO}$	30		50		Volts
Collector-Emitter Breakdown Voltage (I_c = 10 mA, I_B = 0)	$V_{(BR)CEO}$	25		40		Volts
Emitter-Base Breakdown Voltage (I_E = 10 uA, I_c = 0)	$V_{(BR)EBO}$	4		4		Volts
Forward Current Transfer Ratio	h_{FE}					
(I_c = 10 mA, V_{CE} = 1V)		30		30		
(I_c = 100 mA, V_{CE} = 1V)		50	200	50	200	
(I_c = 200 mA, V_{CE} = 1V)		50		50		
(I_c = 500 mA, V_{CE} = 1V)		30		30		
(I_c = 800 mA, V_{CE} = 1V)		20		12		
Collector Saturation Voltage	$V_{CE(sat)}$					
(I_c = 10 mA, I_B = 1 mA)			.2		.2	Volts
(I_c = 100 mA, I_B = 10 mA)			.2		.2	Volts
(I_c = 200 mA, I_B = 20 mA)			.25		.25	Volts
(I_c = 500 mA, I_B = 50 mA)			.35		.35	Volts
(I_c = 800 mA, I_B = 80 mA)			.45		.45	Volts
Base Saturation Voltage	$V_{BE(sat)}$					
(I_c = 10 mA, I_B = 1 mA)			.82		.82	Volts
(I_c = 100 mA, I_B = 10 mA)			.85		.85	Volts
(I_c = 200 mA, I_B = 20 mA)			.9		.9	Volts
(I_c = 500 mA, I_B = 50 mA)			1.0		1.0	Volts
(I_c = 800 mA, I_B = 80 mA)			1.1		1.1	Volts
Collector Cutoff Current	I_{CBO}					
(V_{CB} = 25 V, I_E = 0)					100	nA
(V_{CB} = 25 V, I_E = 0, T_A = 100°C)					10	uA
DYNAMIC						
Collector Base Capacitance (V_{CB} = 10 V, I_E = 0, f = 1 MHz)	Ccb		8		8	pF
Emitter Base Capacitance (V_{EB} = 0.5 V, I_c = 0, f = 1 MHz)	Ceb		60		60	pF

		D32K1		D32K2		
		MIN.	MAX.	MIN.	MAX.	
Gain Bandwidth Product (I_c = 20 mA, V_{CE} = 10 V, f = 100 MHz)	f_T	275		275		MHz
Delay Time—see figure 1 (V_{CC} = 30 V, I_c = 500 mA, I_{B1} = 50 mA, $V_{BE(OFF)}$ = −3.8 V)	t_d		20		20	nsec.
Rise Time—see figure 1 (V_{CC} = 30 V, I_c = 500 mA, I_{B1} = 50 mA, $V_{BE(OFF)}$ = −3.8 V)	t_r		25		25	nsec.
Storage Time—see figure 1 (V_{CC} = 30 V, I_c = 500 mA, I_{B1} = −I_{B2} = 50 mA)	t_s		70		70	nsec.
Fall Time—see figure 1 (V_{CC} = 30 V, I_c = 500 mA, I_{B1} = −I_{B2} = 50 mA)	t_f		30		30	nsec.

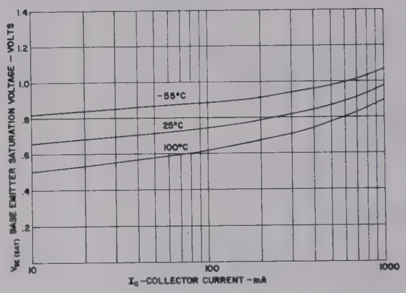
FORWARD TRANSFER RATIO VS. COLLECTOR CUR. K1



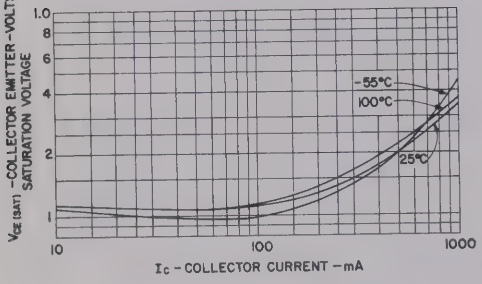
FORWARD TRANSFER RATIO VS. COLLECTOR CUR. K2



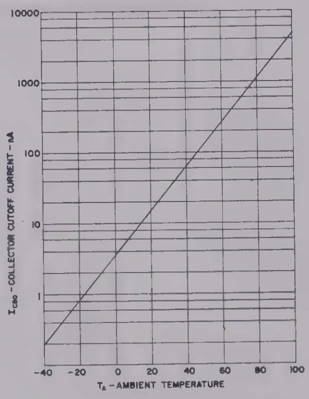
BASE SATURATION VOLTAGE VS. COLLECTOR CURRENT



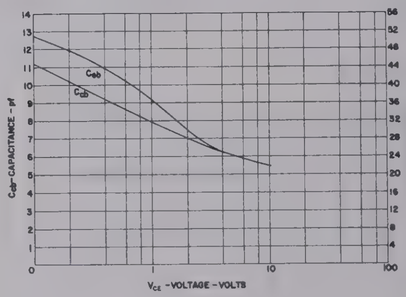
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



COLLECTOR CUTOFF CURRENT VERSUS TEMPERATURE



COLLECTOR BASE AND EMITTER BASE CAPACITANCE VS. REVERSE VOLTAGE



MAXIMUM PERMISSIBLE DC POWER DISSIPATION

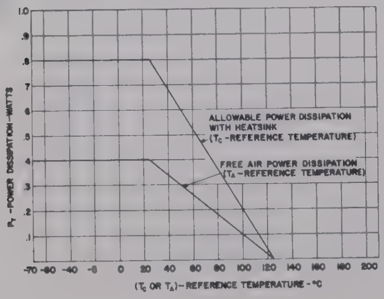
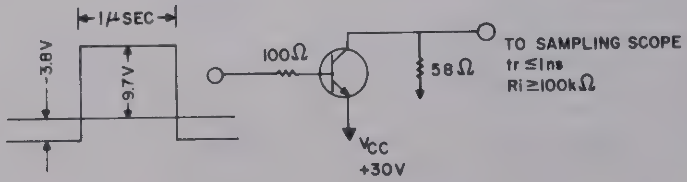


FIGURE 1 SWITCHING CIRCUIT



Silicon Transistor

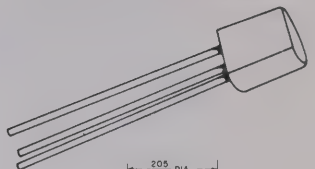
NPN

D32P1
D32P2
D32P3
D32P4

The General Electric D32P is a planar epitaxial passivated NPN silicon transistor developed specifically for radio receiver applications including small signal audio IF and RF functions.

FEATURES:

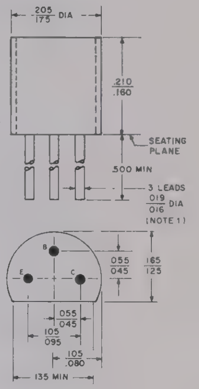
- **Epoxy encapsulation with proven reliability**
- **Performance comparable to hermetic units — excellent characteristic stability under environmental stresses — 85°C/85% relative humidity. (See publication number 95.28)**
- **Low collector base capacitance — 1.5 pF Max.**
- **High gain bandwidth product**
- **Low base resistance**
- **Direct replacements available for 2N4994-5, SE1001-2, and 2N5222.**



NOTE 1:
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND 250 FROM THE SEATING PLANE BETWEEN .250 AND END OF LEAD A MAX. OF .021 IS HELD.

ALL DIMENSIONS ARE IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.

TO-18 LEAD SPACING



absolute maximum ratings: (T_A = 25°C unless otherwise specified)

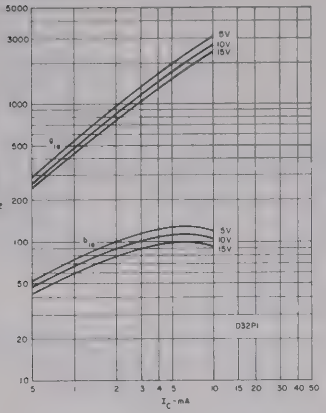
Voltages			
Collector to Emitter	V_{CEO}		30 Volts
Collector to Base	V_{CBO}		40 Volts
Emitter to Base	V_{EBO}		4 Volts
Current			
Collector	I_C		50 mA
Collector (peak, pulsed 10µS ≤ 2% duty cycle)	I_C		100 mA
Dissipation			
Total Power $T_A \leq 25°C$	P_T		0.360 Watts
Derate Factor $T_A > 25°C$			3.6 mW/°C
Temperature			
Operating	T_j	−65 to +125	°C
Storage	T_{stg}	−65 to +150	°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	+260	°C

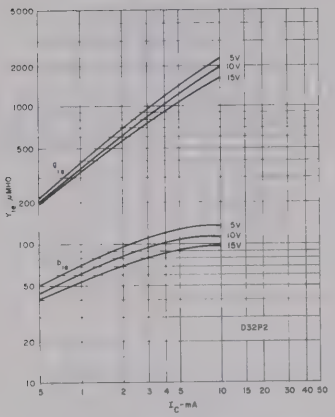
electrical characteristics: (T_A = 25°C unless otherwise specified)

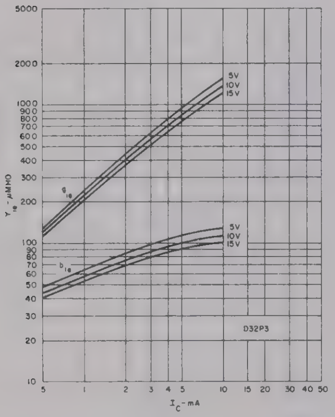
STATIC CHARACTERISTICS		SYMBOL	MIN.	MAX.	UNITS
Collector-emitter breakdown voltage (I_C = 1mA, I_B = 0)		$V_{(BR)CEO}$	30	–	Volts
Collector-base breakdown voltage (I_C = 10µA, I_E = 0)		$V_{(BR)CBO}$	40	–	Volts
Emitter-base breakdown voltage (I_E = 10µA, I_c = 0)		$V_{(BR)EBO}$	4	–	Volts
Collector Cutoff Current (V_{CE} = 25V, V_{BE} = 0)		I_{CES}	–	50	nA
Collector Cutoff Current (V_{CB} = 25V, I_E = 0)		I_{CBO}	–	50	nA
Collector Cutoff Current (V_{CB} = 25V, I_E = 0, T_A = 100°C)		I_{CBO}	–	5	µA
Emitter-base reverse current (V_{EB} = 3V, I_C = 0)		I_{EBO}	–	50	nA
Forward current transfer ratio (V_{CE} = 5V, I_C = 2mA)	D32P1	h_{FE}	40	80	
	D32P2	h_{FE}	60	120	
	D32P3	h_{FE}	100	200	
	D32P4	h_{FE}	150	300	
Collector-emitter saturation voltage (I_C = 10mA, I_B = 1mA)		$V_{CE(sat)}$	–	0.150	Volts
Base-emitter saturation voltage (I_C = 10mA, I_B = 1mA)		$V_{BE(sat)}$	–	0.850	Volts
Base-emitter voltage (V_{CE} = 5V, I_C = 2mA)		$V_{BE(on)}$	0.550	0.750	Volts
DYNAMIC CHARACTERISTICS					
Collector-Base capacitance (V_{CB} = 10V, I_e = 0, f = 1MHz)		C_{cb}	0.7	1.5	pF
Magnitude of forward current transfer ratio (V_{CE} = 10V, I_c = 1mA, f = 100MHz)	D32P1	$\lvert h_{fe} \rvert$	1.2	9.5	dB
	D32P2	$\lvert h_{fe} \rvert$	1.9	10.9	dB
	D32P3	$\lvert h_{fe} \rvert$	3.5	12	dB
	D32P4	$\lvert h_{fe} \rvert$	4.9	13.1	dB
Collector Base Time Constant (V_{CE} = 10V, I_c = 1mA, f = 31.9MHz)		$r_b'C_c$	15	60	psec

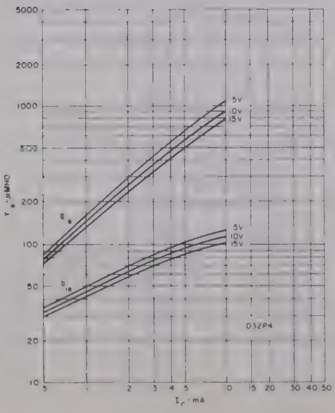
Typical 455 KHz Y Parameters

Input Admittance vs Collector Current ($T_A = 25°C$)

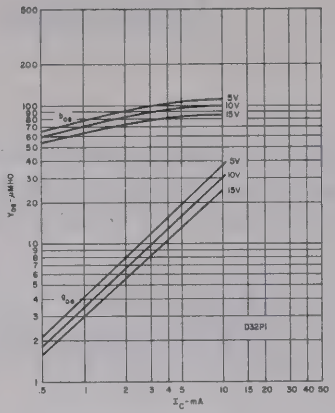


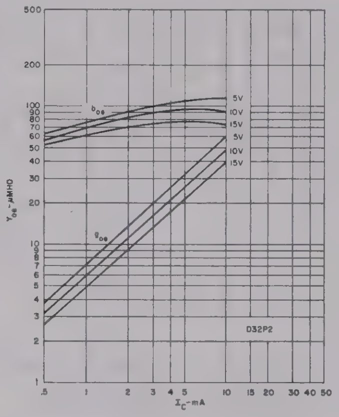


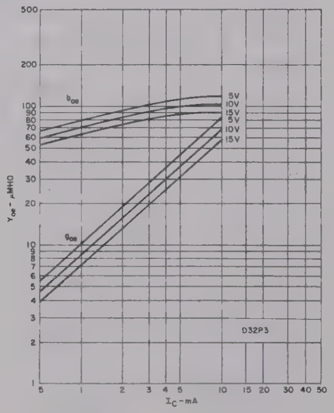


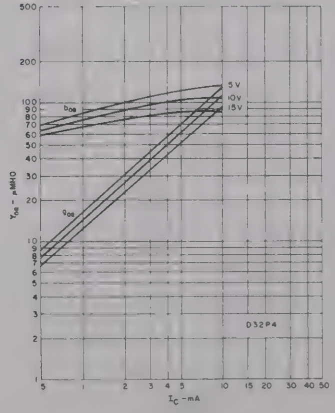


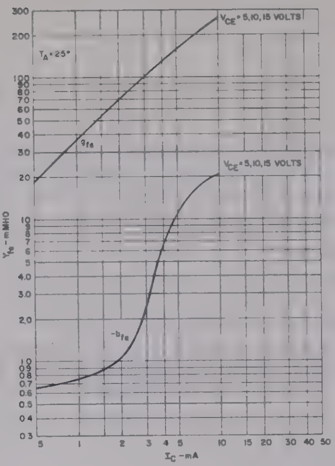
Output Admittance vs Collector Current ($T_A = 25°C$)



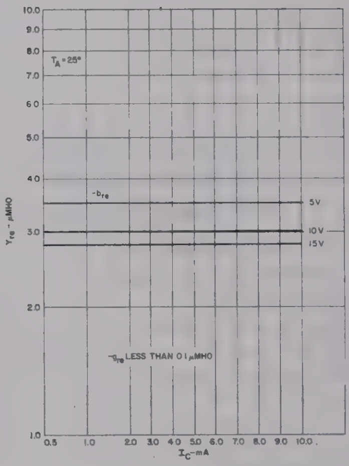








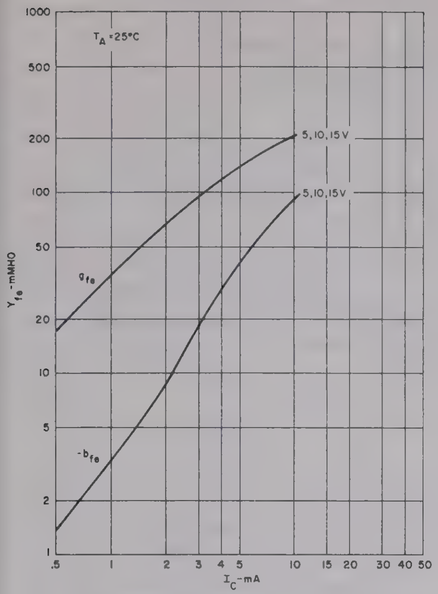
Forward Transfer Admittance vs Collector Current



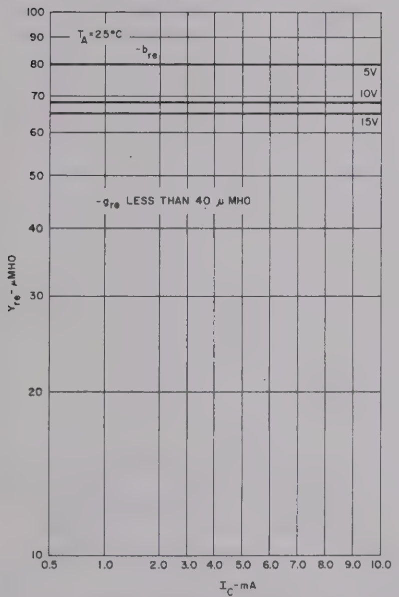
Reverse Transfer Admittance vs Collector Current

Measurements of 455 KHz Y parameters were made with the following equipment:
Generator: Tektronix Type 190 A
R.F. Bridge: Wayne Kerr Type B601
Detector: RCA Type CRV-46151
Aircraft Radio Receiver

Typical 10.7 MHz Y Parameters



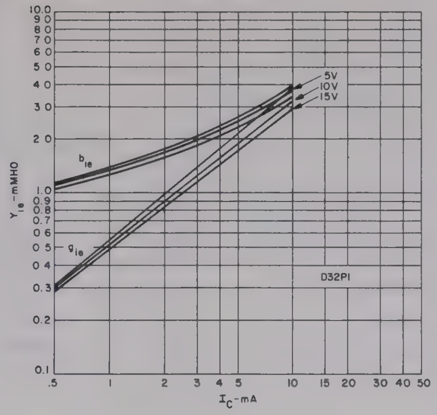
Forward Transfer Admittance vs Collector Current

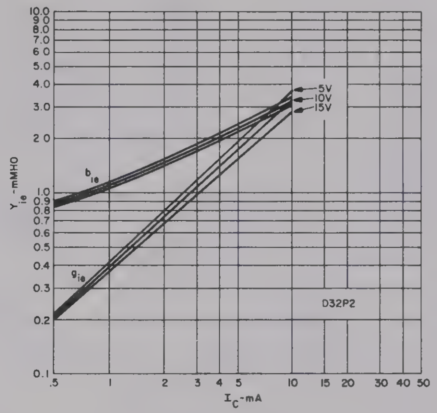


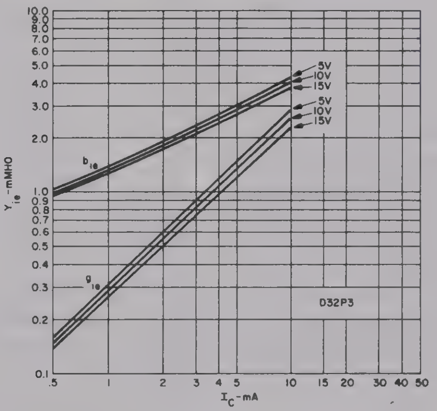
Reverse Transfer Admittance vs Collector Current

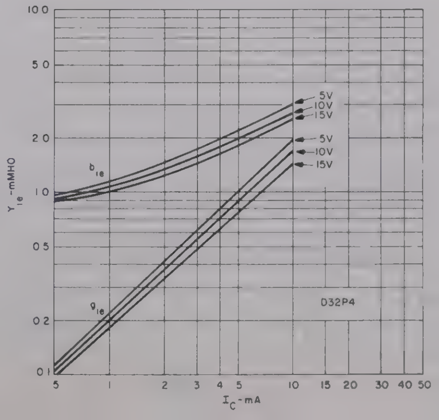
Measurements of 10.7 MHz Y parameters were made with the following equipment:
Generator: Wayne Kerr Bridge Source S161B
V.H.F. Bridge: Wayne Kerr Admittance B801
Detector: Wayne Kerr Bridge R161 and Rohde and Schwartz (tuned V.T.V.M. 10 kHz - 30 MHz) Type U.S.V.H. BN 1521 FNr.

Input Admittance vs Collector Current ($T_A = 25°C$)

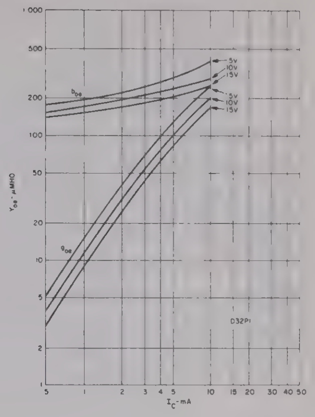


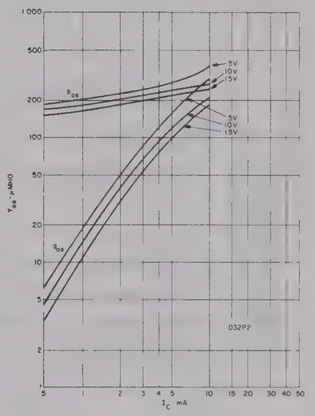


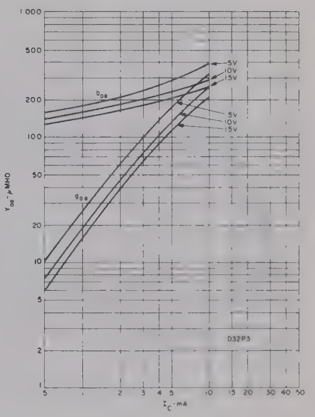


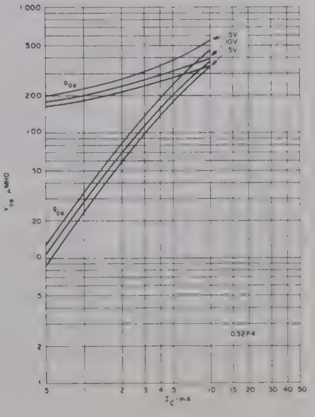


Output Admittance vs Collector Current ($T_A = 25°C$)

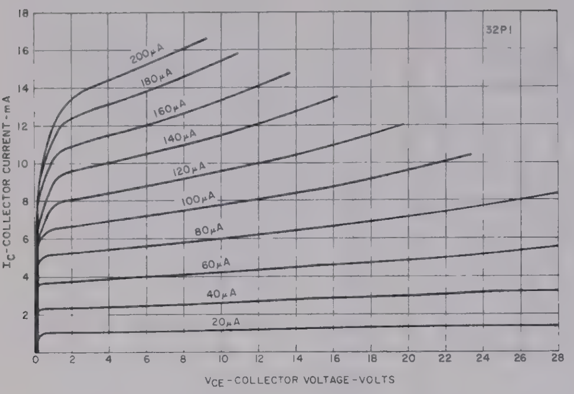


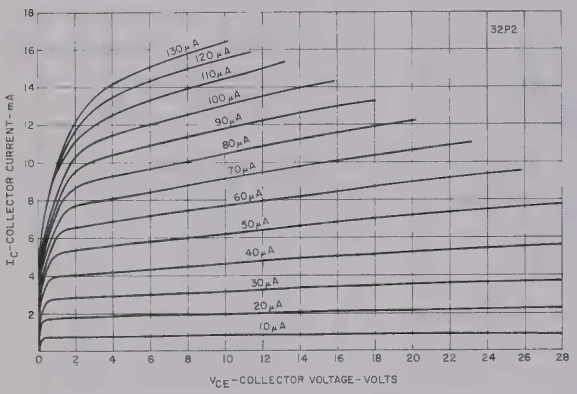


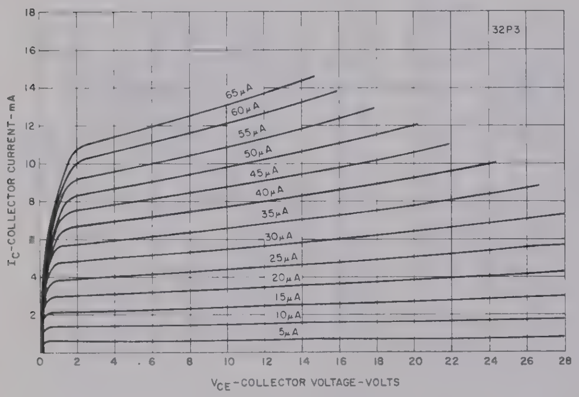


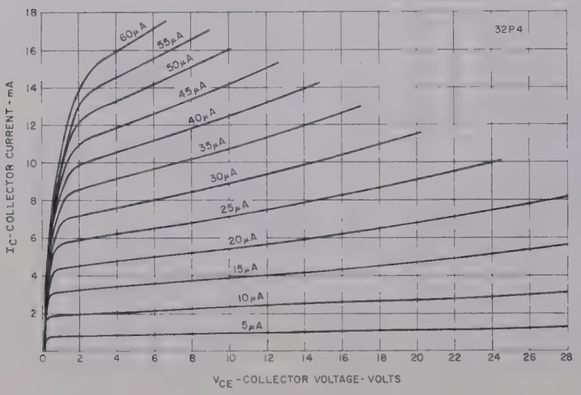


Collector Characteristics
($T_A = 25°C$)

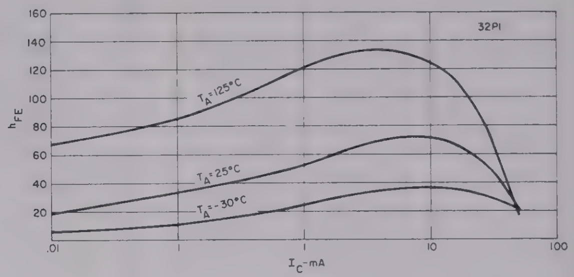


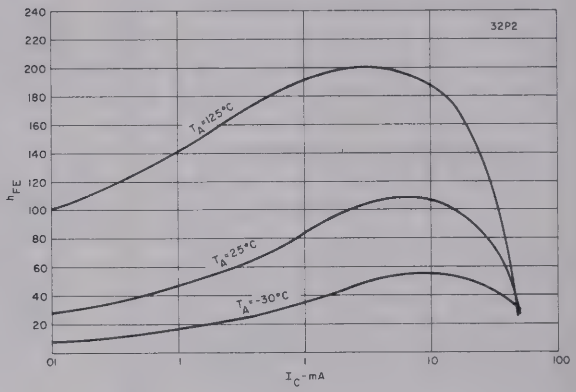


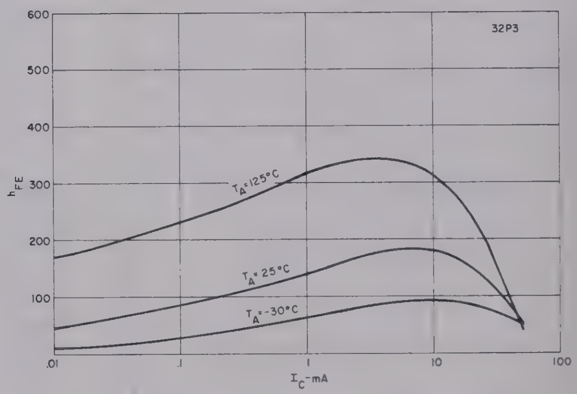


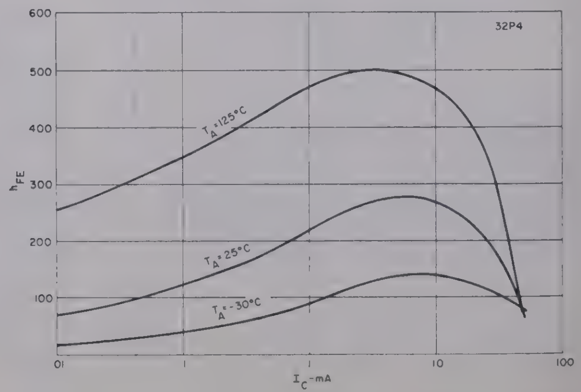


Forward Current Transfer Ratio
vs
Collector Current
($V_{CE} = 5V$)

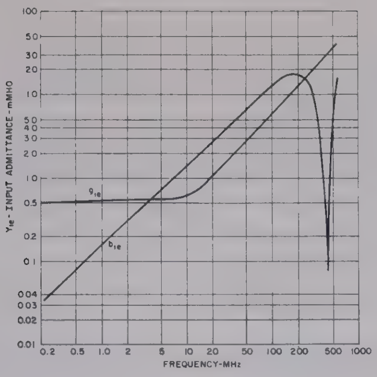


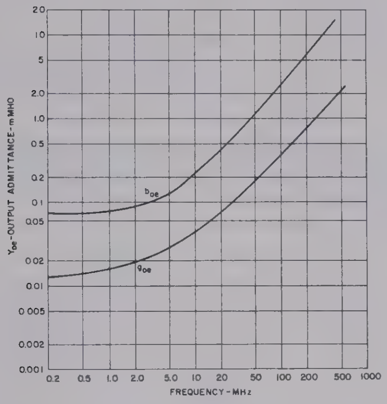


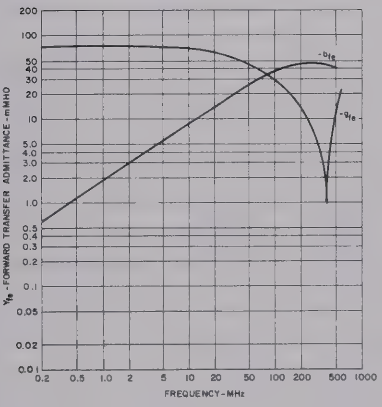


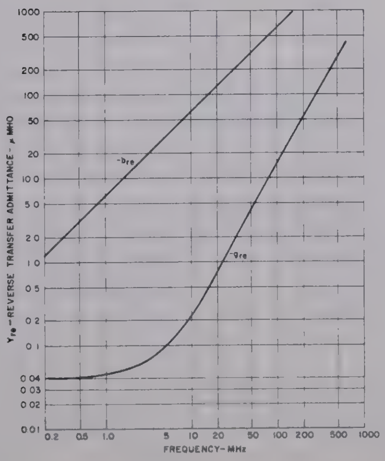


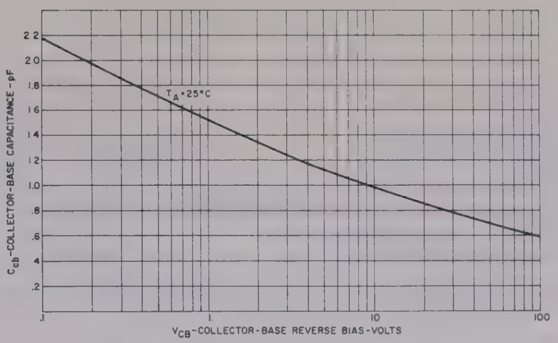
Typical Y Parameters
vs
Frequency
(V_{CE} = 10V; I_C = 2 mA; T_A = 25°C)



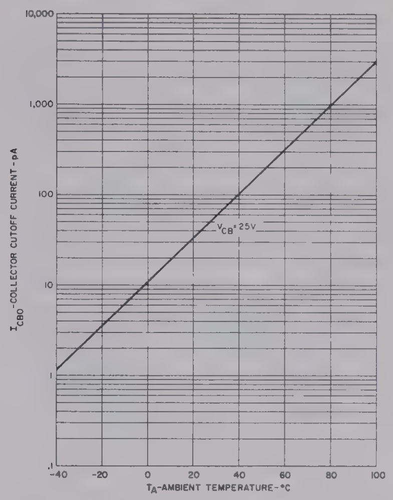




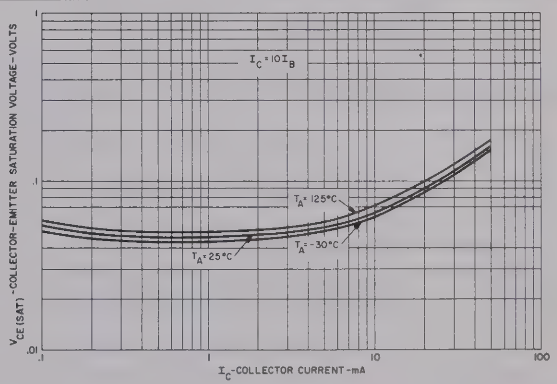




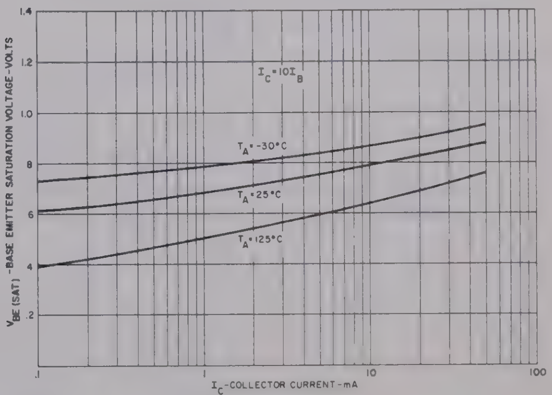
COLLECTOR-BASE CAPACITANCE VS. REVERSE BIAS VOLTAGE



COLLECTOR-BASE CUTOFF CURRENT VS. AMBIENT TEMPERATURE



COLLECTOR-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT

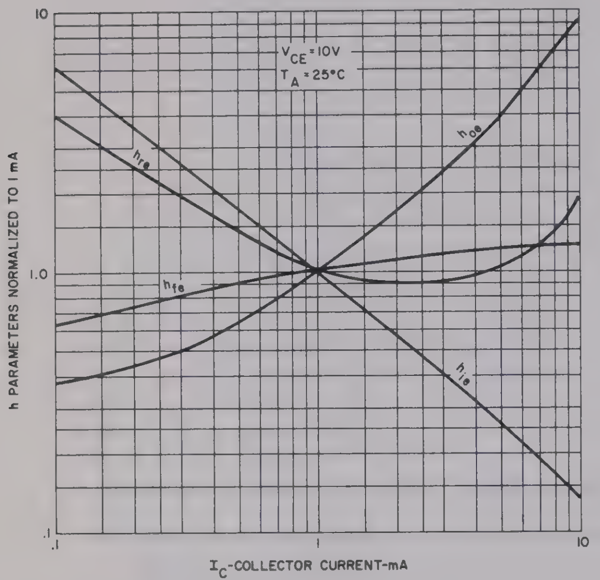


BASE-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT

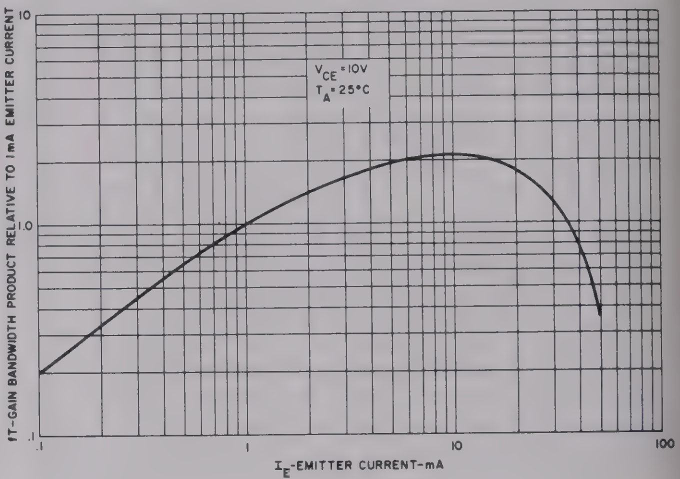
TYPICAL SMALL SIGNAL CHARACTERISTICS

f = 1 kHz, V_{CE} = 10V, I_e = 1 mA

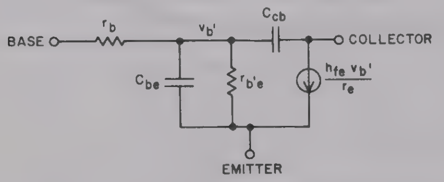
SYMBOL	CHARACTERISTIC	P1	P2	P3	P4	UNITS
h_{ie}	Input Resistance	2.0	3.0	5.0	7.5	Kohms
h_{fe}	Forward Current Transfer Ratio	65	95	160	240	
h_{oe}	Output Conductance	4.8	7.3	12	18.4	umhos
h_{re}	Reverse Voltage Feedback Ratio	1	1.6	2.7	4.1	$X10^{-4}$



		SYM.	MIN.	MAX.	UNITS
Gain bandwidth product (V_{CE} = 10V, I_c = 1mA, f = 100MHz)	D32P1	f_T	115	300	MHz
	D32P2	f_T	125	350	MHz
	D32P3	f_T	150	400	MHz
	D32P4	f_T	175	450	MHz



HYBRID π TRANSISTOR MODEL PARAMETERS



PARAMETER

r_b { LOW FREQUENCY: SEE r_b vs COLLECTOR CURRENT GRAPH
*HIGH FREQUENCY: 36Ω

$C_{be} = \frac{1}{2\pi f_T r_e}$

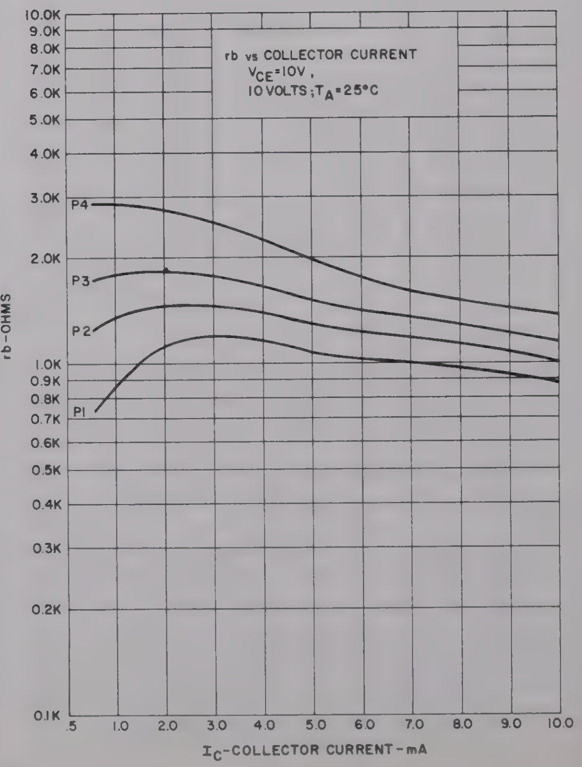
h PARAMETERS, AND f_T ARE SPECIFIED

$r_{b'e} = h_{fe} r_e$

$r_e = \frac{h_{re}}{h_{oe}}$

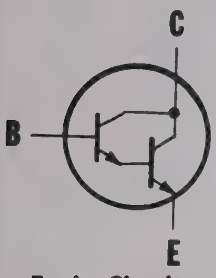
C_{cb} SEE COLLECTOR CAPACITANCE vs VOLTAGE GRAPH

* USE THIS VALUE WHEN THE $r_{b'}C_C$ TIME CONSTANT MAY BE SIGNIFICANT



Silicon Power Tab
Monolithic Transistor
Very High Gain Darlington Amplifier
"Color Molded"

NPN
D40C



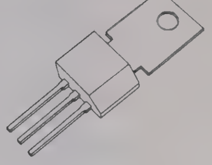
Equiv. Circuit

- h_{FE} Min.—10,000 and 40,000
- 1.33 Watt Free-Air Power Dissipation at T_A = 50°C
- Hard Solder Mountdown

TYPICAL APPLICATIONS:

Driver	Audio Output
Regulator	Relay Substitute
Touch Switch	Oscillator
I.C. Driver	Servo-Amplifier

Capacitor Multiplier



Brown

Leads Can Be Formed To A TO-5 Pin Configuration

absolute maximum ratings: (25°C unless otherwise specified)

		D40C1(1) D40C2 D40C3	D40C4 D40C5	D40C7	
Voltages					
Collector to Emitter	V_{CEO}	30	40	50	Volts
Emitter to Base	V_{EBO}	13	13	13	Volts
Collector to Emitter	V_{CES}	30	40	50	Volts
Current(2)					
Collector (Continuous)	I_C	← 0.5 →			Amps
Collector (Peak) (50% duty cycle, 25 msec. pulse width)		← 1.0 →			Amps
Power Dissipation(2)					
Tab at 25°C(3)	P_T	← 6.25 →			Watts
Tab at 70°C		← 4 →			Watts
Free Air at 50°C					
With Tab		← 1.33 →			Watts
Without Tab		← 1 →			Watts
Thermal Resistance(3)					
Junction to Case	$R\theta_{JC}$	← 20 →			°C/W
Junction to Ambient	$R\theta_{JA}$				
With Tab		← 75 →			°C/W
Without Tab		← 100 →			°C/W
Temperature(3)					
Operating	T_J	← −55 to +150 →			°C
Storage	T_{STG}	← −55 to +150 →			°C
Lead Soldering, 1/16" ± 1/32" from case for 10 sec. max.	T_L	← +260 →			°C

NOTES:

(1) The last digit is a part number which designates a voltage grade and an h_{FE} level. Tab and lead forming is specified by a letter after this digit.
(2) Please refer to the safe region of operation curves for more information.
(3) Tab temperature is measured on center of tab, 1/16" from plastic body.

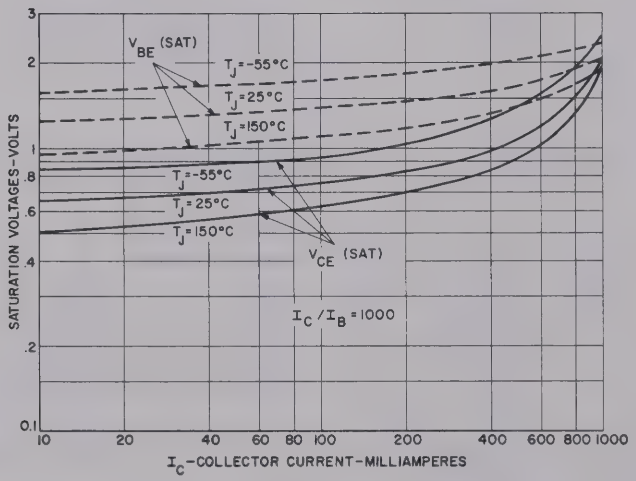
electrical characteristics: (25°C unless otherwise specified)

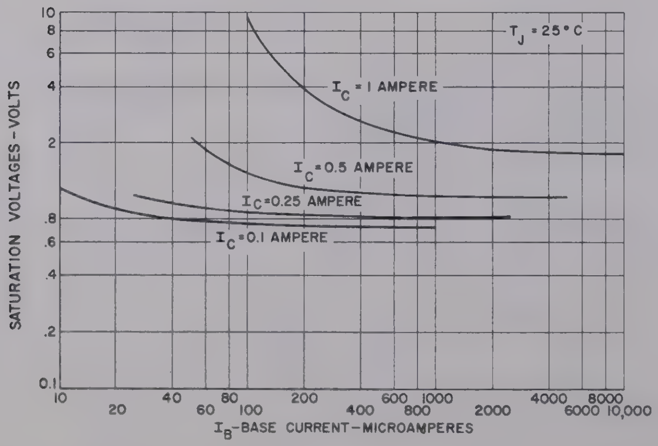
		Min.	Typ.	Max.
Forward Current Transfer Ratio				
(I_C = 200 mA, V_{CE} = 5V)	h_{FE}			
D40C1, 4, 7		10 K	–	60K
D40C2, 5		40 K	–	–
D40C3		90 K	–	–
(I_C = 20 mA, V_{CE} = 5V, f = 1 kHz)	h_{fe}			
D40C1, 4, 7		–	10 K	–
D40C2, 5		–	20 K	–
D40C3		90K	–	–

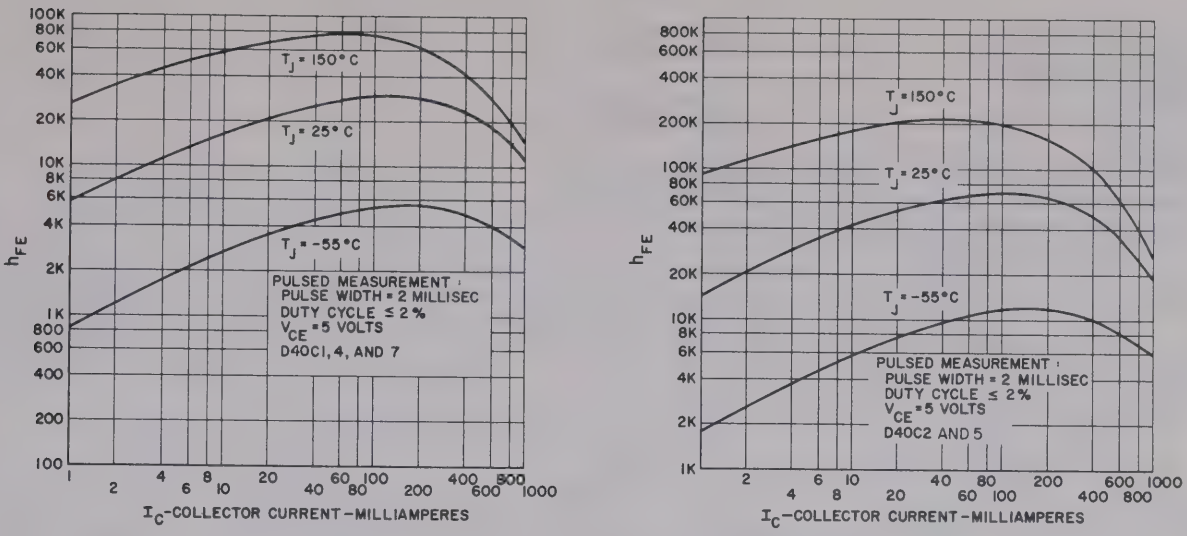
		Min.	Typ.	Max.	
Collector to Emitter Voltage					
(I_C = 10 mA)	V_{CEO}				
D40C1, 2, 3		30	–	–	Volts
D40C4, 5		40	–	–	Volts
D40C7		50	–	–	Volts
Collector Saturation Voltage(4)					
(I_C = 500 mA, I_B = 0.5 mA)	$V_{CE(SAT)}$	–	–	1.5	Volts
Base Saturation Voltage(4)					
(I_C = 500 mA, I_B = 0.5 mA)	$V_{BE(SAT)}$	–	–	2.0	Volts
Collector Cutoff Current					
(V_{CE} = Rated V_{CES}, T_J = 25°C)	I_{CES}	–	–	0.5	μA
(V_{CE} = Rated V_{CES}, T_J = 150°C)	I_{CBO}	–	–	20	μA
Emitter Cutoff Current					
(V_{EB} = 13V)	I_{EBO}	–	–	0.1	μA
Input Impedance					
(I_C = 20 mA, V_{CE} = 5V, f = 1 kHz)	h_{ie}	50	500	–	Ohms
Collector Capacitance					
(V_{CB} = 10V, f = 1 MHz)	C_{CBO}	–	5	10	pF
Gain Bandwidth Product					
(V_{CE} = 5V, I_C = 20 mA)	f_T	–	75	–	MHz
Switching Times					
Delay Time and Rise Time					
(I_C = 1A, I_{B1} = 1 mA)	$t_d + t_r$	–	100	–	nsec
Storage Time					
(I_C = 1A, I_{B1} = I_{B2} = 1 mA)	t_s	–	350	–	nsec
Fall Time					
(I_C = 1A, I_{B1} = I_{B2} = 1 mA)	t_f	–	800	–	nsec

NOTE:

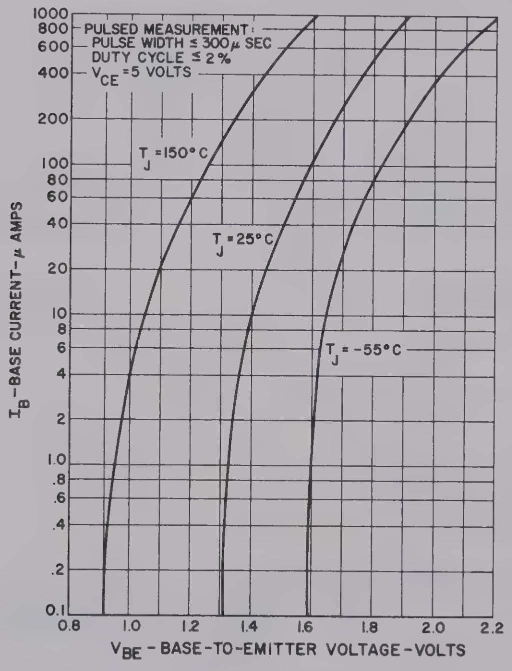
(4) Pulsed measurement, 300 μsec pulse width, duty cycle ≦ 2%.



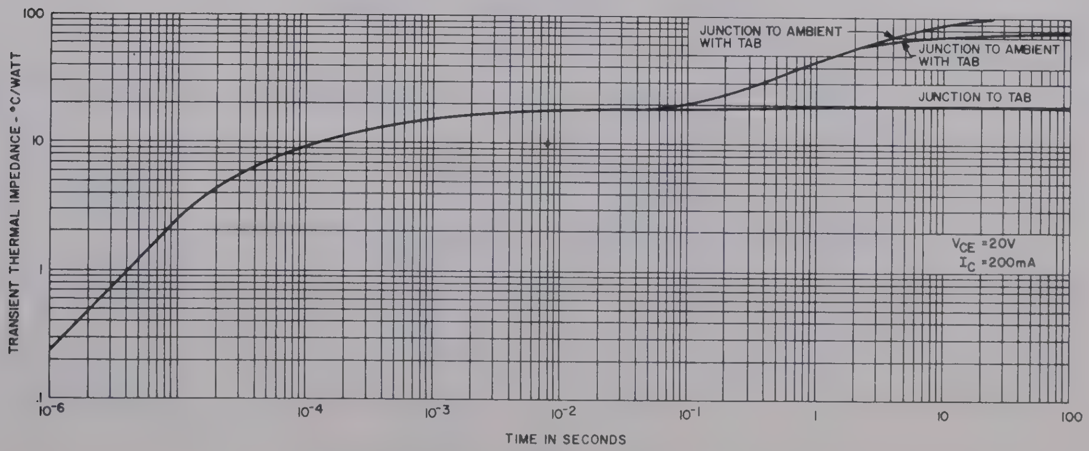




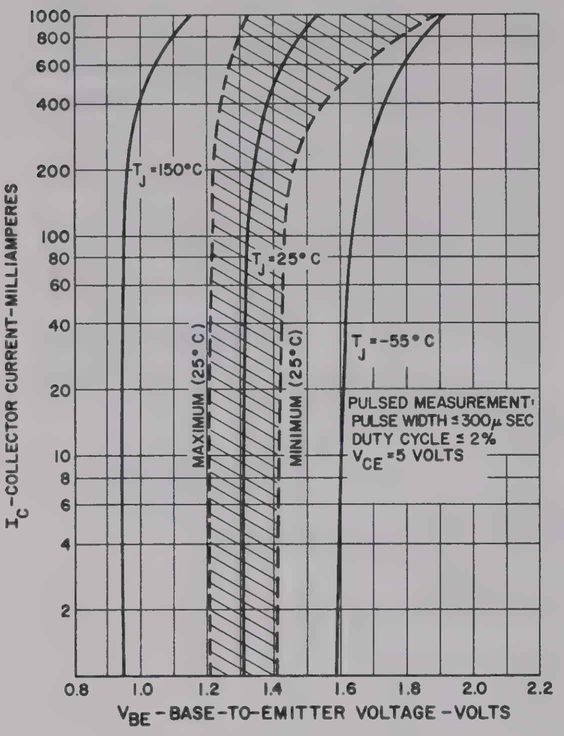
TYPICAL h_{FE} vs. I_C



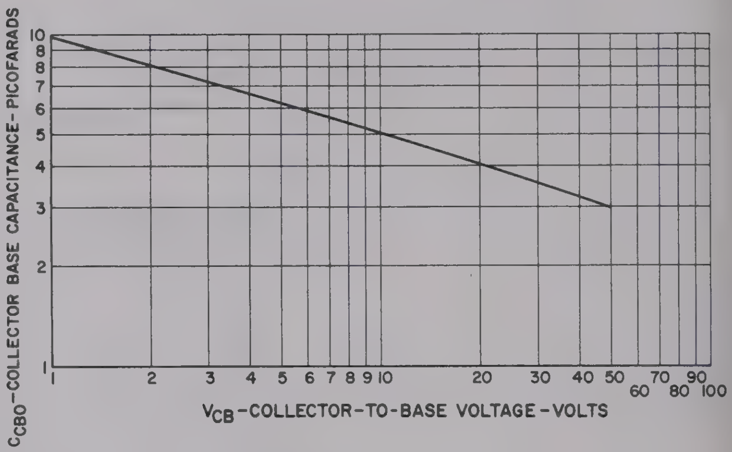
TYPICAL INPUT CHARACTERISTICS



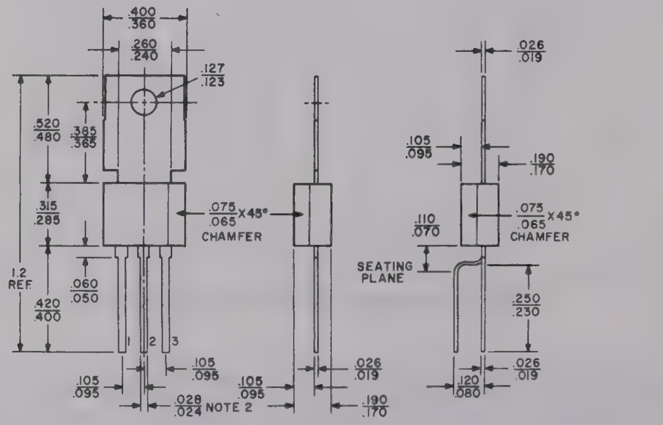
MAXIMUM TRANSIENT THERMAL IMPEDANCE



TYPICAL TRANSCONDUCTANCE CHARACTERISTICS



TYPICAL C_{CBO} vs. VOLTAGE



.400 / .360
.260 / .240
.127 / .123
.520 / .480
.395 / .365
.315 / .285
.075 / .065 X45°
CHAMFER
1.2 REF.
.060 / .050
.420 / .400
1
2
3
.105 / .095
.105 / .095
.028 / .024 NOTE 2
.105 / .095
.026 / .019
.190 / .170
.026 / .019
.105 / .095
.190 / .170
.110 / .070
.075 / .065 X45°
CHAMFER
SEATING PLANE
.250 / .230
.120 / .080
.026 / .019

TYPE U
LEAD LABELS
1. EMITTER
2. BASE
3. COLLECTOR

NOTES:
1. ALL DIM. ARE IN INCHES AND ARE REF. UNLESS TOLERANCED.
2. .043-.057 LEAD WIDTH WITHIN 0.100 OF BODY.

TYPE U
FITS TO-5 PRINTED CIRCUIT BOARD MOUNTING CONFIGURATION

DIMENSIONAL OUTLINES

FOR OPTIONAL LEAD CONFIGURATIONS SEE SELECTOR GUIDE P. 117

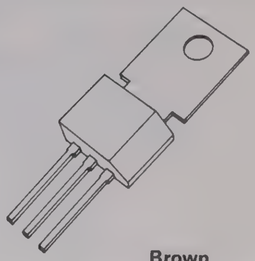
Silicon
Power Tab
Transistors
"COLOR MOLDED"

NPN

D40D

The General Electric D40D is a brown, silicone plastic encapsulated, power transistor designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1.0 MHz; series, shunt and switching regulators; low and high frequency inverters/converters; and many others.

FEATURING:
- High free-air power dissipation
- NPN complement to D41D PNP
- Brown for NPN, black for PNP
- Low collector saturation voltage (0.5V typ. @ 1.0A I_C)
- Excellent linearity
- Fast switching
- Hard solder mount down



Brown
Leads Can Be Formed To A TO-5 Pin Configuration

absolute maximum ratings: (25°C) (unless otherwise specified)

<table>
<tr><th></th><th></th><th>D40D1[1]
D40D2
D40D3</th><th>D40D4
D40D5</th><th>D40D7
D40D8</th><th>D40D10
D40D11</th><th></th></tr>
<tr><td>Voltages</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Collector to Emitter</td><td>V_{CEO}</td><td>30</td><td>45</td><td>60</td><td>75</td><td>Volts</td></tr>
<tr><td>Emitter to Base</td><td>V_{EBO}</td><td>5</td><td>5</td><td>5</td><td>5</td><td>Volts</td></tr>
<tr><td>Collector to Emitter</td><td>V_{CES}</td><td>45</td><td>60</td><td>75</td><td>90</td><td>Volts</td></tr>
<tr><td>Current[2]</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Collector (Continuous)</td><td>I_c</td><td colspan="4">← 1 →</td><td>Amps</td></tr>
<tr><td>Collector (Peak)</td><td></td><td colspan="4">← 1.5 →</td><td>Amps</td></tr>
<tr><td>Power Dissipation[2]</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Tab at 25°C</td><td>P_T</td><td colspan="4">← 6.25 →</td><td>Watts</td></tr>
<tr><td>Tab at 70°C</td><td></td><td colspan="4">← 4 →</td><td>Watts</td></tr>
<tr><td>Free Air at 50°C</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>With Tab</td><td></td><td colspan="4">← 1.33 →</td><td>Watts</td></tr>
<tr><td>Without Tab</td><td></td><td colspan="4">← 1.0 →</td><td>Watts</td></tr>
<tr><td>Thermal Resistance[3]</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Junction to Case</td><td>$R_{\theta JC}$</td><td colspan="4">← 20 →</td><td>°C/W</td></tr>
<tr><td>Junction to Ambient</td><td>$R_{\theta JA}$</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>With Tab</td><td></td><td colspan="4">← 75 →</td><td>°C/W</td></tr>
<tr><td>Without Tab</td><td></td><td colspan="4">← 100 →</td><td>°C/W</td></tr>
<tr><td>Temperature[3]</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Operating</td><td>T_J</td><td colspan="4">← −55 to +150 →</td><td>°C</td></tr>
<tr><td>Storage</td><td>T_{STG}</td><td colspan="4">← −55 to +150 →</td><td>°C</td></tr>
<tr><td>Lead Soldering, 1/16" ± 1/32" from case for 10 sec max</td><td>T_L</td><td colspan="4">+260</td><td>°C</td></tr>
</table>

NOTES:

[1] The last digit is a part number which designates a voltage grade and an h_{FE} level. Tab and lead forming is specified by a letter after this digit.

[2] Please refer to the safe region of operation curves for more information.

[3] Tab temperature is measured on center of tab, 1/16" from plastic body.

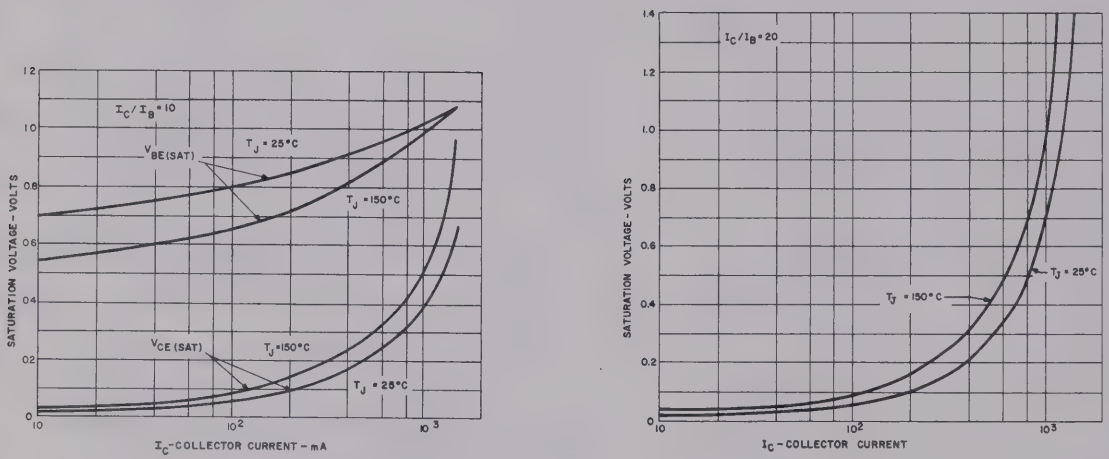
electrical characteristics: (25°C) (unless otherwise specified)

		D40D1 D40D4 D40D7 D40D10		D40D2		D40D3		D40D5 D40D8 D40D11	
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Forward Current Transfer Ratio									
(V_{CE} = 2 V, I_c = 100 mA)	h_{FE}	50	150	120	360	290	–	120	360
(V_{CE} = 2 V, I_c = 1 A)	h_{FE}	10	–	20	–	10	–	10	–

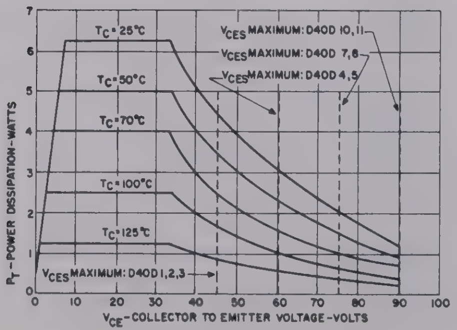
		Min.	Typ.	Max.	
Collector to Emitter Voltage					
(I_c = 10 mA) D40D1, 2, 3	V_{CEO}	30	–	–	Volts
D40D4, 5	V_{CEO}	45	–	–	Volts
D40D7, 8	V_{CEO}	60	–	–	Volts
D40D10, 11	V_{CEO}	75	–	–	Volts
Collector Saturation Voltage					
(I_c = 500 mA, I_B = 50 mA)					
D40D1, 2, 4, 5	$V_{CE(SAT)}$	–	–	0.5	Volts
D40D7, 8, 10, 11	$V_{CE(SAT)}$	–	–	1.0	Volts
Base Saturation Voltage					
(I_c = 500 mA, I_B = 50 mA)	$V_{BE(SAT)}$			1.5	Volts

		MIN.	TYP.	MAX.	
Collector Cutoff Current					
(V_{CE} = Rated V_{CES})	I_{CES}	–	–	0.1	μA
(V_{CE} = Rated V_{CES}, T_J = 150°C)		–	1	–	μA
(V_{CE} = Rated V_{CEO})	I_{CEO}	–	1	–	μA
(V_{CE} = Rated V_{CEO}, T_J = 150°C)		–	50	–	μA
Emitter Cutoff Current					
(V_{EB} = 5 V)	I_{EBO}	–	–	0.1	μA
Collector Capacitance					
(V_{CB} = 10 V, f = 1 MHz	C_{CBO}	–	8	–	pF
Gain Bandwidth Product					
(V_{CE} = 10 V, I_c = 20 mA)	f_T	–	200	–	MHz
Switching Times					
Delay Time and Rise Time					
(I_c = 1 A, I_{B1} = 0.1 A)	$t_d + t_r$	–	25	–	nsec
Storage Time					
(I_c = 1 A, I_{B1} = I_{B2} = 0.1 A)	t_s	–	200	–	nsec
Fall Time					
(I_c = 1 A, I_{B1} = I_{B2} = 0.1 A)	t_f	–	50	–	nsec

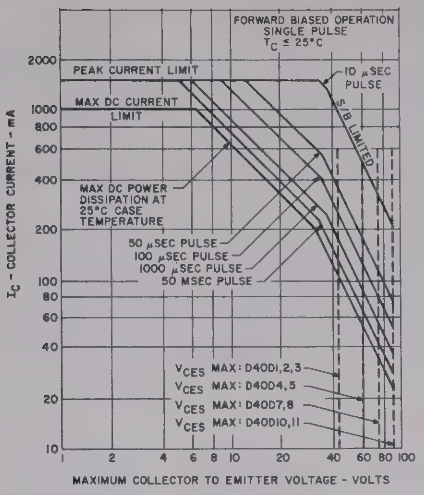
TYPICAL SATURATION VOLTAGE CHARACTERISTICS

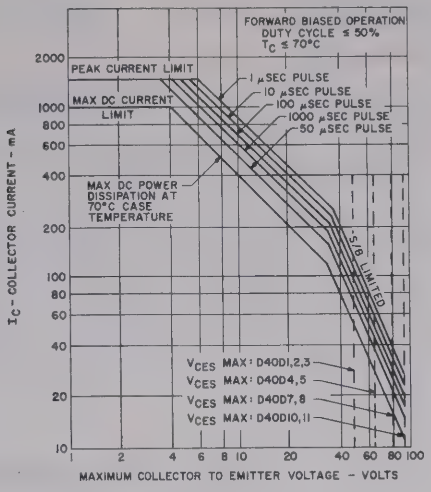


MAXIMUM PERMISSIBLE DC POWER DISSIPATION

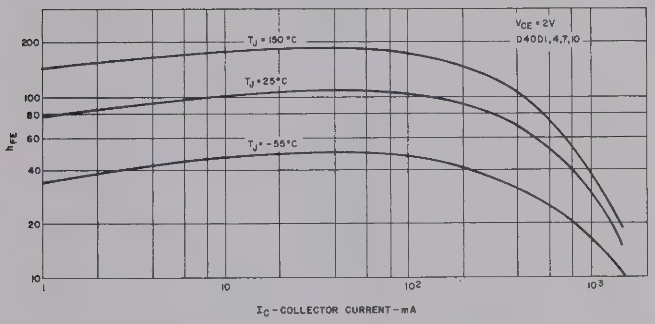


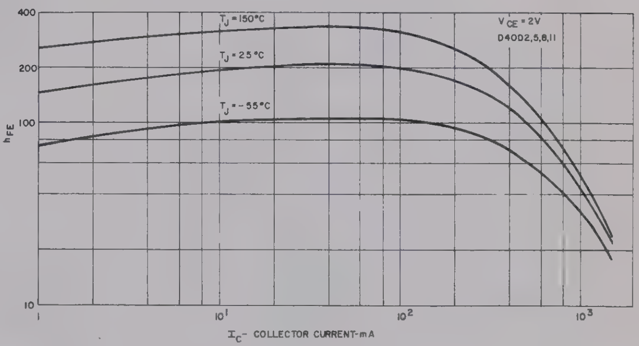
SAFE REGION OF OPERATION



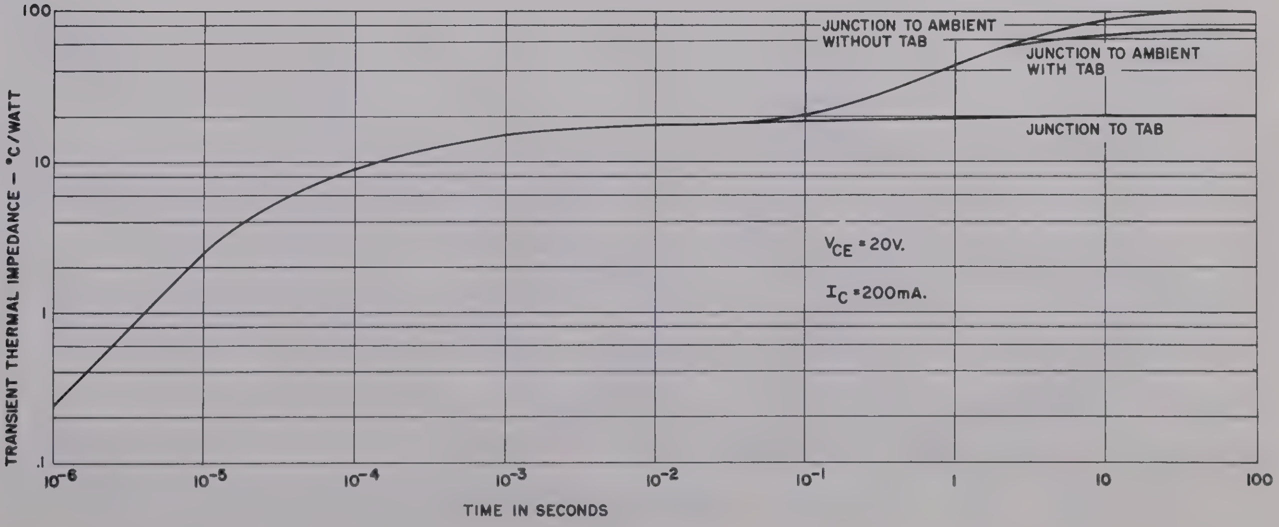


TYPICAL H_{FE} VS I_C

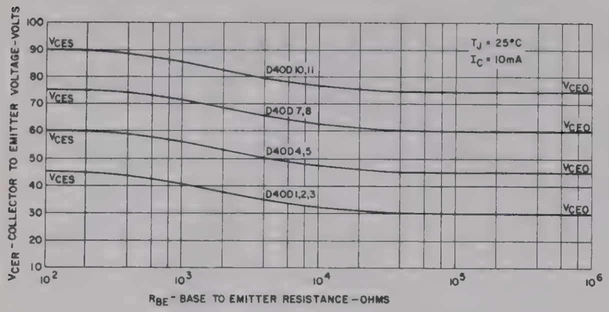




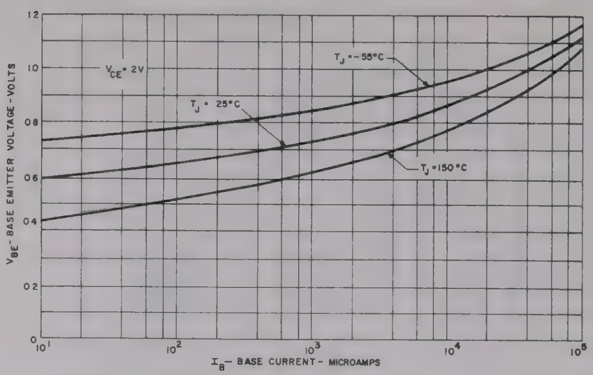
MAXIMUM TRANSIENT THERMAL IMPEDANCE



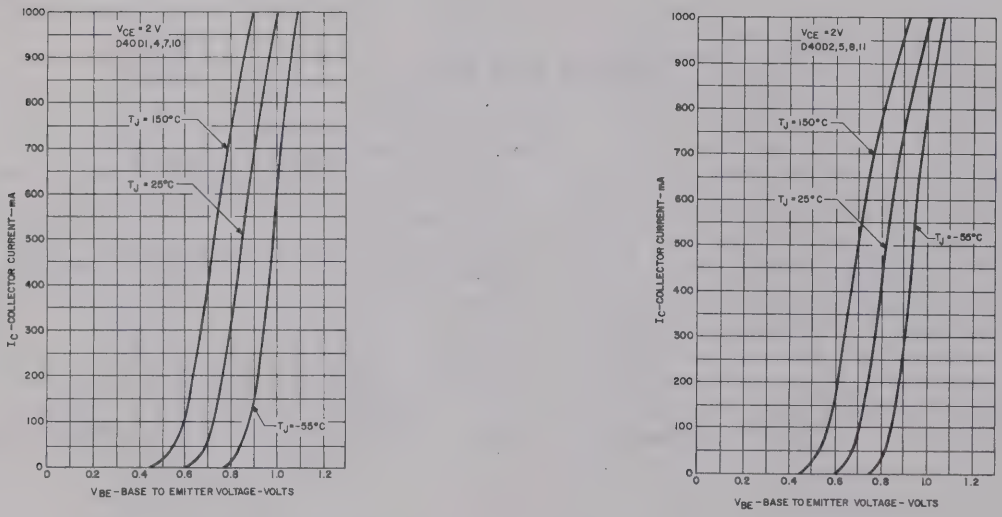
TYPICAL V_{CER}

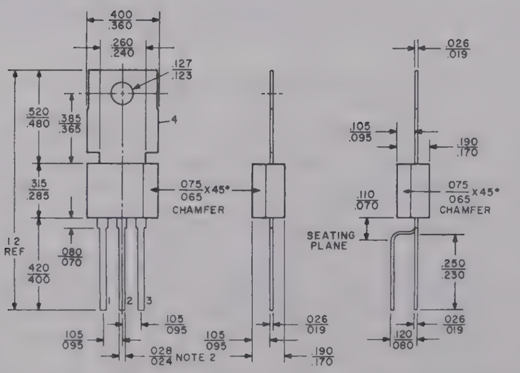


TYPICAL INPUT CHARACTERISTICS



TYPICAL TRANSCONDUCTANCE CHARACTERISTICS




.400
.360
.260
.240
.127
.123
4
.520
.480
.385
.365
.315
.285
.075
.065
X45°
CHAMFER
1.2
REF
.080
.070
.420
.400
1
2
3
.105
.095
.105
.095
.028
.024
NOTE 2
.105
.095
.026
.019
.190
.170
.026
.019
.105
.095
.190
.170
.110
.070
.075
.065
X45°
CHAMFER
SEATING PLANE
.250
.230
.120
.080
.026
.019

LEAD LABELS
1. EMITTER
2. BASE
3. COLLECTOR

NOTES:
1. ALL DIM. ARE IN INCHES AND ARE REF. UNLESS TOLERANCED.
2. .043-.057 LEAD WIDTH WITHIN 0.100 OF BODY

TYPE U
FITS TO-5 PRINTED CIRCUIT BOARD MOUNTING CONFIGURATION

FOR OPTIONAL LEAD CONFIGURATIONS SEE SELECTOR GUIDE P. 117

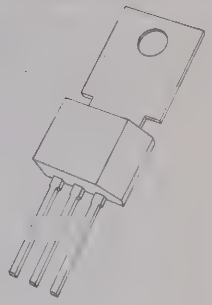
Silicon Power Tab Transistors

High Voltage Video Output Transistor

NPN

D40N

The D40N is a silicone plastic encapsulated power transistor for TV video and color output stages. Other TV and general applications include: (1) Drive for the TV horizontal sweep tube; (2) Audio output stage for portable TV sets; (3) High-voltage transistor regulator; (4) Video display drivers for oscilloscopes, electroluminescent displays and desk calculators; (5) High-voltage general usage.



Brown Silicone
Leads Can Be Formed
To A TO-5 Pin Configuration

FEATURING:

- ***POWER-GLAS*** passivation
- Low C_{CB} (2.0 pf typ. @ V_{CB} = 20V)
- Gain rated at 3 collector currents

absolute maximum ratings: (25°C) (unless otherwise specified)

		D40N1(1) D40N2		D40N3 D40N4	
Voltages(2) (4)					
Collector to Emitter	V_{CER}	250		300	Volts
Emitter to Base	V_{EBO}	5		5	Volts
Current					
Collector (Continuous)	I_C	←	0.1	→	Amps
Power Dissipation					
Tab at 25°C(3)	P_T	←	6.25	→	Watts
Tab at 70°C		←	4	→	Watts
Free Air at 50°C		←	1.33	→	Watts
Free Air at 50°C (Without Tab)		←	1	→	Watts
Thermal Resistance(3)					
Junction to Case	$R\theta_{JC}$	←	20	→	°C/W
Junction to Ambient	$R\theta_{JA}$				
With Tab		←	75	→	°C/W
Without Tab		←	100	→	°C/W
Temperature(3)					
Storage	T_{STG}	←	–55 to +150	→	°C
Operating	T_J	←	–55 to +150	→	°C
Lead Soldering, 1/16" ± 1/32" from case for 10 seconds max.	T_L	←	+260	→	°C

NOTES:

(1) The last digit is a part number which designates a voltage grade. Tab and lead forming is specified by a letter after this digit.
(2) Test conditions: I_C = 1.0 mA, R_{BE} = 10 kΩ.
(3) Tab temperature is measured on center of tab, 1/16" from plastic body.
(4) Pulsed measurement, 300 μsec pulse width, duty cycle ≤ 2%.

electrical characteristics: (25°C) (unless otherwise specified)

		D40N1 D40N3		D40N2 D40N4	
		Min.	Max.	Min.	Max.
Forward Current Ratio					
(V_{CE} = 10V, I_C = 4 mA)	h_{FE}	20	–	30	–
(V_{CE} = 10V, I_C = 20 mA)	h_{FE}	30	90	60	180
(V_{CE} = 10V, I_C = 40 mA)	h_{FE}	20	–	30	–

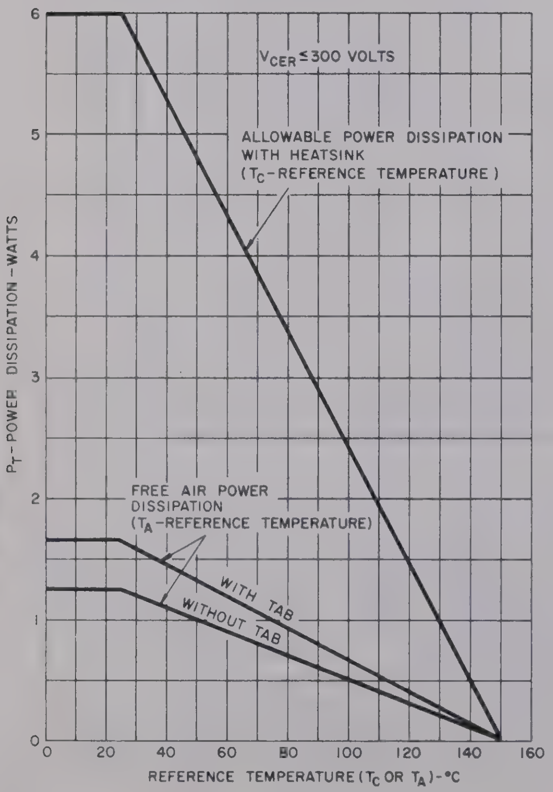
ELECTRICAL CHARACTERISTICS (Continued)

		Min.	Typ.	Max.	
Collector to Emitter Voltage[4]					
(I_{CE} = 1.0 mA, Base to Emitter R = 10 kΩ)	V_{CER}				
D40N1, 2		250	–	–	Volts
D40N3, 4		300	–	–	Volts
Collector Cutoff Current					
(V_{CB} = 300V, T_J = 25°C) D40N3, 4	I_{CBO}	–	0.1	10	μA
(V_{CB} = 250V, T_J = 25°C) D40N1, 2		–	0.1	10	μA
(V_{CB} = 250V, T_J = 150°C)		–	5	–	μA
Emitter Cutoff Current					
(V_{EB} = 5V)	I_{EBO}	–	–	10	μA
Collector Capacitance					
(V_{CB} = 20V, I_E = 0, f = 1MHz)	C_{CB}	–	–	3	pF
Gain Bandwidth Product					
(I_C = 20 mA, V_{CE} = 10V)	f_T	50	80	–	MHz
(I_C = 20 mA, V_{CE} = 20V)		75	95	–	MHz

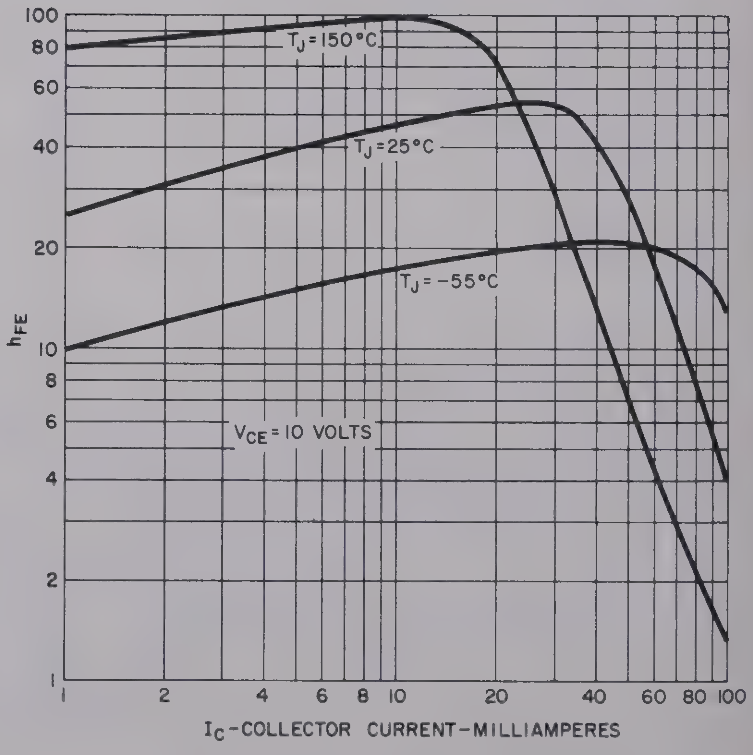
NOTE:

(4) Pulsed measurement, 300 μsec pulse width, duty cycle ≤ 2%.

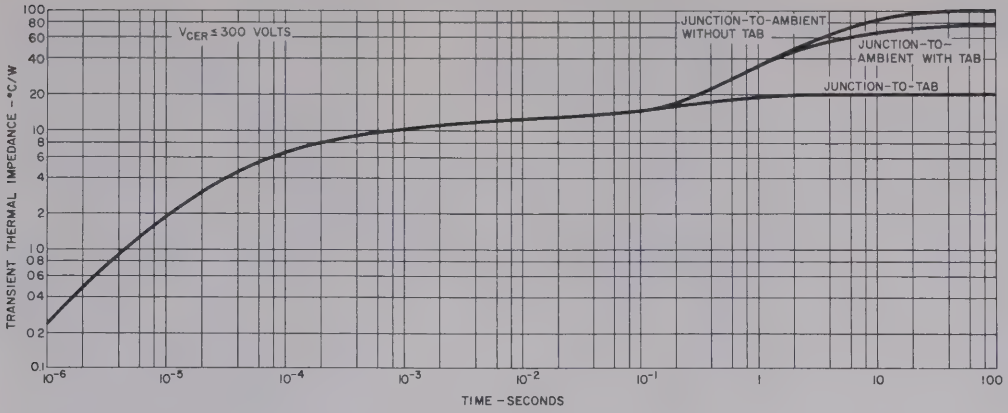
MAXIMUM PERMISSIBLE DC POWER DISSIPATION



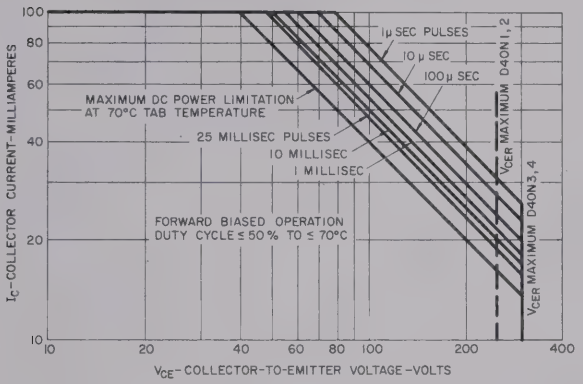
TYPICAL H_{FE} VS. I_C



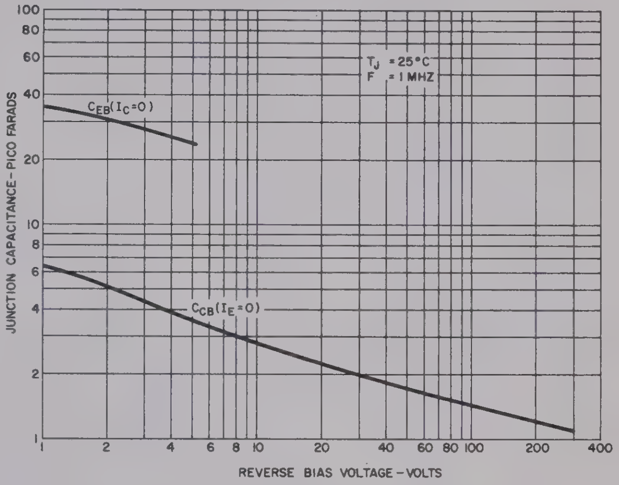
MAXIMUM TRANSIENT THERMAL IMPEDANCE



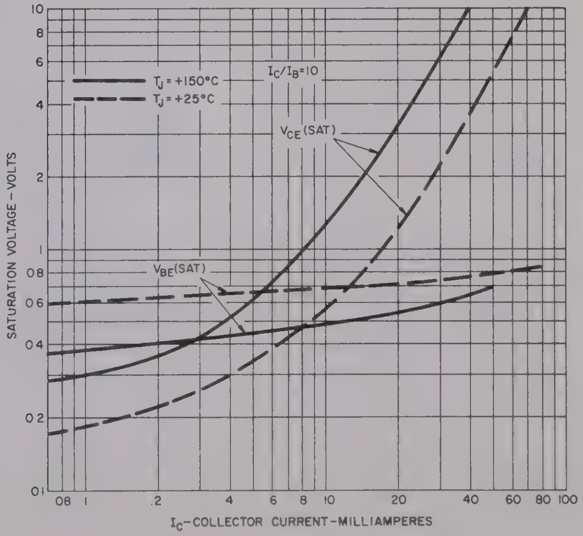
SAFE REGION OF OPERATION



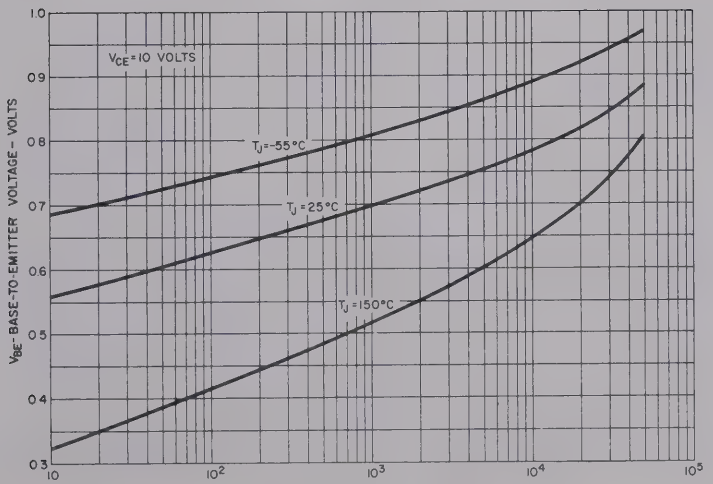
JUNCTION CAPACITANCE VS. REVERSE BIAS VOLTAGE



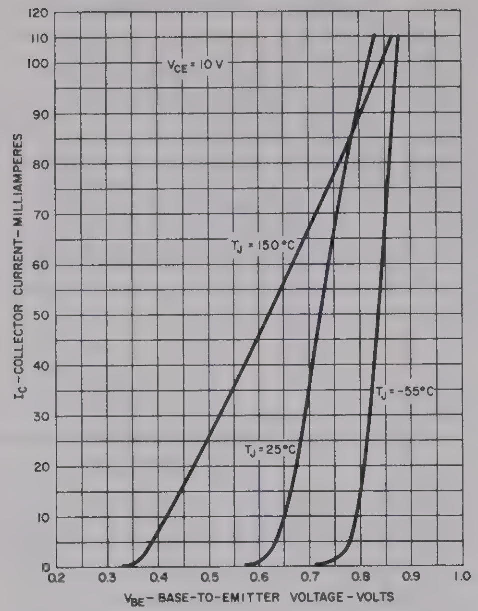
SATURATION VOLTAGE CHARACTERISTICS



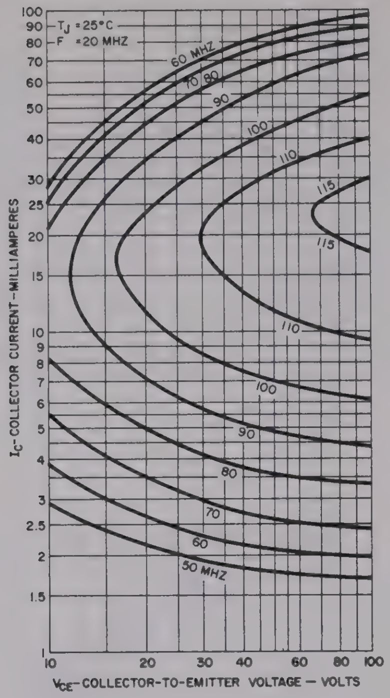
INPUT CHARACTERISTICS



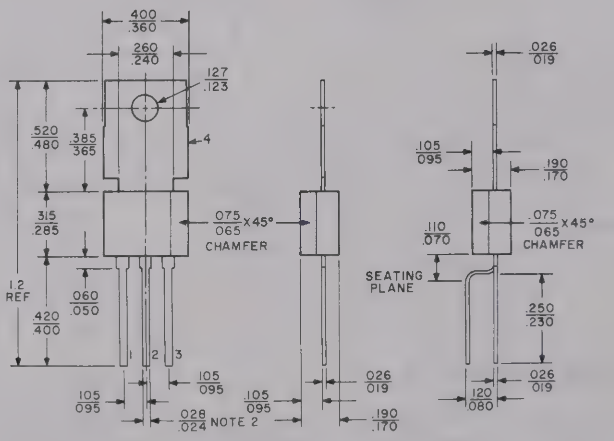
TYPICAL TRANSCONDUCTANCE CHARACTERISTICS



CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT



DIMENSIONAL OUTLINES



.400/.360
.260/.240
.127/.123
.520/.480
.385/.365
4
.315/.285
.075/.065 X45° CHAMFER
1.2 REF
.060/.050
.420/.400
1
2
3
.105/.095
.105/.095
.028/.024 NOTE 2
.105/.095
.026/.019
.190/.170
.026/.019
.105/.095
.190/.170
.110/.070
.075/.065 X45° CHAMFER
SEATING PLANE
.250/.230
.026/.019
.120/.080

TYPE U
LEAD LABELS
1 EMITTER
2 BASE
3 COLLECTOR
4 MOUNTING TAB
(electrically common to collector)

NOTES
1. ALL DIM ARE IN INCHES AND ARE REF UNLESS TOLERANCED.
2. .043-.057 LEAD WIDTH WITHIN 0.100 OF BODY

TYPE U
FITS TO-5 PRINTED CIRCUIT BOARD MOUNTING CONFIGURATION

FOR OPTIONAL LEAD CONFIGURATIONS SEE SELECTOR GUIDE P. 117

Silicon
Power Tab
Transistor

D40P

The D40P is a brown silicone encapsulated glass passivated power transistor designed for various specific and general purpose applications such as: series, shunt and switching regulators, high frequency invertors, and display tube and TV deflection circuitry.

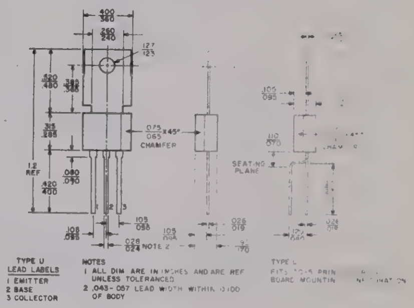
Brown Silicon

FEATURING:
- ***POWER-GLAS*** Passivation
- High Free Air Power Dissipation
- Hard Solder Mountdown
- Fast Switching
- Brown for NPN

absolute maximum ratings: (25°C unless otherwise specified)

		D40P1	D40P3	D40P5	
Voltages					
Collector to Emitter	V_{CEO}	120	180	225	Volts
Emitter to Base	V_{EBO}	7	7	7	Volts
Collector to Base	V_{CBO}	200	250	300	Volts
Current					
Collector (Continous)	I_c		0.5		Amp.
Power Dissipation					
Tab at 25°C	P_T	← 6.25 →			Watts
Tab at 70°C		← 4.0 →			Watts
Free Air at 50°C		← 1.33 →			Watts
Free Air at 50°C (without tab)		← 1.0 →			Watts
Thermal Impedance					
Junction to Case	$R\theta_{JC}$		20		°C/W
Junction to Ambient	$R\theta_{JA}$				
(with tab)		← 75 →			°C/W
(without tab)		← 100 →			°C/W
Temperature					
Operating	T_j		−55 to +150		°C
Storage	T_{stg}		−55 to +150		°C
Lead Soldering, 1/16" ± 1/32" From case for 10 sec. max.	T_L		260		°C

Leads can be formed to a TO-5 Pin Configuration.

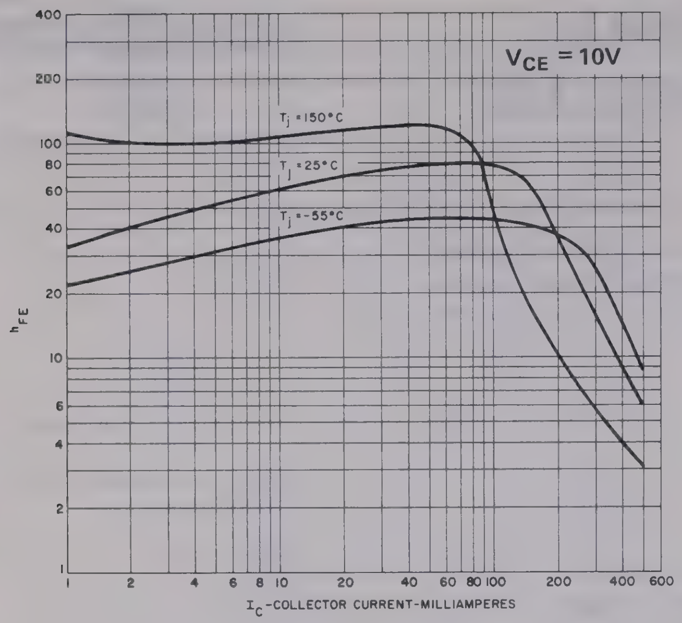

.400
.360
.260
.240
.127
.123
.420
.480
.315
.285
1.2 REF
.080
.090
.420
.400
.075
.065 x45°
CHAMFER
.105
.095
.110
.070
SEATING PLANE
.105
.095
.108
.095
.028
.024 NOTE 2
.026
.019
1
2
3
TYPE U
LEAD LABELS
1 EMITTER
2 BASE
3 COLLECTOR
NOTES
1 ALL DIM ARE IN INCHES AND ARE REF UNLESS TOLERANCED
2 .043-.067 LEAD WIDTH WITHIN 0.100 OF BODY
TYPE L

An insulating hardware kit (mica washer, nylon shoulder washer, and solder lug) is available at an additional cost upon request. Kit #138B8189P11.

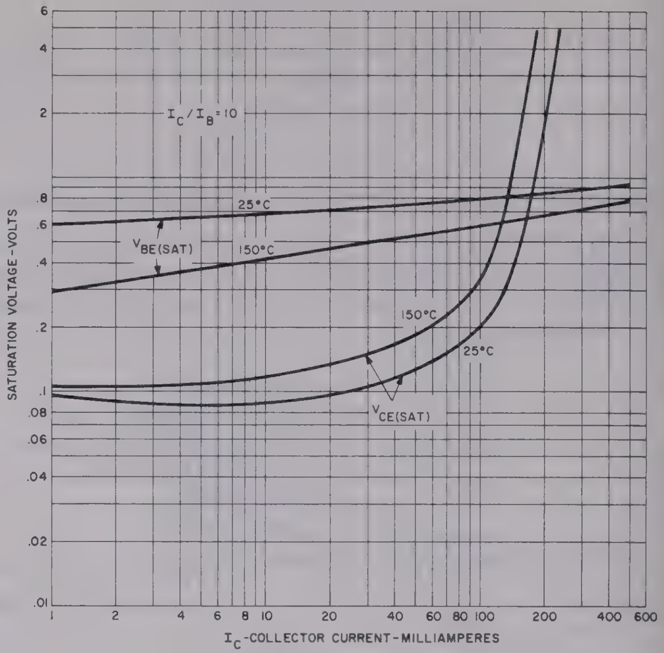
Dimensional Outlines

electrical characteristics: (25°C unless otherwise specified)

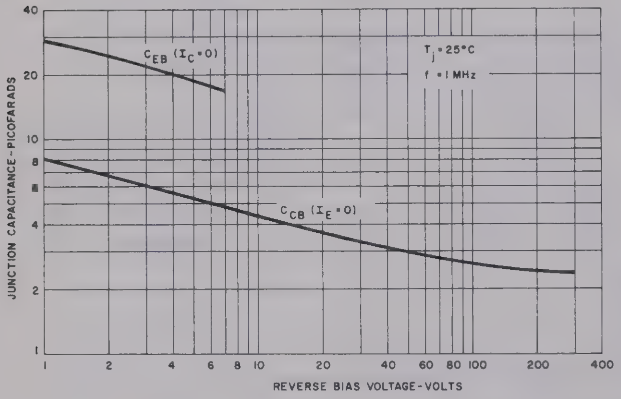
		Min.	Max.	Units
Forward Current Transfer Ratio				
(I_C = 80 mA, V_{CE} = 10V)	h_{FE}	40		
(I_C = 2 mA, V_{CE} = 10V)		20		
Collector to Emitter Voltage				
(I_C = 1.0 mA, I_b = 0)	V_{CEO}			
D40P1		120		Volts
D40P3		180		Volts
D40P5		225		Volts
Collector Cutoff Current (Rated V_{CBO})	I_{CBO}		10	μA
Emitter Cutoff Current (V_{EBO} = 7V)	I_{EBO}		10	μA
Collector Saturation Voltage (I_C = 100 mA, I_B = 10 mA)	V_{CE} (SAT)		1	Volt
Base Saturation Voltage (I_C = 100 mA, I_B = 10 mA)	V_{BE} (SAT)		1.5	Volt
Gain Bandwidth Product (I_C = 80 mA, V_{CE} = 10V)	f_T	50		MHz
Storage Time (I_C (ON) = 80 mA, I_B (ON) = 8 mA I_B (OFF) = 8 mA)	t_S		2.5	μsec
Collector Capacitance (V_{CB} = 10V, I_E = 0)	C_{CB}		6	pf



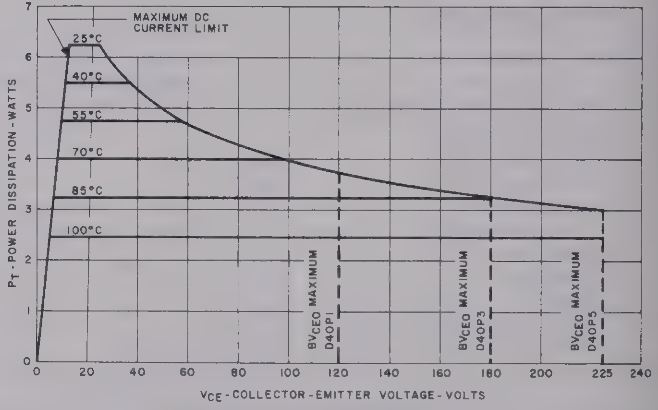
TYPICAL h_{FE} vs. I_C



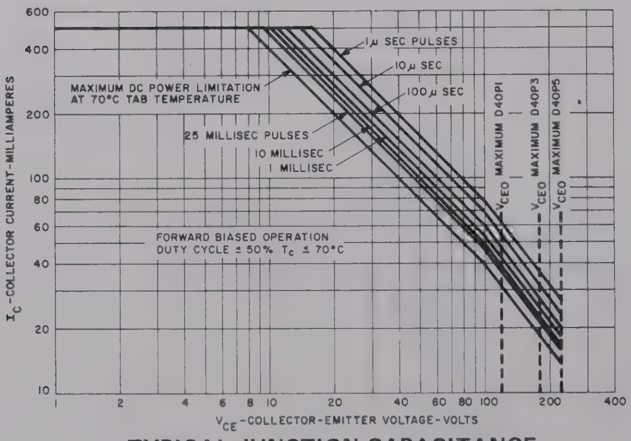
TYPICAL SATURATION
VOLTAGE CHARACTERISTICS



SAFE REGION OF OPERATION



MAXIMUM PERMISSIBLE
DC POWER DISSIPATION



TYPICAL JUNCTION CAPACITANCE
VS. REVERSE BIAS VOLTAGE

Silicon
Power Tab
Transistors

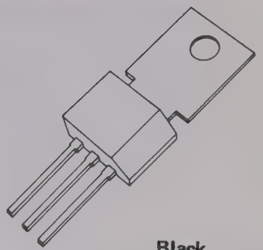
"Color Molded"

PNP

D41D

The General Electric D41D is a black, silicone plastic encapsulated, power transistor designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1.0 MHz; series, shunt and switching regulators; low and high frequency inverters/converters; and many others.

FEATURING:
- High free-air power dissipation
- PNP complement to D40D NPN (previously D28D)
- Black for PNP, brown for NPN
- Low collector saturation voltage (−0.5V typ. @ −1.0A I_c)
- Excellent linearity
- Fast switching
- Hard solder mount down



Black
Leads Can Be Formed
To A TO-5 Pin Configuration

absolute maximum ratings: (25°C) (unless otherwise specified)

		D41D1[1] D41D2	D41D4 D41D5	D41D7 D41D8	D41D10 D41D11	
Voltages						
Collector to Emitter	V_{CEO}	−30	−45	−60	−75	Volts
Emitter to Base	V_{EBO}	− 5	− 5	− 5	− 5	Volts
Collector to Emitter	V_{CES}	−45	−60	−75	−90	Volts
Current[2]						
Collector (Continuous)	I_c	−1	−1	−1	−1	Amps
Collector (Peak)		−1.5	−1.5	−1.5	−1.5	Amps
Power Dissipation						
Tab at 25°C	P_T	6.25	6.25	6.25	6.25	Watts
Tab at 70°C		4	4	4	4	Watts
Free Air at 50°C						
With Tab		1.33	1.33	1.33	1.33	Watts
Without Tab		1.0	1.0	1.0	1.0	Watts
Thermal Resistance[3]						
Junction to Case	$R_{\theta JC}$	20	20	20	20	°C/W
Junction to Ambient	$R_{\theta JA}$					
With Tab		75	75	75	75	°C/W
Without Tab		100	100	100	100	°C/W
Temperature[3]						
Operating	T_J	−55 to +150	−55 to +150	−55 to +150	−55 to +150	°C
Storage	T_{STG}	−55 to +150	−55 to +150	−55 to +150	−55 to +150	°C
Lead Soldering, 1/16" ± 1/32" from case for 10 sec max	T_L	+260	+260	+260	+260	°C

NOTES:

[1] The last digit is a part number which designates a voltage grade and an h_{FE} level. Tab and lead forming is specified by a letter after this digit.

[2] Please refer to the safe region of operation curves for more information.

[3] Tab temperature is measured on center of tab, 1/16" from plastic body.

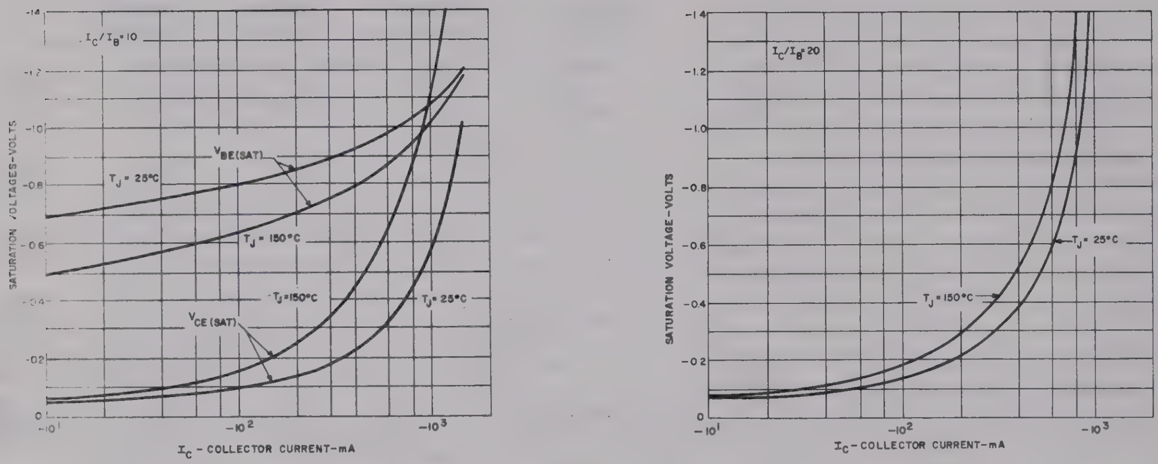
electrical characteristics: (25°C) (unless otherwise specified)

		D41D1 D41D4 D41D7 D41D10 Min.	Max.	D41D2 Min.	Max.	D41D5 D41D8 D41D11 Min.	Max.
Forward Current Transfer Ratio							
(V_{CE} = −2 V, I_c = −100 mA)	h_{FE}	50	150	120	360	120	360
(V_{CE} = −2 V, I_c = −1 A)	h_{FE}	10	–	20		10	–

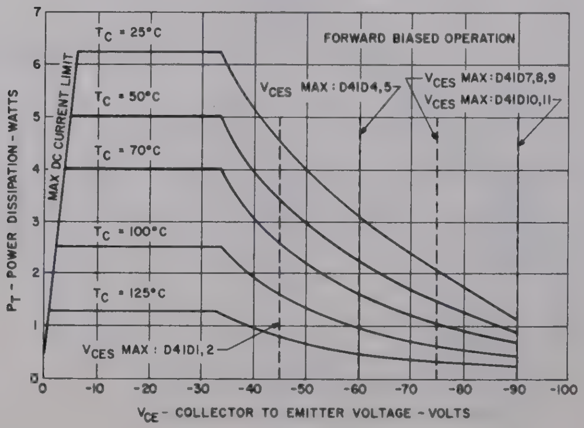
		Min.	Typ.	Max.	
Collector to Emitter Voltage					
(I_c = −10 mA) D41D1, 2	V_{CEO}	−30	–	–	Volts
D41D4, 5	V_{CEO}	−45	–	–	Volts
D41D7, 8	V_{CEO}	−60	–	–	Volts
D41D10, 11	V_{CEO}	−75	–	–	Volts
Collector Saturation Voltage					
(I_c = −500 mA, I_B = −50 mA)					
D41D1, 2, 4, 5	$V_{CE(SAT)}$	–	–	−0.5	Volts
D41D7, 8, 10, 11	$V_{CE(SAT)}$	–	–	−1.0	Volts
Base Saturation Voltage					
(I_c = −500 mA, I_B = −50 mA)	$V_{BE(SAT)}$	–	–	−1.5	Volts

		MIN.	TYP.	MAX.	
Collector Cutoff Current					
(V_{CE} = Rated V_{CES})	I_{CES}	–	–	–0.1	μA
(V_{CE} = Rated V_{CES}, T_J = 125°C)		–	–1	–	μA
(V_{CE} = Rated V_{CEO})	I_{CEO}	–	–1	–	μA
(V_{CE} = Rated V_{CES}, T_J = 125°C)		–	–50	–	μA
Emitter Cutoff Current					
(V_{EB} = –5 V)	I_{EBO}	–	–	–0.1	μA
Collector Capitance					
(V_{CB} = –10 V, f = 1 MHz)	C_{CBO}	–	10	–	pF
Gain Bandwidth Product					
(V_{CE} = –10 V, I_c = –20 mA)	f_T	–	150	–	MHz
Switching Times					
Delay Time and Rise Time					
(I_c = –1 A, I_{B1} = –0.1 A)	$t_d + t_r$	–	50	–	nsec
Storage Time					
(I_c = –1 A, I_{B1} = I_{B2} = –0.1 A)	t_s	–	75	–	nsec
Fall Time					
(I_c = –1 A, I_{B1} = I_{B2} = –0.1 A)	t_f	–	40	–	nsec

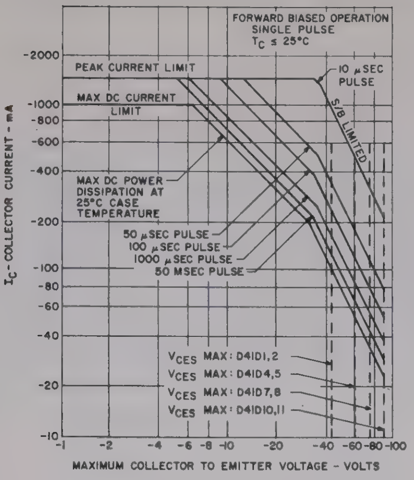
TYPICAL SATURATION VOLTAGE CHARACTERISTICS

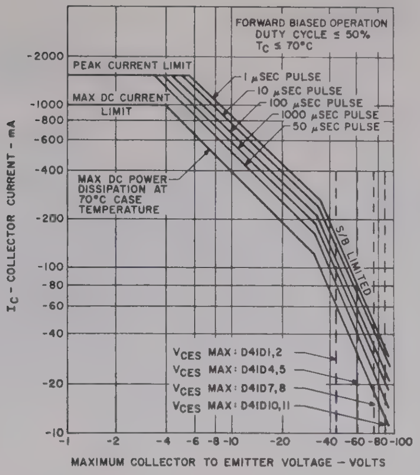


MAXIMUM PERMISSIBLE DC POWER DISSIPATION

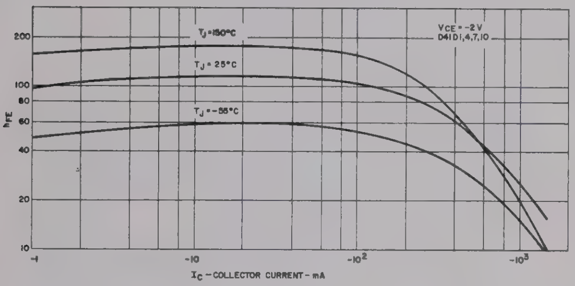


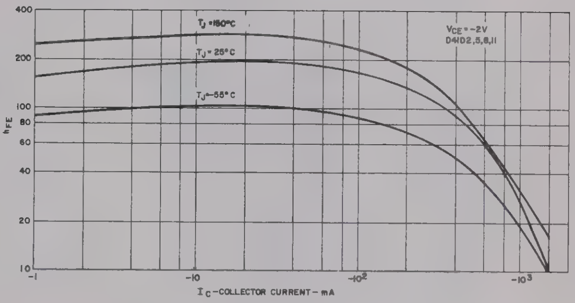
SAFE REGION OF OPERATION



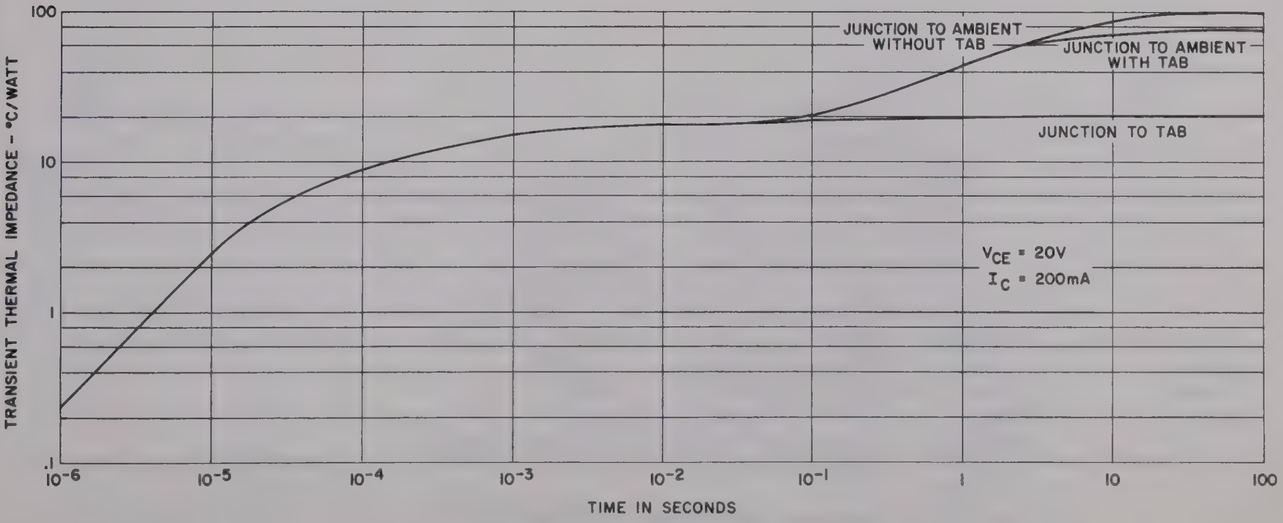


TYPICAL H_{FE} VS I_C

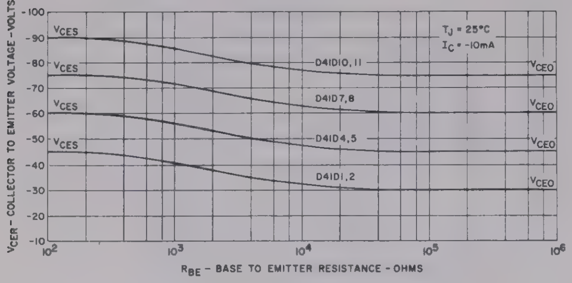




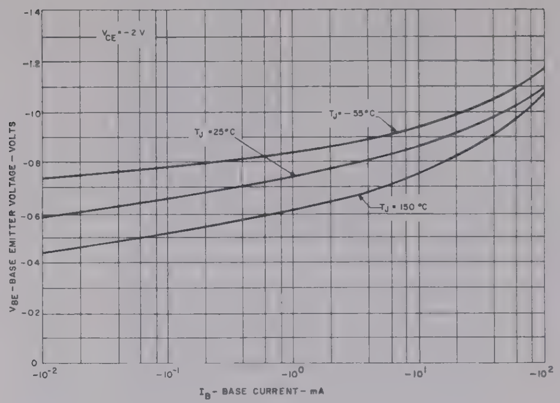
MAXINUM TRANSIENT THERMAL IMPEDANCE



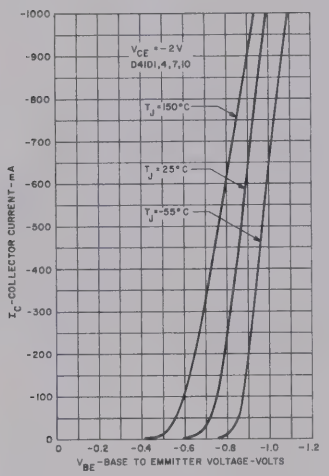
TYPICAL V_{CER}

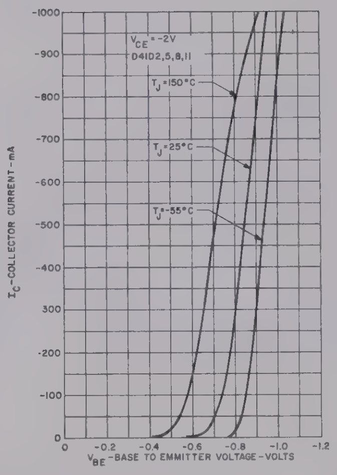


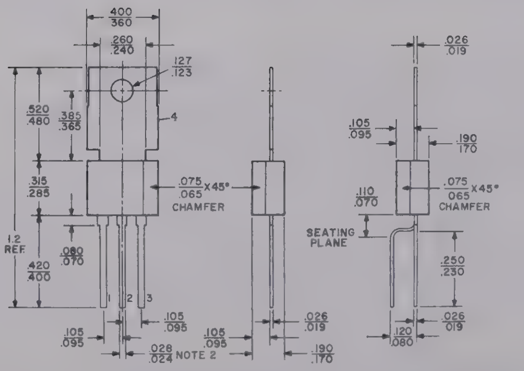
TYPICAL INPUT CHARACTERISTICS



TYPICAL TRANSCONDUCTANCE CHARACTERISTICS






400 / 360
.260 / .240
.127 / .123
4
.520 / .480
.385 / .365
.315 / .285
1.2 REF
.080 / .070
.420 / .400
1
2
3
.075 / .065 X45° CHAMFER
.105 / .095
.105 / .095
.028 / .024 NOTE 2
.105 / .095
.026 / .019
.190 / .170
.026 / .019
.105 / .095
.190 / .170
.110 / .070
.075 / .065 X45° CHAMFER
SEATING PLANE
.250 / .230
.026 / .019
.120 / .080

TYPE U
FITS TO-5 PRINTED CIRCUIT
BOARD MOUNTING CONFIGURATION

LEAD LABELS
1. EMITTER
2 BASE
3. COLLECTOR

NOTES:
1. ALL DIM. ARE IN INCHES AND ARE REF. UNLESS TOLERANCED.
2. .043-.057 LEAD WIDTH WITHIN 0.100 OF BODY

FOR OPTIONAL LEAD CONFIGURATIONS SEE SELECTOR GUIDE P. 117

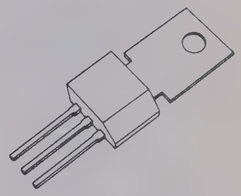
Silicon
Power Tab
Transistors
"Color Molded"

NPN
D42C

The General Electric D42C is a red, silicone plastic encapsulated, power transistor designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1.0 MHz; series, shunt and switching regulators; low and high frequency inverters/converters; and many others.

FEATURING:

- High free-air power dissipation
- NPN complement to D43C PNP
- Red for NPN, green for PNP
- Very low collector saturation voltage (0.5V typ. @ 3.0A I_C)
- Excellent linearity
- Fast switching
- Hard solder mountdown



Red

Leads Can Be Formed To Fit
TO-66 & TO-5 Outlines

absolute maximum ratings: (25°C) (unless otherwise specified)

		D42C1[(1)] D42C2 D42C3	D42C4 D42C5 D42C6	D42C7 D42C8 D42C9	D42C10 D42C11	
Voltages						
Collector to Emitter	V_{CEO}	30	45	60	80	Volts
Emitter to Base	V_{EBO}	5	5	5	5	Volts
Collector to Emitter	V_{CES}	40	55	70	90	Volts
Current(2)						
Collector (Continuous)	I_C	←	3	→	→	Amps
Collector (Peak)		←	5	→	→	Amps
Power Dissipation(2)						
Tab at 25°C	P_T	←	12.5	→	→	Watts
Tab at 70°C		←	8.0	→	→	Watts
Free Air at 25°C		←	2.1	→	→	Watts
Free Air at 50°C		←	1.7	→	→	Watts
Thermal Resistance(3)						
Junction to Case	$R_{\theta JC}$	←	10	→	→	°C/W
Junction to Ambient	$R_{\theta JA}$					
With Tab		←	60	→	→	°C/W
Without Tab		←	80	→	→	°C/W
Temperature(3)						
Operating	T_J	←	−55 to +150	→	→	°C
Storage	T_{STG}	←	−55 to +150	→	→	°C
Lead Soldering, 1/16" ± 1/32" from case for 10 seconds max.	T_L	←	+260	→	→	°C

NOTES:

(1) The last digit is a part number which designates a voltage grade and an h_{FE} level. Tab and lead forming is specified by a letter after this digit.

(2) Please refer to the safe region of operation curves for more information.

(3) Tab temperature is measured on center of tab, 1/16" from plastic body.

electrical characteristics: (25°C) (unless otherwise specified)

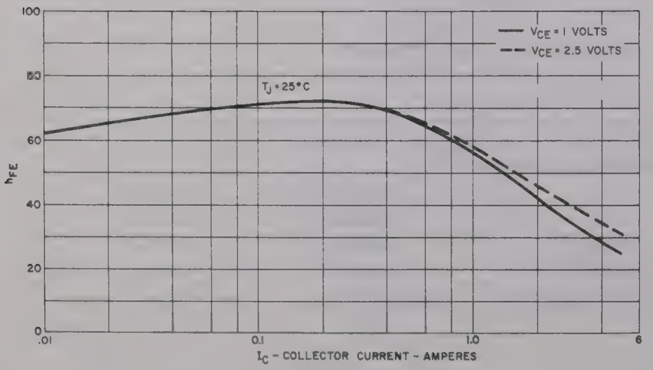
		D42C3 D42C6 D42C9		D42C2 D42C5 D42C8 D42C11		D42C1 D42C4 D42C7 D42C10
Forward Current Transfer Ratio		**Min.**	**Max.**	**Min.**	**Max.**	**Min.**
($V_{CE} = 1V, I_C = 0.2A$)	h_{FE}	40	—	40	120	25
($V_{CE} = 1V, I_C = 2A$)	h_{FE}	20	—	—	—	—
($V_{CE} = 1V, I_C = 1A$)	h_{FE}	—	—	20	—	10

Electrical Characteristics (Continued)

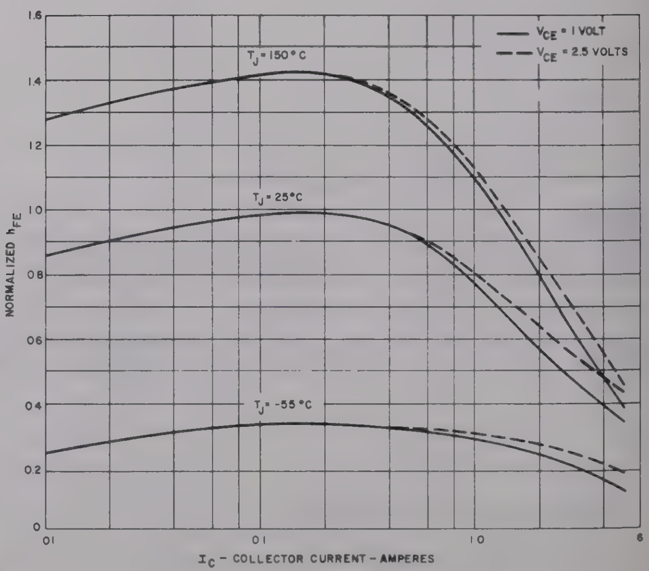
		Min.	Typ.	Max.	
Collector to Emitter Sustaining Voltage[4]					
($I_C = 100$ mA) D42C1, 2, 3	$V_{CEO\,(SUS)}$	30		—	Volts
D42C4, 5, 6		45		—	Volts
D42C7,8,9		60		—	Volts
D42C10,11		80		—	Volts
Collector Saturation Voltage					
($I_C = 1$A, $I_B = 50$ mA) D42C2,3,5,6,8,9,11	$V_{CE\,(SAT)}$	—		0.5	Volt
($I_C = 1$A, $I_B = 100$ mA) D42C1,4,7,10	$V_{CE\,(SAT)}$	—		0.5	Volt
Base Saturation Voltage					
($I_C = 1$A, $I_B = 100$ mA)	$V_{BE\,(SAT)}$	—		1.3	Volts
Collector Cutoff Current					
(V_{CE} = Rated V_{CES}, $T_J = 25°$C)	I_{CES}	—		10	μA
Emitter Cutoff Current					
($V_{EB} = 5$V, $T_J = 25°$C)	I_{EBO}	—		100	μA
Collector Capacitance					
($V_{CB} = 10$V, f = 1 MHz)	C_{CBO}	—		100	pF
Gain Bandwidth Product					
($V_{CE} = 4$V, $I_C = 20$ mA)	f_t		50		MHz
Switching Times					
Rise Time and Delay Time ($I_C = 1$A, $I_{B1} = 0.1$A)	$t_d + t_r$		100		nsec
Storage Time ($I_C = 1$A, $I_{B1} = I_{B2} = 0.1$A)	t_s		500		nsec
Fall Time ($I_C = 1$A, $I_{B1} = I_{B2} = 0.1$A)	t_f		75		nsec

NOTE:

[4] Pulsed measurement, 300 μsec pulse width, duty cycle ≦2%.

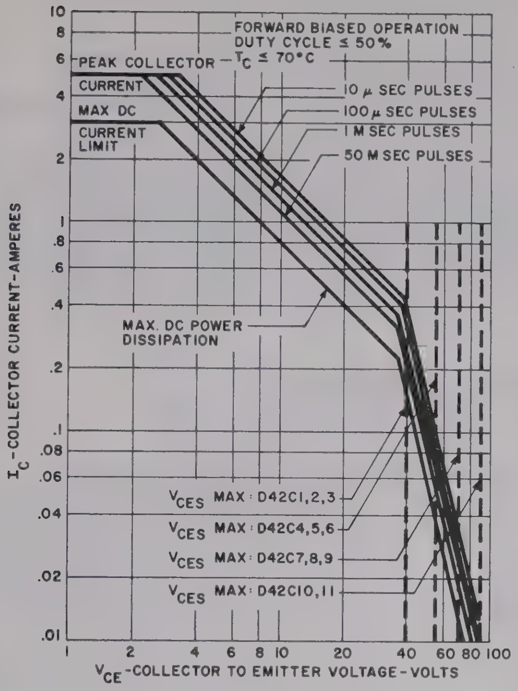


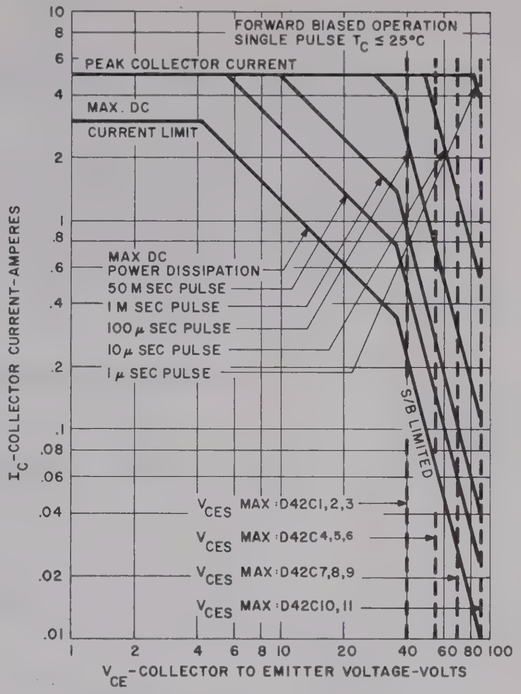
TYPICAL h_{FE} VS. I_C

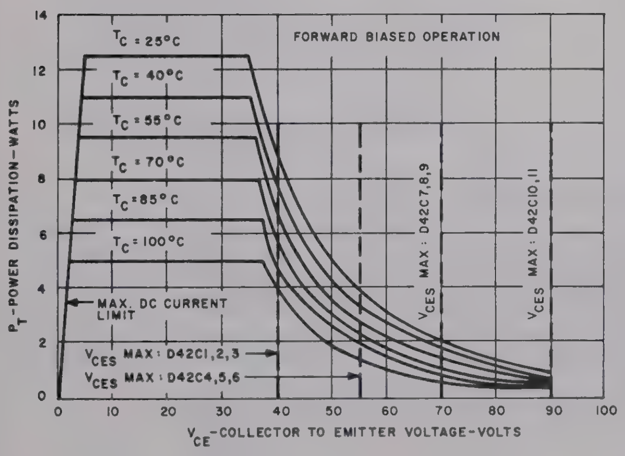


TYPICAL NORMALIZED h_{FE} VS. I_C

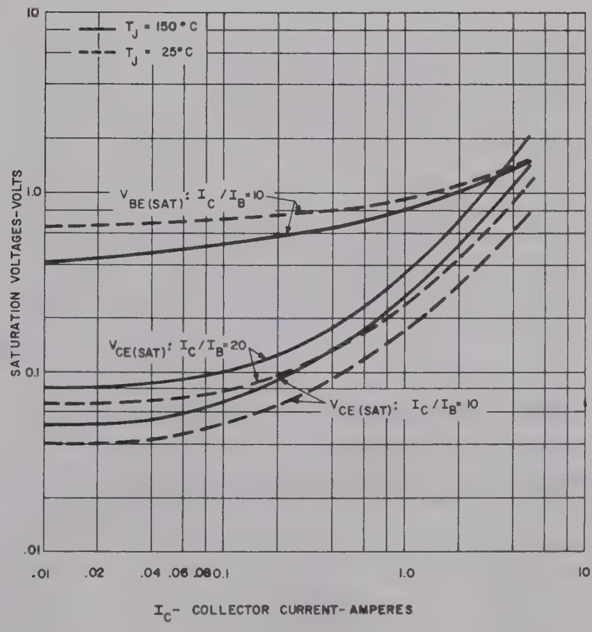
SAFE REGION OF OPERATION



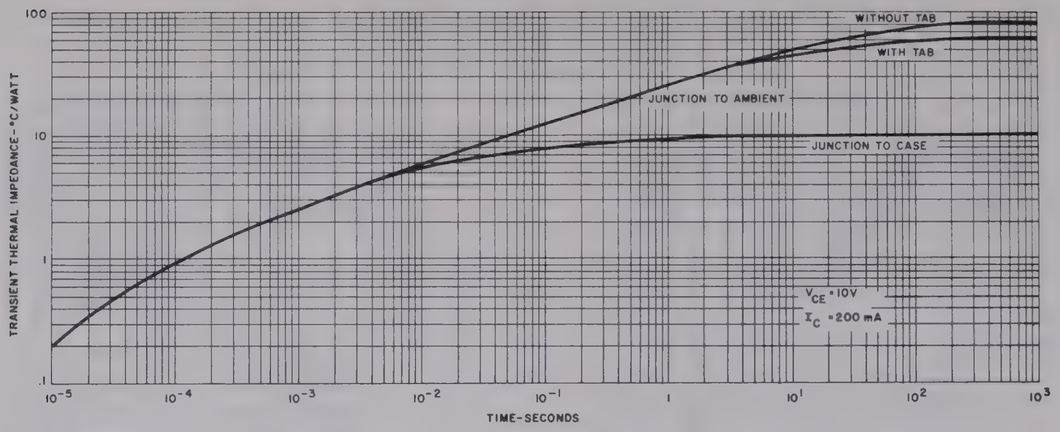




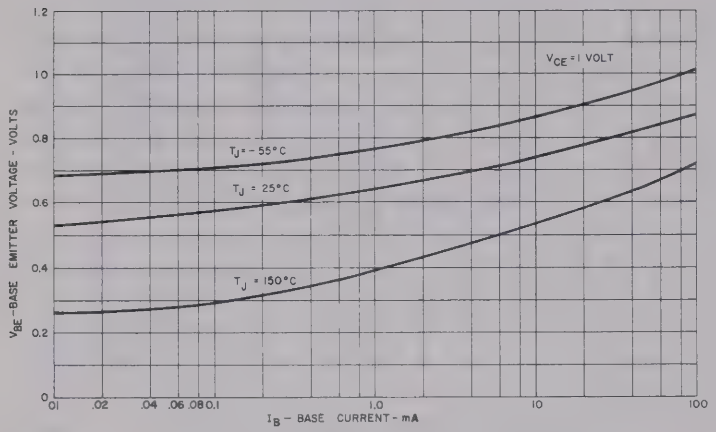
MAXIMUM PERMISSIBLE DC POWER DISSIPATION



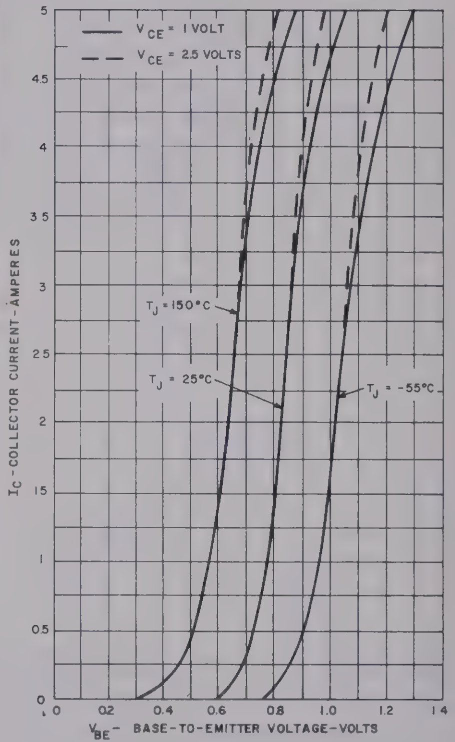
TYPICAL SATURATION VOLTAGE CHARACTERISTICS



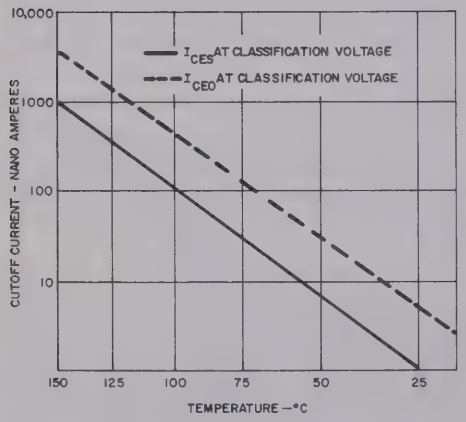
MAXIMUM TRANSIENT THERMAL IMPEDANCE



TYPICAL INPUT CHARACTERISTICS

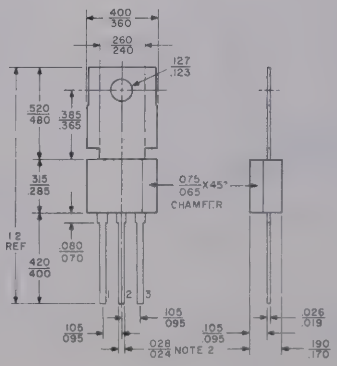


TYPICAL TRANSCONDUCTANCE CHARACTERISTICS



TYPICAL I_{CEO}, I_{CES} VS. TEMPERATURE

DIMENSIONAL OUTLINES


400/360
260/240
.127/.123
.520/480
.385/.365
.315/.285
.075/.065 X45°
CHAMFER
1.2 REF
.080/.070
.420/.400
1
2
3
.105/.095
.105/.095
.028/.024 NOTE 2
.105/.095
.026/.019
.190/.170

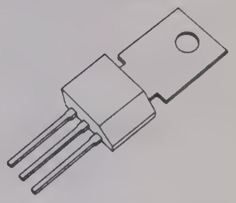
Notes:
(1) All dimensions are in inches and are reference unless toleranced.
(2) .043-.053 lead width within 0.100 of body.

Lead Labels:
(1) Base
(2) Collector (Common with tab)
(3) Emitter
(4) Mounting tab (Electrically common to collector)

Silicon
Power Tab
Transistors
"Color Molded"

PNP
D43C

The General Electric D43C is a green, silicone plastic encapsulated, power transistor designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1.0 MHz; series, shunt and switching regulators; low and high frequency inverters/converters; and many others.


Green

Leads Can Be Formed To Fit
TO-66 & TO-5 Outlines

FEATURING:

- High free-air power dissipation
- PNP complement to D42C NPN
- Green for PNP, red for NPN
- Very low collector saturation voltage (−0.5V typ. @ −3.0A I_C)
- Excellent linearity
- Fast switching
- Hard solder mountdown

absolute maximum ratings: (25°C) (unless otherwise specified)

		D43C1[1] D43C2 D43C3	D43C4 D43C5 D43C6	D43C7 D43C8 D43C9	D43C10 D43C11	
Voltages						
Collector to Emitter	V_{CEO}	−30	−45	−60	−80	Volts
Emitter to Base	V_{EBO}	− 5	− 5	− 5	− 5	Volts
Collector to Emitter	V_{CES}	−40	−55	−70	−90	Volts
Current(2)						
Collector (Continuous)	I_C	← −3 →				Amps
Collector (Peak)		← −5 →				Amps
Power Dissipation(2)						
Tab at 25°C	P_T	← 12.5 →				Watts
Tab at 70°C		← 8.0 →				Watts
Free Air at 25°C		← 2.1 →				Watts
Free Air at 50°C		← 1.7 →				Watts
Thermal Resistance(3)						
Junction to Case	$R_{\theta JC}$	← 10 →				°C/W
Junction to Ambient	$R_{\theta JA}$					
With Tab		← 60 →				°C/W
Without Tab		← 80 →				°C/W
Temperature(3)						
Operating	T_J	← −55 to +150 →				°C
Storage	T_{STG}	← −55 to +150 →				°C
Lead Soldering, 1/16" ± 1/32" from case for 10 seconds max.	T_L	← +260 →				°C

NOTES:

(1)The last digit is a part number which designates a voltage grade and an h_{FE} level. Tab and lead forming is specified by a letter after this digit.
(2)Please refer to the safe region of operation curves for more information.
(3)Tab temperature is measured on center of tab, 1/16" from plastic body.

electrical characteristics: (25°C) (unless otherwise specified)

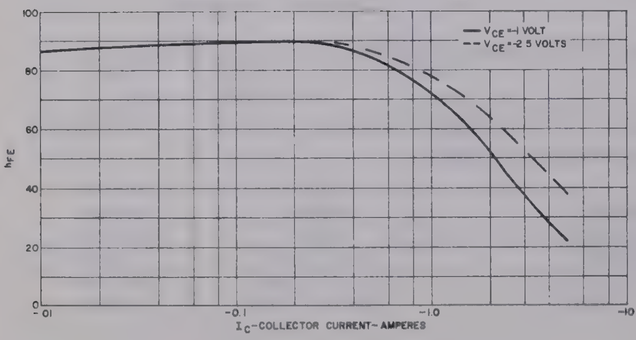
		D43C3 D43C6 D43C9		D43C2 D43C5 D43C8 D43C11		D43C1 D43C4 D43C7 D43C10
		Min.	Max.	Min.	Max.	Min.
Forward Current Transfer Ratio						
($V_{CE} = -1V, I_C = -0.2A$)	h_{FE}	40	—	40	120	25
($V_{CE} = -1V, I_C = -2A$)	h_{FE}	20	—	—	—	—
($V_{CE} = -1V, I_C = -1A$)	h_{FE}	—	—	20	—	10

Electrical Characteristics (Continued)

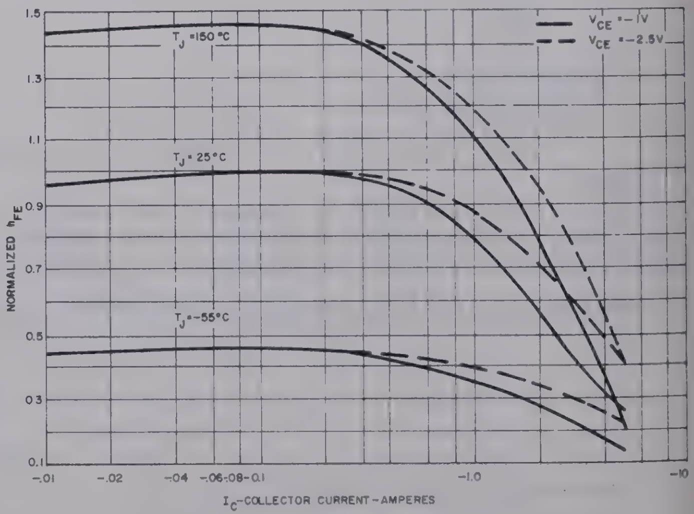
		Min.	Typ.	Max.	
Collector to Emitter Sustaining Voltage[4]					
($I_C = -100$ mA) D43C1, 2, 3	$V_{CEO(SUS)}$	−30		—	Volts
D43C4, 5, 6		−45		—	Volts
D43C7,8,9		−60		—	Volts
D43C10,11		−80		—	Volts
Collector Saturation Voltage					
($I_C = -1$A, $I_B = -50$ mA) D43C2,3,5,6,8,9,11	$V_{CE(SAT)}$	—		−0.5	Volt
($I_C = -1$A, $I_B = -100$ mA) D43C1,4,7,10	$V_{CE(SAT)}$	—		−0.5	Volt
Base Saturation Voltage					
($I_C = -1$A, $I_B = -100$ mA)	$V_{BE(SAT)}$	—		−1.3	Volts
Collector Cutoff Current					
(V_{CE} = Rated V_{CES}, $T_J = 25$°C)	I_{CES}	—		−10	μA
Emitter Cutoff Current					
($V_{EB} = -5$V, $T_J = 25$°C)	I_{EBO}	—		−100	μA
Collector Capacitance					
($V_{CB} = 10$V, f = 1 MHz)	C_{CBO}	—		125	pF
Gain Bandwidth Product					
($V_{CE} = -4$V, $I_C = -20$ mA)	f_t		40		MHz
Switching Times					
Rise Time and Delay Time ($I_C = -1$A, $I_{B1} = -0.1$A)	$t_d + t_r$		50		nsec
Storage Time ($I_C = -1$A, $I_{B1} = I_{B2} = -0.1$A)	t_s		500		nsec
Fall Time ($I_C = -1$A, $I_{B1} = I_{B2} = -0.1$A)	t_f		50		nsec

NOTE:

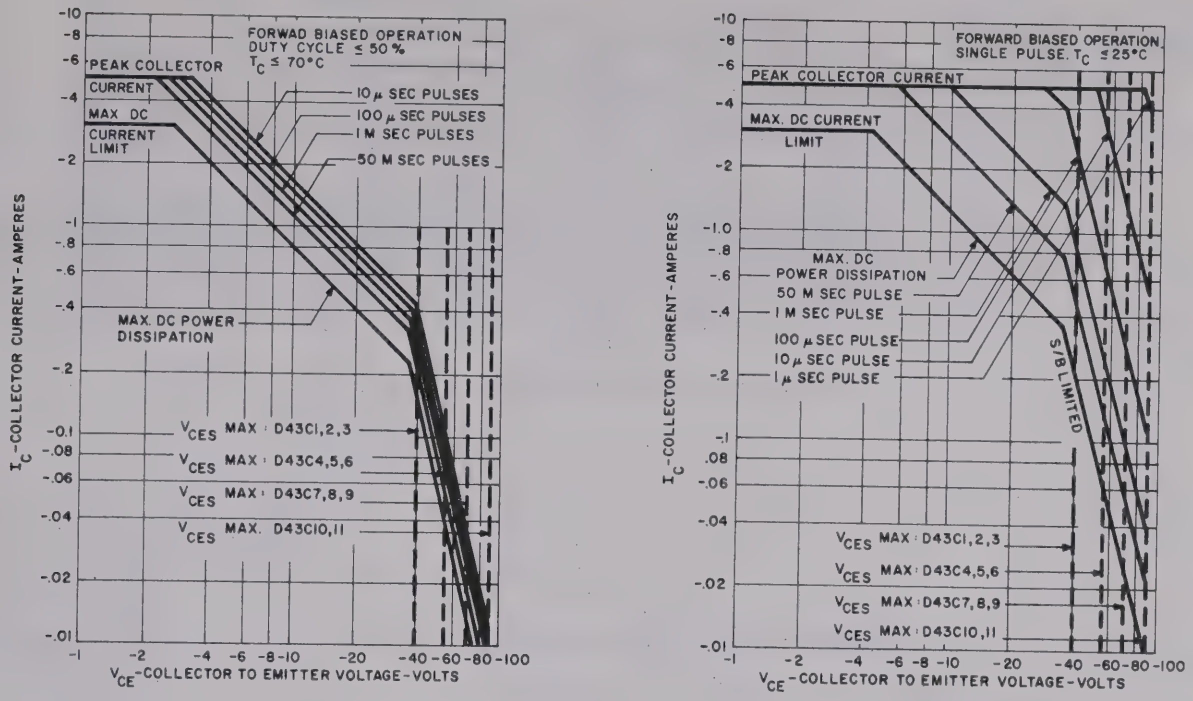
(4) Pulsed measurement, 300 μsec pulse width, duty cycle ≦2%.



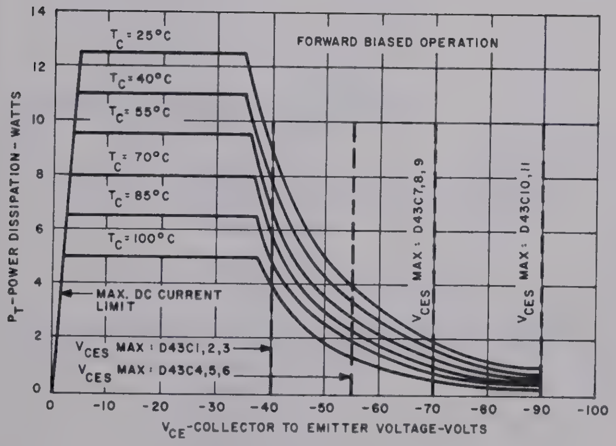
TYPICAL h_{FE} VS. I_C



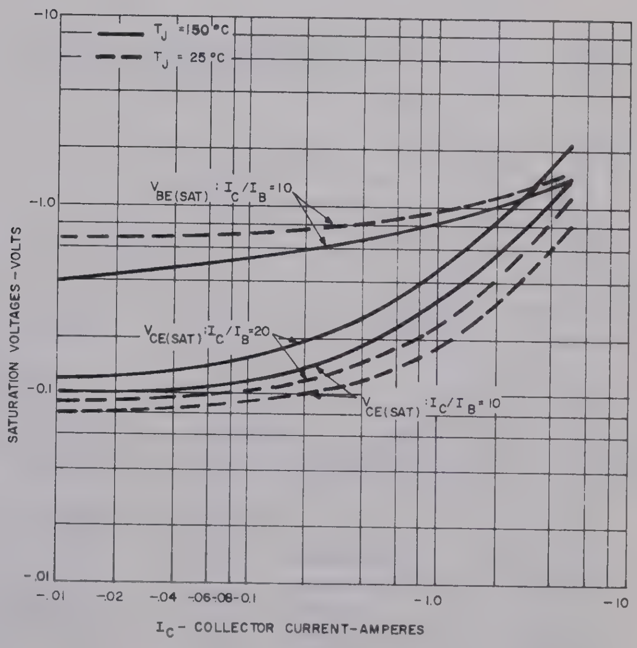
TYPICAL NORMALIZED h_{FE} VS. I_C



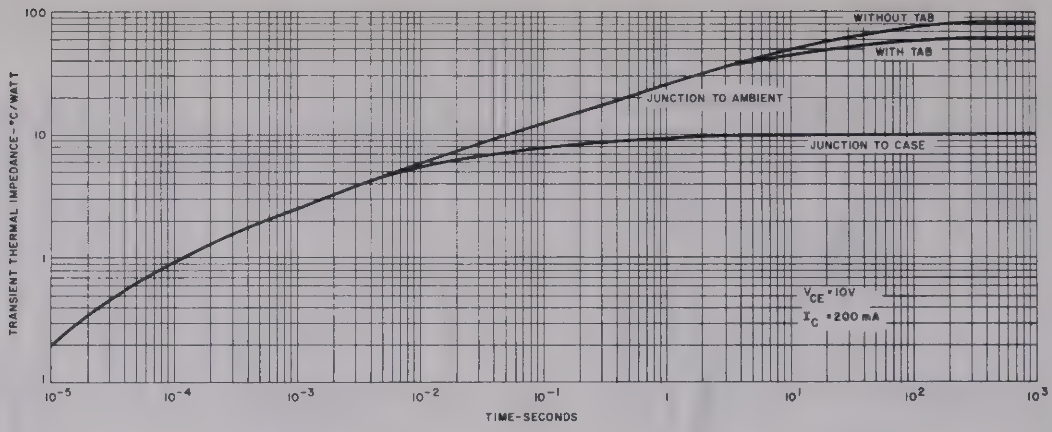
SAFE REGION OF OPERATION



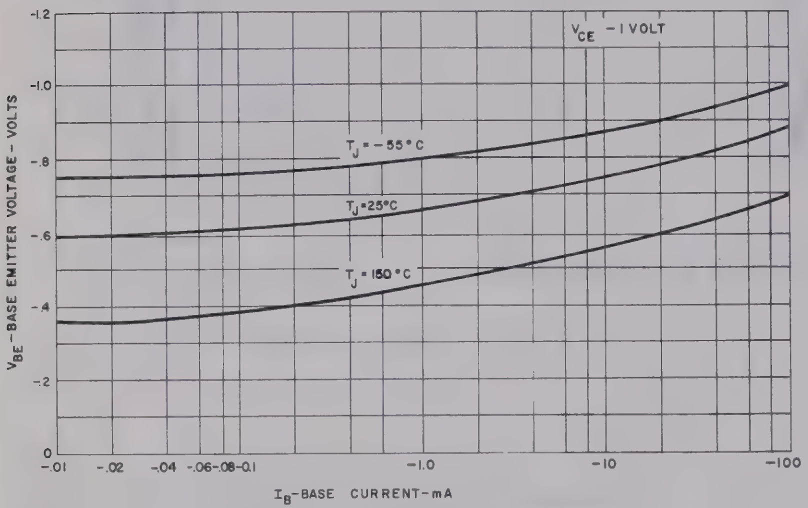
MAXIMUM PERMISSIBLE DC POWER DISSIPATION



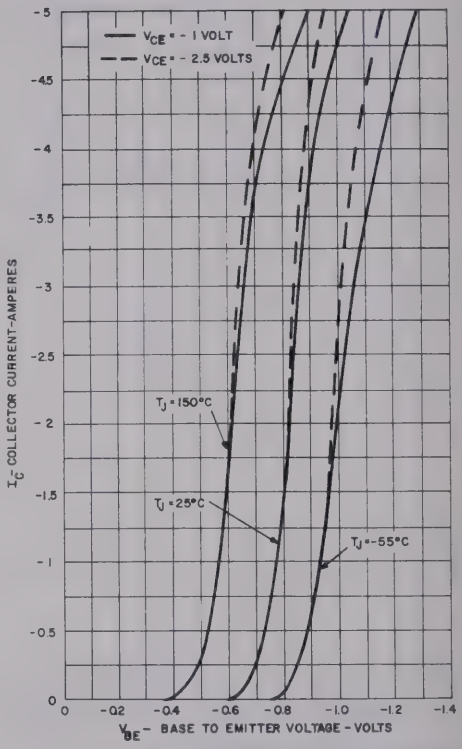
TYPICAL SATURATION VOLTAGE CHARACTERISTICS



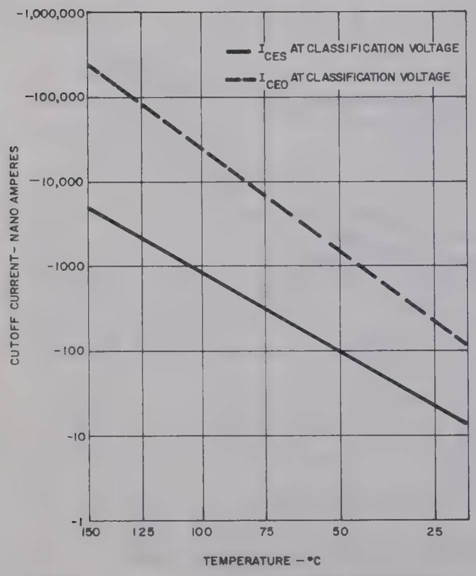
MAXIMUM TRANSIENT THERMAL IMPEDANCE



TYPICAL INPUT CHARACTERISTICS

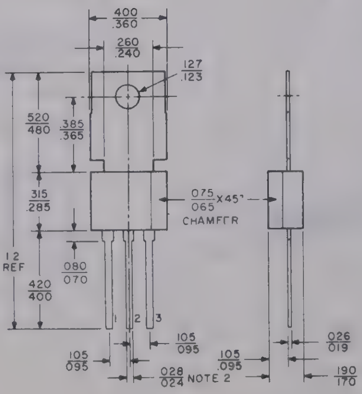


TYPICAL TRANSCONDUCTANCE CHARACTERISTICS



TYPICAL I_{CEO}, I_{CES} VS. TEMPERATURE

DIMENSIONAL OUTLINES


.400/.360
.260/.240
.127/.123
.520/.480
.385/.365
.315/.285
.075/.065 X45° CHAMFER
1.2 REF
.080/.070
.420/.400
1
2
3
.105/.095
.105/.095
.028/.024 NOTE 2
.105/.095
.026/.019
.190/.170

Notes: (1) All dimensions are in inches and are reference unless toleranced.
(2) .043-.053 lead width within 0.100 of body.

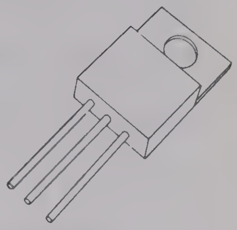
Lead Labels:
(1) Base
(2) Collector (Common with tab)
(3) Emitter
(4) Mounting tab (Electrically common to collector)

Silicon
Power Pac
Transistors
"Color Molded"

NPN

D44C

The General Electric D44C is a red, silicone plastic encapsulated, power transistor designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1.0 MHz; series, shunt and switching regulators; low and high frequency inverters/converters; and many others.



JEDEC TO-220 A B

FEATURING:

- NPN complement to D45C PNP
- Red for NPN, green for PNP
- Very low collector saturation voltage (0.5V typ. @ 3.0A I_C)
- Excellent linearity
- Fast switching
- Round leads
- Hard solder mountdown

absolute maximum ratings: (25°C) (unless otherwise specified)

<table>
<tr><th></th><th></th><th>D44C1
D44C2
D44C3</th><th>D44C4
D44C5
D44C6</th><th>D44C7
D44C8
D44C9</th><th>D44C10
D44C11</th><th></th></tr>
<tr><td>Voltages</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Collector to Emitter</td><td>V_{CEO}</td><td>30</td><td>45</td><td>60</td><td>80</td><td>Volts</td></tr>
<tr><td>Emitter to Base</td><td>V_{EBO}</td><td>5</td><td>5</td><td>5</td><td>5</td><td>Volts</td></tr>
<tr><td>Collector to Emitter</td><td>V_{CES}</td><td>40</td><td>55</td><td>70</td><td>90</td><td>Volts</td></tr>
<tr><td>Current(1)</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Collector (Continuous)</td><td>I_C</td><td colspan="4">4</td><td>Amps</td></tr>
<tr><td>Collector (Peak)</td><td></td><td colspan="4">6</td><td>Amps</td></tr>
<tr><td>Power Dissipation(1)</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Case at 25°C</td><td>P_T</td><td colspan="4">30</td><td>Watts</td></tr>
<tr><td>Case at 70°C</td><td></td><td colspan="4">19</td><td>Watts</td></tr>
<tr><td>Free Air at 25°C</td><td></td><td colspan="4">1.67</td><td>Watts</td></tr>
<tr><td>Free Air at 50°C</td><td></td><td colspan="4">1.33</td><td>Watts</td></tr>
<tr><td>Thermal Resistance(2)</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Junction to Case</td><td>$R_{\theta JC}$</td><td colspan="4">4.2</td><td>°C/W</td></tr>
<tr><td>Junction to Ambient</td><td>$R_{\theta JA}$</td><td colspan="4">75</td><td>°C/W</td></tr>
<tr><td>Temperature(2)</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Operating</td><td>T_J</td><td colspan="4">−55 to +150</td><td>°C</td></tr>
<tr><td>Storage</td><td>T_{STG}</td><td colspan="4">−55 to +150</td><td>°C</td></tr>
<tr><td>Lead Soldering, 1/16" ± 1/32" from case for 10 seconds max.</td><td>T_L</td><td colspan="4">+260</td><td>°C</td></tr>
</table>

Notes:

(1) Refer to the Safe Region of Operation curve for further information.

(2) Case temperature reference point is indicated on the Dimensional Outline Drawing.

electrical characteristics: (25°C) (unless otherwise specified)

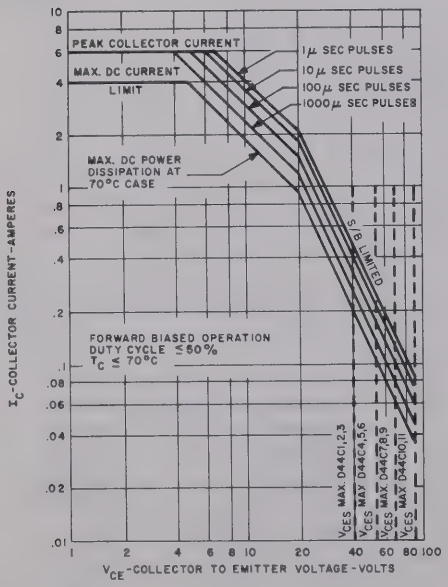
		D44C3 D44C6 D44C9		D44C2 D44C5 D44C8 D44C11		D44C1 D44C4 D44C7 D44C10
		Min.	Max.	Min.	Max.	Min.
Forward Current Transfer Ratio						
($V_{CE} = 1V$, $I_C = 0.2A$)	h_{FE}	40	—	40	120	25
($V_{CE} = 1V$, $I_C = 2A$)	h_{FE}	20	—	—	—	—
($V_{CE} = 1V$, $I_C = 1A$)	h_{FE}	—	—	20	—	10

Electrical Characteristics (Continued)

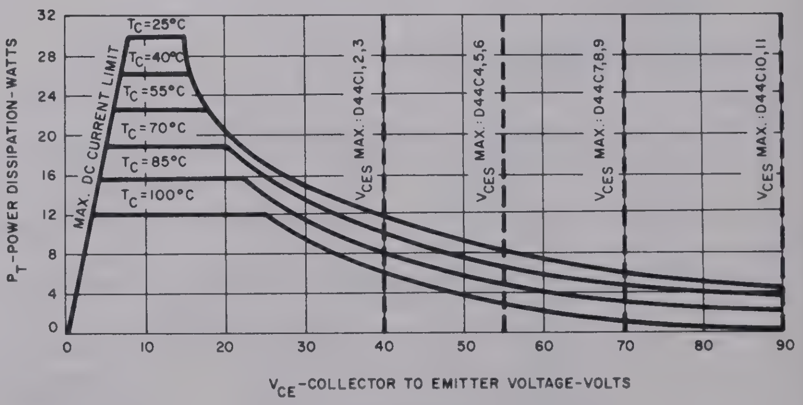
		Min.	Max.	
Collector to Emitter Sustaining Voltage$^{(3)}$				
($I_C = 100$ mA) D44C1, 2, 3	$V_{CEO(SUS)}$	30	—	Volts
D44C4, 5, 6		45	—	Volts
D44C7,8,9		60	—	Volts
D44C10,11		80	—	Volts
Collector Saturation Voltage$^{(3)}$				
($I_C = 1$A, $I_B = 50$ mA) D45C2,3,5,6,8,9,11	$V_{CE(SAT)}$	—	0.5	Volt
($I_C = 1$A, $I_B = 100$ mA) D45C1,4,7,10	$V_{CE(SAT)}$	—	0.5	Volt
Base Saturation Voltage$^{(3)}$ ($I_C = 1$A, $I_B = 100$ mA)	$V_{BE(SAT)}$	—	1.3	Volts
Collector Cutoff Current (V_{CE} = Rated V_{CES}, $T_J = 25°C$)	I_{CES}	—	10	μA
Emitter Cutoff Current ($V_{EB} = 5V$, $T_J = 25°C$)	I_{EBO}	—	100	μA
Collector Capacitance ($V_{CB} = 10V$, f = 1 MHz)	C_{CBO}	—	100	pF

		Typ.	
Gain Bandwidth Product ($V_{CE} = 4V$, $I_C = 20$ mA)	f_t	50	MHz
Switching Times			
Rise Time and Delay Time ($I_C = 1$A, $I_{B1} = 0.1$A)	$t_d + t_r$	100	nsec
Storage Time ($I_C = 1$A, $I_{B1} = I_{B2} = 0.1$A)	t_s	500	nsec
Fall Time ($I_C = 1$A, $I_{B1} = I_{B2} = 0.1$A)	t_f	75	nsec

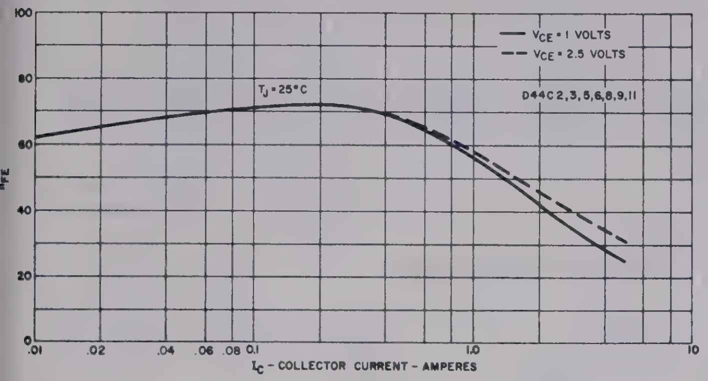
Note:
(3) Pulsed measurement, 300 μsec pulse, duty cycle ≤2%.



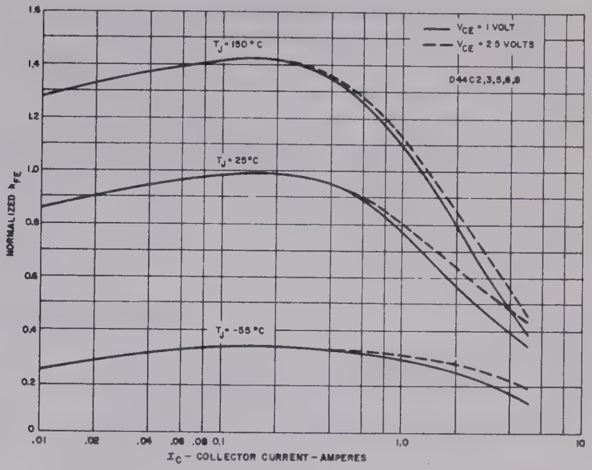
SAFE REGION OF OPERATION



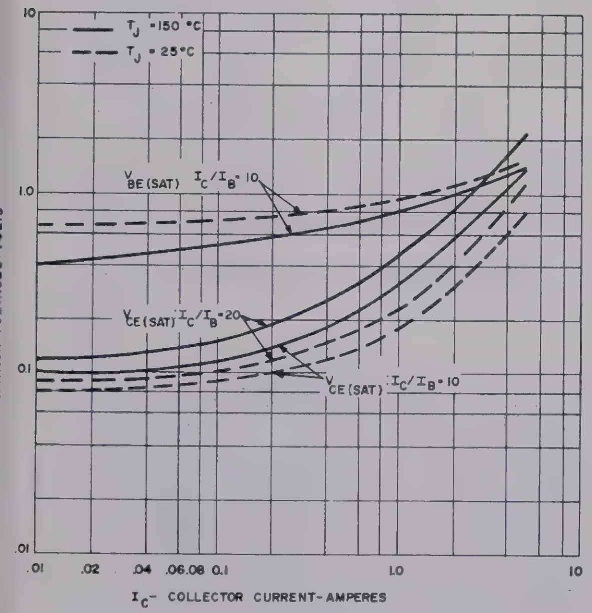
MAXIMUM PERMISSIBLE DC POWER DISSIPATION



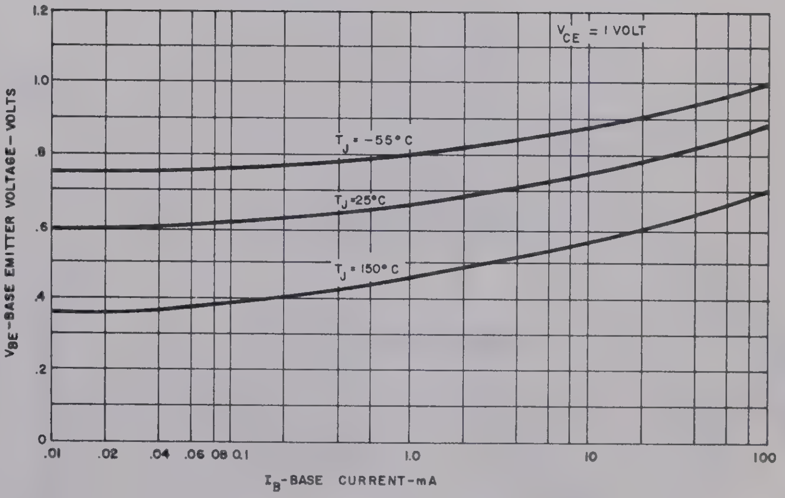
TYPICAL h_{FE} VS. I_C



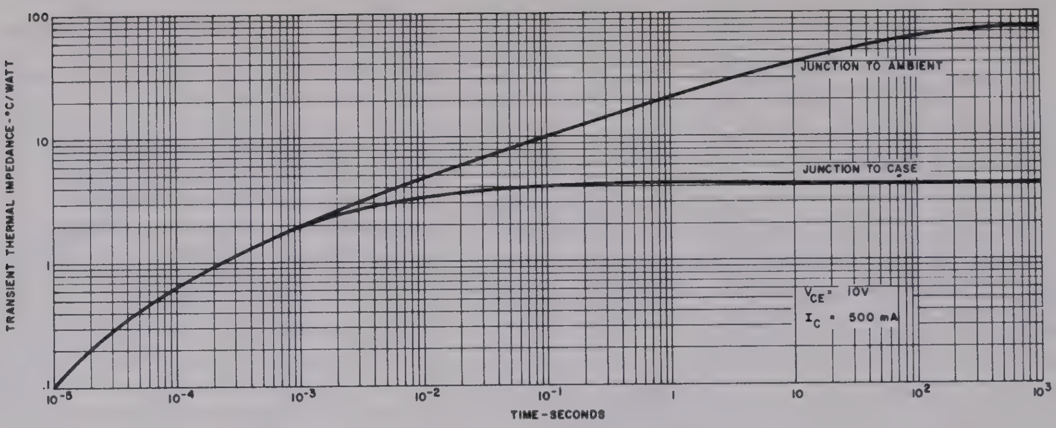
TYPICAL NORMALIZED h_{FE} VS. I_C



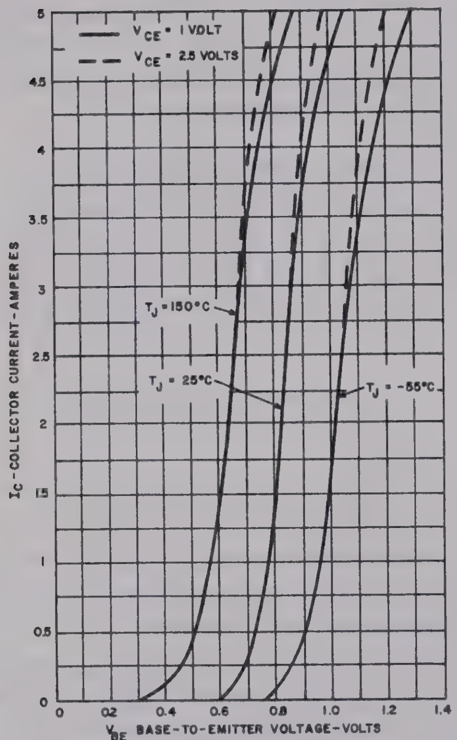
TYPICAL SATURATION VOLTAGE CHARACTERISTICS



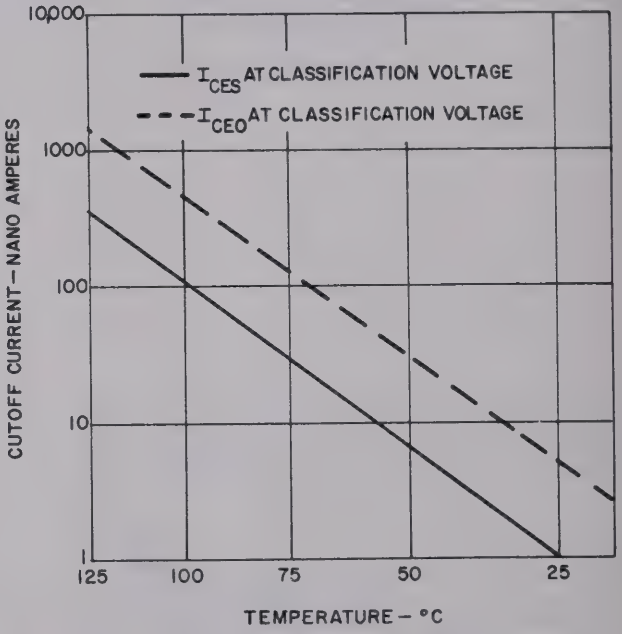
TYPICAL INPUT CHARACTERISTICS



MAXIMUM TRANSIENT THERMAL IMPEDANCE

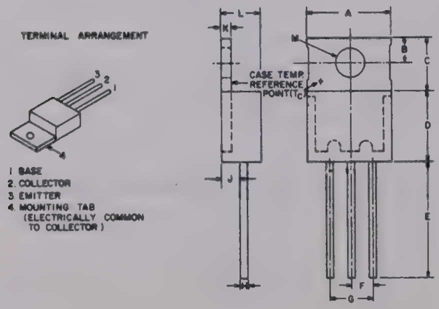


TYPICAL TRANSCONDUCTANCE CHARACTERISTICS



TYPICAL I_{CEO}, I_{CES} VS. TEMPERATURE

DIMENSIONAL OUTLINES


TERMINAL ARRANGEMENT
3
2
1
4
1 BASE
2. COLLECTOR
3. EMITTER
4. MOUNTING TAB (ELECTRICALLY COMMON TO COLLECTOR)
L
K
A
M
B
C
CASE TEMP. REFERENCE POINT(T_C)
D
J
E
N
F
G

Sym.	Dec. In.		Metric MM	
	Min.	Max.	Min.	Max.
A	.390	.420	9.91	10.67
B	.110	.120	2.79	3.05
C	.240	.260	6.10	6.61
D	.325	.355	8.26	9.02
E	.500	——	12.7	——
F	.095	.105	2.41	2.67
G	.190	.210	4.82	5.34
H	.029	.035	.73	.89
J	.085	.115	2.16	2.92
K	.040	.060	1.02	1.52
L	.160	.190	4.06	4.83
M	.141	.145	3.58	3.68
N	——	.065	——	1.65

FOR OPTIONAL LEAD CONFIGURATIONS SEE SELECTOR GUIDE P. 117

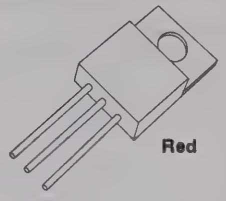
Silicon
Power Pac
Transistors

"Color Molded"

NPN

D44H

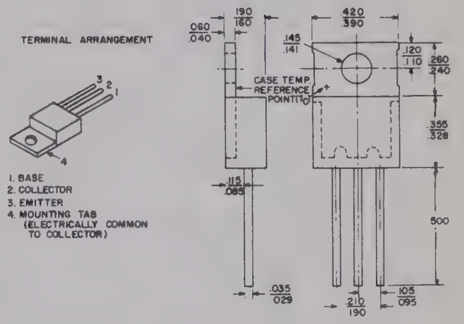
The General Electric D44H is a red, silicone plastic encapsulated, power transistor designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1.0 MHz; series, shunt and switching regulators; low and high frequency inverters/converters; and many others.



JEDEC TO-220 A B

FEATURING:

- NPN complement to D45H PNP
- Red for NPN, green for PNP
- Very low collector saturation voltage (0.24 V typ. @ 5.0 A I_C)
- Excellent linearity
- Fast switching
- Round leads
- Hard solder mount down



Outline Drawing

FOR OPTIONAL LEAD CONFIGURATIONS SEE SELECTOR GUIDE P. 117

absolute maximum ratings: (25°C unless otherwise specified)

<table>
<tr><th></th><th></th><th>D44H1
D44H2</th><th>D44H4
D44H5</th><th>D44H7
D44H8</th><th>D44H10</th><th></th></tr>
<tr><td>Voltages</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Collector to Emitter</td><td>V_{CEO}</td><td>30</td><td>45</td><td>60</td><td>80</td><td>Volts</td></tr>
<tr><td>Emitter to Base</td><td>V_{EBO}</td><td>5</td><td>5</td><td>5</td><td>5</td><td>Volts</td></tr>
<tr><td>Current (1)</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Collector (Continuous)</td><td>I_C</td><td colspan="4">← 10 →</td><td>Amps</td></tr>
<tr><td>Collector (Peak)</td><td></td><td colspan="4">← 20 →</td><td>Amps</td></tr>
<tr><td>Power Dissipation (1)</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Case at 25° C</td><td>P_T</td><td colspan="4">← 50 →</td><td>Watts</td></tr>
<tr><td>Case at 70° C</td><td></td><td colspan="4">← 32 →</td><td>Watts</td></tr>
<tr><td>Free Air at 25° C</td><td></td><td colspan="4">← 1.67 →</td><td>Watts</td></tr>
<tr><td>Free Air at 50° C</td><td></td><td colspan="4">← 1.33 →</td><td>Watts</td></tr>
<tr><td>Thermal Resistance (2)</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Junction to Case</td><td>$R\theta_{JC}$</td><td colspan="4">← 2.5 →</td><td>°C/W</td></tr>
<tr><td>Junction to Ambient</td><td>$R\theta_{JA}$</td><td colspan="4">← 75 →</td><td>°C/W</td></tr>
<tr><td>Temperature (2)</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Operating</td><td>T_J</td><td colspan="4">← −55 to +150 →</td><td>°C</td></tr>
<tr><td>Storage</td><td>T_{STG}</td><td colspan="4">← −55 to +150 →</td><td>°C</td></tr>
<tr><td>Lead Soldering, 1/16" ± 1/32" from case for 10 seconds max.</td><td>T_L</td><td colspan="4">← +260 →</td><td>°C</td></tr>
</table>

NOTES:

(1) Refer to the Safe Region of Operation curve for further information.
(2) Case temperature reference point is indicated on the Dimensional Outline Drawing.

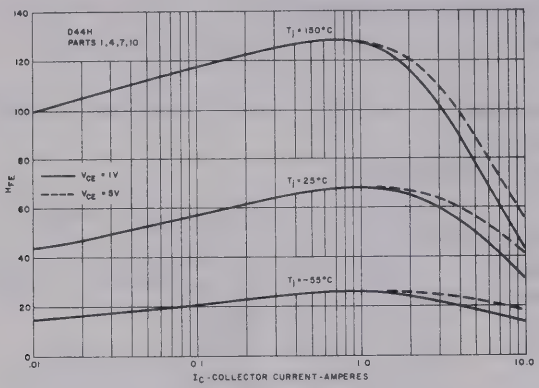
electrical characteristics: (25°C unless otherwise specified)

			Min.	Max.	
Forward Current Transfer Ratio					
(V_{CE} = 1V, I_C = 2A)	D44H1, 4, 7, 10	h_{FE}	35	–	Volts
	D44H2, 5, 8	h_{FE}	60	–	Volts
(V_{CE} = 1V, I_C = 4A)	D44H1, 4, 7, 10	h_{FE}	20	–	Volts
	D44H2, 5, 8	h_{FE}	40	–	Volts
Collector to Emitter Sustaining Voltage (3)					
(I_C = 100 mA)	D44H1, 2	$V_{CEO(SUS)}$	30	–	Volts
	D44H4, 5		45	–	Volts
	D44H7, 8		60	–	Volts
	D44H10		80	–	Volts
Collector Saturation Voltage (3)					
(I_C = 8A, I_B = 0.4A)	D44H2, 5, 8	$V_{CE(SAT)}$	–	1.0	Volt
(I_C = 8A, I_B = 0.8A)	D44H1, 4, 7, 10	$V_{CE(SAT)}$	–	1.0	Volt
Base Saturation Voltage (3)					
(I_C = 8A, I_B = 0.8A)		$V_{BE(SAT)}$	–	1.5	Volts
On-Voltage					
(I_C = 10 mA, V_{CE} = 2V)		$V_{BE(on)}$	0.52	0.62	Volts
Collector Cutoff Current					
(V_{CE} = Rated V_{CEO}, T_J = 25°C)		I_{CBO}	–	10	μA
Emitter Cutoff Current					
(V_{EB} = 5V, T_J = 25°C)		I_{EBO}	–	100	μA

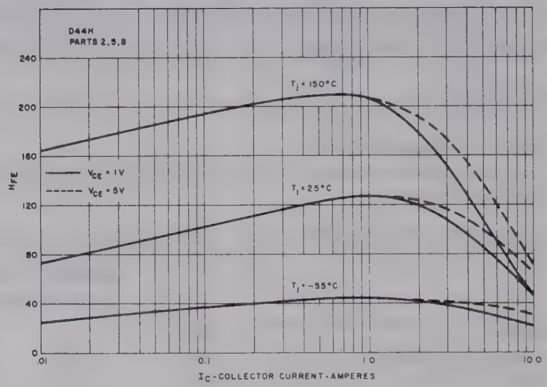
			Typ.		
Collector Capacitance (V_{CB} = 10V, f = 1 MHz)	C_{CBO}	–	130	–	pF
Gain Bandwidth Product (V_{CE} = 10V, I_C = 500 mA)	f_t	–	50	–	MHz
Switching Times					
Rise Time and Delay Time (I_C = 5A, I_{B1} = 0.5A)	$t_d + t_r$		300		nsec
Storage Time (I_C = 5A, I_{B1} = I_{B2} = 0.5A)	t_s		500		nsec
Fall Time (I_C = 5A, I_{B1} = I_{B2} = 0.5A)	t_f		140		nsec

NOTE:

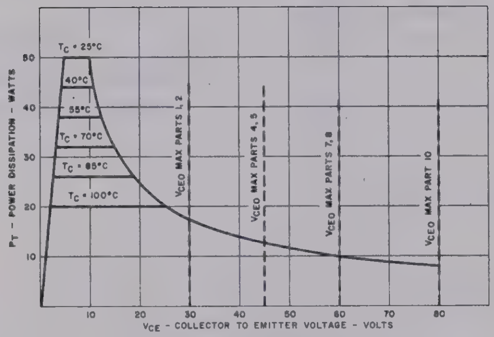
(3) Pulsed measurement, 300 μsec pulse, duty cycle ≤ 2%.



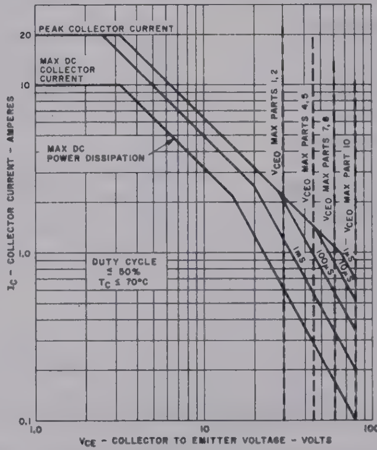
TYPICAL GAIN CHARACTERISTICS



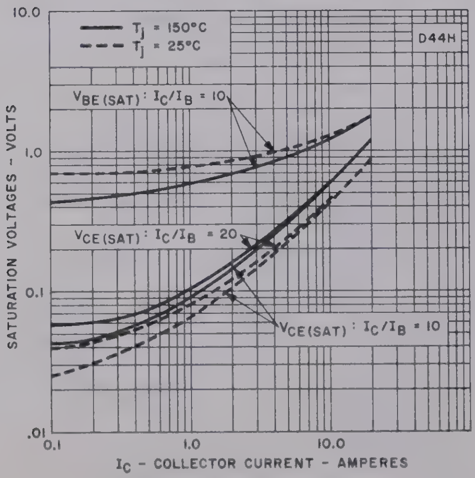
TYPICAL GAIN CHARACTERISTICS



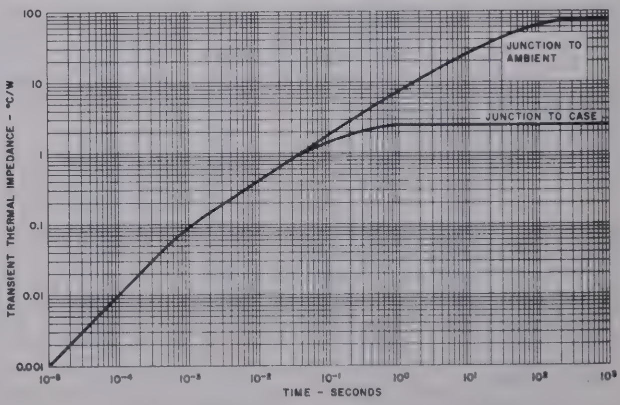
MAXIMUM PERMISSIBLE DC POWER DISSIPATION



SAFE REGION OF OPERATION



TYPICAL SATURATION VOLTAGE CHARACTERISTICS

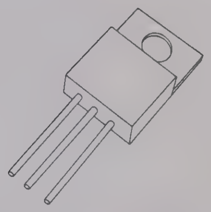


TRANSIENT THERMAL IMPEDANCE

Silicon
Power Pac
Transistors
HIGH VOLTAGE

NPN
D44R

The General Electric D44R is a red, silicone encapsulated, power transistor designed for various specific and general purpose applications such as: 120 V.A.C. line operated amplifiers; series, shunt and switching regulators; low thru high frequency inverters/converters; t-v and other display tube deflection; and many others.



Compatible with JEDEC TO-220AB mounting registration

FEATURING:

- Red for NPN
- Very low collector saturation voltage
- Excellent linearity
- Fast switching
- Round leads
- ***POWER-GLAS*** passivated mesa
- Hard solder mountdown

absolute maximum ratings: (25°C unless otherwise specified)

		D44R1 D44R2	D44R3 D44R4	Units
Voltages				
Collector to Emitter	V_{CEO}	250	300	Volts
Emitter to Base	V_{CES}	400	500	Volts
	V_{EBO}	5		Volts
Current				
Collector (Cont.)	I_C	1.0		Amp.
Power Dissipation(1)				
Tab at 25°C	P_T	31.25		Watts
Tab at 70°C		20.0		Watts
Free Air at 25°C		1.67		Watts
Free Air at 50°C		1.33		Watts
Thermal Resistance				
Junction to Case	$R_{\theta JC}$	4.0		°C/W
Junction to Ambient	$R_{\theta JA}$	75		°C/W
Temperature (2)				
Operating	T_J	−55 to +150		°C
Storage	T_{STG}	−55 to +250		°C
Lead Soldering, 1/16" ± 1/32" from case for 10 seconds max.	T_L	+260		°C

NOTES:
(1) Refer to the Safe Region of Operation curve for further information.
(2) Case temperature reference point is indicated on the Dimensional Outline Drawing.

electrical characteristics: (25°C unless otherwise specified)

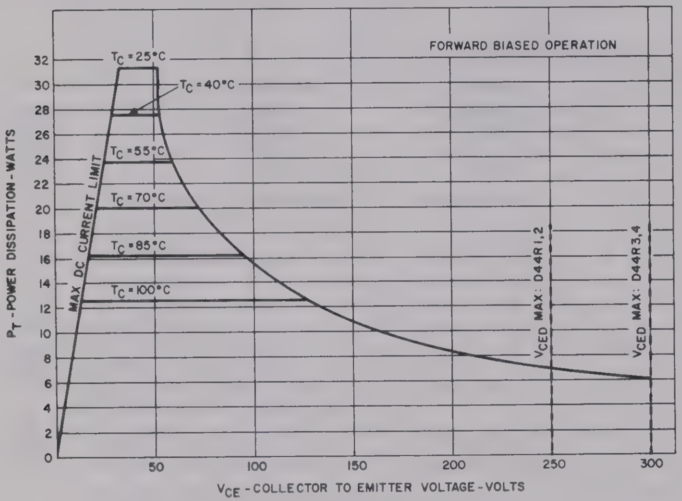
		Min.	Typ.	Max.	Units
Forward Current Transfer Ratio					
@ I_C = 500 ma, V_{CE} = 10V	h_{FE}				
D44R1, 3		30	75	90	Volts
D44R2, 4		75	–	175	Volts
@ I_C = 50 ma, V_{CE} = 10V	h_{FE}				
D44R1, 3		20	65	–	Volts
D44R2, 4		40	–	–	Volts
Collector to Emitter Sustaining Voltage(2)					
@ I_C = 100 ma	$V_{CEO(SUS)}$				
D44R1, 2		250	–	–	Volts
D44R3, 4		300	–	–	Volts
Collector to Emitter Saturation Voltage(1)					
@ I_C = 500 ma I_B = 50 ma	$V_{CE(SAT)}$	–	0.4	1.0	Volts
Base to Emitter Saturation Voltage(1)					
@ I_C = 500 ma I_B = 50 ma	$V_{BE(SAT)}$	–	–	1.2	Volts
Collector Cut-off Current(1)					
V_{CES} = Max. Rating	I_{CES}	–	–	1.0	ma

Electrical Characteristics (Continued)

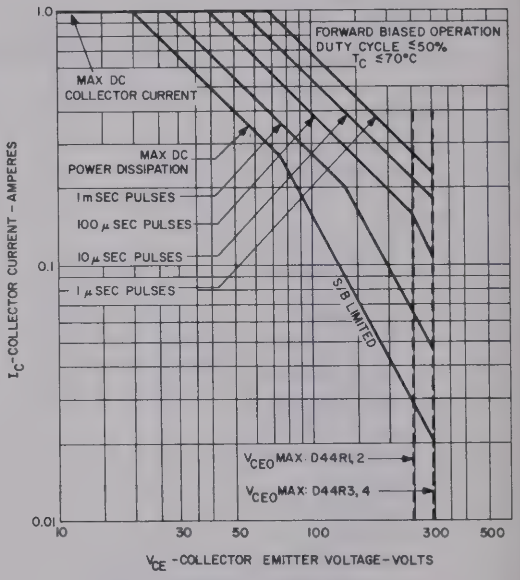
		Min.	Typ.	Max.	Units
Emitter Cut-off Current (V_{EB} = 5V, T_J = 25°C)	I_{EBO}	–	–	10	μA
Collector Capacitance (V_{CB} = 10V, f = 1MHz)	C_{CBO}	–	30	–	pF
Gain Bandwidth Product (V_{CE} = 10V, I_C = 100 mA)	f_t	20	40	–	MHz
Switching Times					
Rise Time and Delay Time (I (I_C = 500 mA, I_{B1} = 100 mA)	$t_d + t_r$	–	3.7	–	μsec
Storage Time (I_C = 500 mA, I_{B1} = I_{B2} = 100 mA)	t_s	–	.6	–	μsec
Fall Time ((I_C = 500 ma, I_{B1} = I_{B2} = 100 ma)	t_f	–	1.9	–	μsec

NOTES:

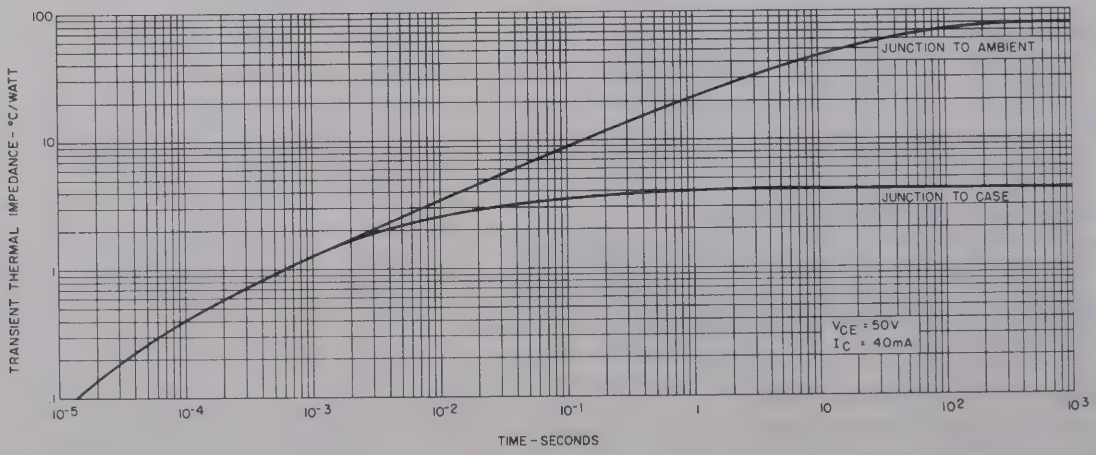
(1) Pulsed measurement, 300 μsec. pulse, Duty cycle ≦ 2%.



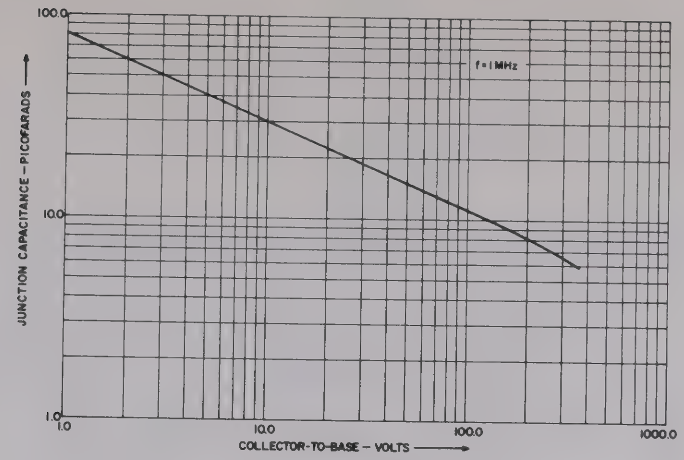
MAXIMUM PERMISSIBLE DC POWER DISSIPATION



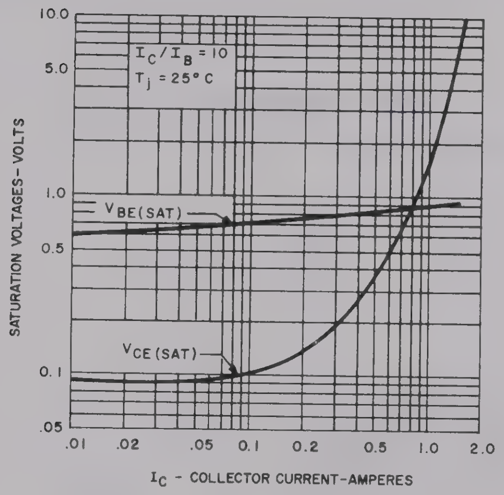
SAFE REGION OF OPERATION



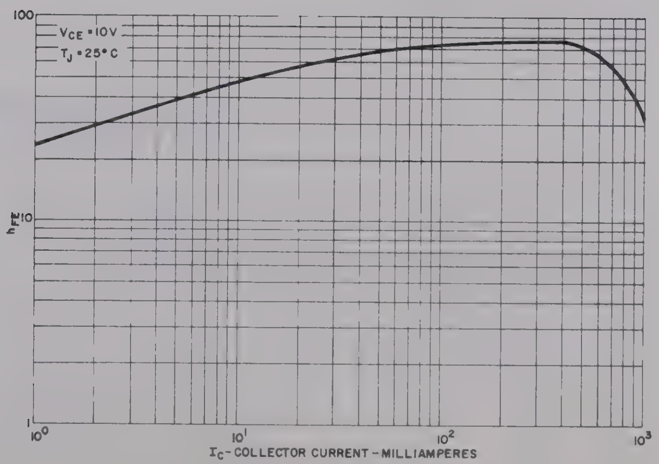
MAXIMUM TRANSIENT THERMAL IMPEDANCE



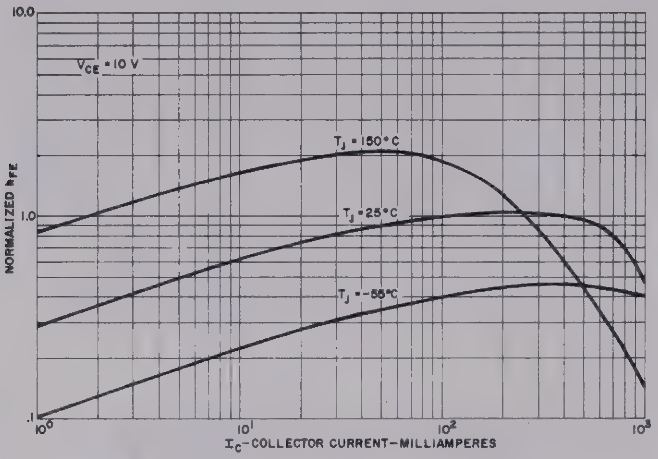
COLLECTOR-TO-BASE JUNCTION CAPACITANCE VS. REVERSE BIAS VOLTAGE



TYPICAL SATURATION VOLTAGE CHARACTERISTICS

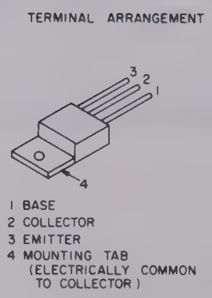


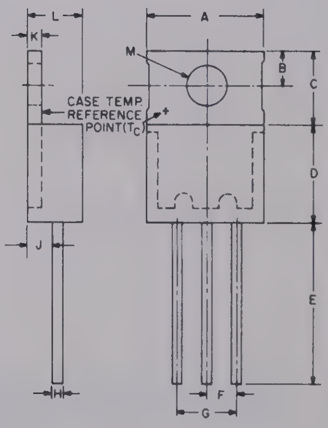
TYPICAL h_{FE} VS. I_C



TYPICAL NORMALIZED h_{FE} VS. I_C

Sym.	Dec. In.		Metric MM	
	Min.	Max.	Min.	Max.
A	.390	.420	9.91	10.67
B	.110	.120	2.79	3.05
C	.240	.260	6.10	6.61
D	.325	.355	8.26	9.02
E	.500	——	12.7	——
F	.095	.105	2.41	2.67
G	.190	.210	4.82	5.34
H	.029	.035	.73	.89
J	.085	.115	2.16	2.92
K	.040	.060	1.02	1.52
L	.160	.190	4.06	4.83
M	.141	.145	3.58	3.68
N	——	.065	——	1.65


TERMINAL ARRANGEMENT
3
2
1
4
1 BASE
2 COLLECTOR
3 EMITTER
4 MOUNTING TAB
(ELECTRICALLY COMMON
TO COLLECTOR)


L
K
A
M
B
C
CASE TEMP.
REFERENCE
POINT(T_C)
D
J
E
H
F
G

POWER PAC POWER TRANSISTOR DIMENSIONAL OUTLINES

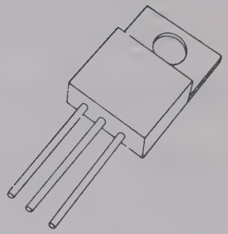
FOR OPTIONAL LEAD CONFIGURATIONS SEE SELECTOR GUIDE P. 117

Silicon
Power Pac
Transistors
"Color Molded"

PNP

D45C

The General Electric D45C is a green, silicone plastic encapsulated, power transistor designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1.0 MHz; series, shunt and switching regulators; low and high frequency inverters/converters; and many others.



Green

JEDEC TO-220 A B

FEATURING:

- PNP complement to D44C NPN
- Green for PNP, red for NPN
- Very low collector saturation voltage (−0.5V typ. @ −3.0A I_C)
- Excellent linearity
- Fast switching
- Round leads
- Hard solder mountdown

absolute maximum ratings: (25°C) (unless otherwise specified)

		D45C1 D45C2 D45C3	D45C4 D45C5 D45C6	D45C7 D45C8 D45C9	D45C10 D45C11	
Voltages						
Collector to Emitter	V_{CEO}	−30	−45	−60	−80	Volts
Emitter to Base	V_{EBO}	− 5	− 5	− 5	− 5	Volts
Collector to Emitter	V_{CES}	−40	−55	−70	−90	Volts
Current(1)						
Collector (Continuous)	I_C	−4				Amps
Collector (Peak)		−6				Amps
Power Dissipation(1)						
Tab at 25°C	P_T	30				Watts
Tab at 70°C		19				Watts
Free Air at 25°C		1.67				Watts
Free Air at 50°C		1.33				Watts
Thermal Resistance(2)						
Junction to Case	$R_{\theta JC}$	4.2				°C/W
Junction to Ambient	$R_{\theta JA}$	75				°C/W
Temperature(2)						
Operating	T_J	−55 to +150				°C
Storage	T_{STG}	−55 to +150				°C
Lead Soldering, 1/16" ± 1/32" from case for 10 seconds max.	T_L	+260				°C

Notes:
(1) Refer to the Safe Region of Operation curve for further information.
(2) Case temperature reference point is indicated on the Dimensional Outline Drawing.

electrical characteristics: (25°C) (unless otherwise specified)

		D45C3 D45C6 D45C9		D45C2 D45C5 D45C8 D45C11		D45C1 D45C4 D45C7 D45C10
		Min.	Max.	Min.	Max.	Min.
Forward Current Transfer Ratio						
($V_{CE} = -1V$, $I_C = -0.2A$)	h_{FE}	40	—	40	120	25
($V_{CE} = -1V$, $I_C = -2A$)	h_{FE}	20	—	—	—	—
($V_{CE} = -1V$, $I_C = -1A$)	h_{FE}	—	—	20	—	10

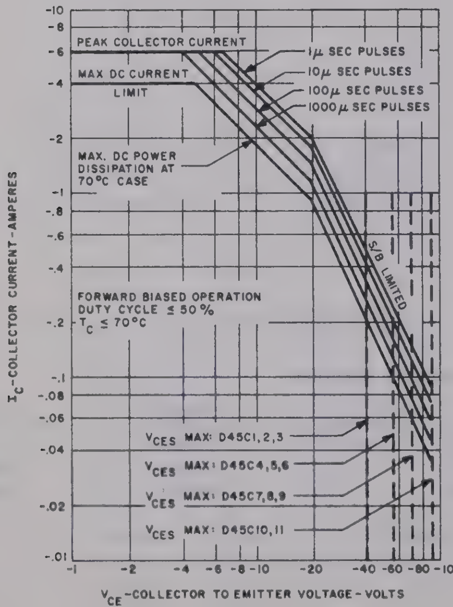
Electrical Characteristics (Continued)

		Min.	Max.	
Collector to Emitter Sustaining Voltage(3)				
($I_C = -100$ mA) D45C1, 2, 3	$V_{CEO(SUS)}$	−30	—	Volts
D45C4, 5, 6		−45	—	Volts
D44C7,8,9		−60	—	Volts
D44C10,11		−80	—	Volts
Collector Saturation Voltage(3)				
($I_C = -1$A, $I_B = -50$ mA) D45C2,3,5,6,8,9,11	$V_{CE(SAT)}$	—	−0.5	Volt
($I_C = -1$A, $I_B = -100$ mA) D45C1,4,7,10	$V_{CE(SAT)}$	—	−0.5	Volt
Base Saturation Voltage(3)				
($I_C = -1$A, $I_B = -100$ mA)	$V_{BE(SAT)}$	—	−1.3	Volts
Collector Cutoff Current				
(V_{CE} = Rated V_{CES}, $T_J = 25°C$)	I_{CES}	—	−10	μA
Emitter Cutoff Current				
($V_{EB} = -5V$, $T_J = 25°C$)	I_{EBO}	—	−100	μA
Collector Capacitance				
($V_{CB} = 10V$, f = 1 MHz)	C_{CBO}	—	125	pF

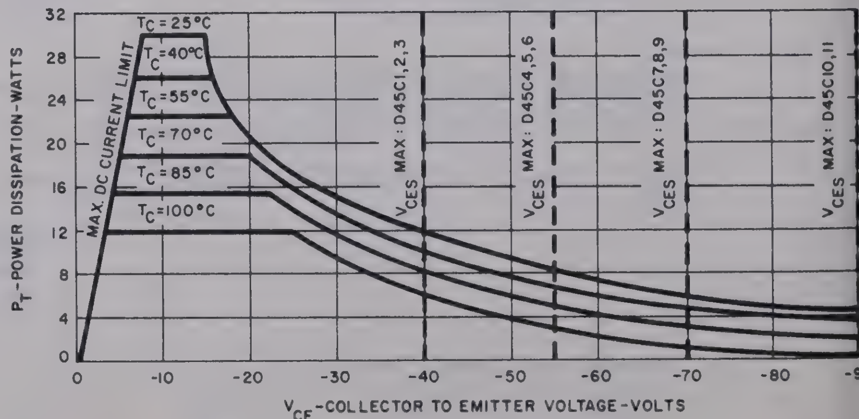
		Typ.	
Gain Bandwidth Product			
($V_{CE} = -4V$, $I_C = -20$ mA)	f_t	40	MHz
Switching Times			
Rise Time and Delay Time ($I_C = -1$A, $I_{B1} = -0.1$A)	$t_d + t_r$	50	nsec
Storage Time ($I_C = -1$A, $I_{B1} = I_{B2} = -0.1$A)	t_s	500	nsec
Fall Time ($I_C = -1$A, $I_{B1} = I_{B2} = -0.1$A)	t_f	50	nsec

Note:

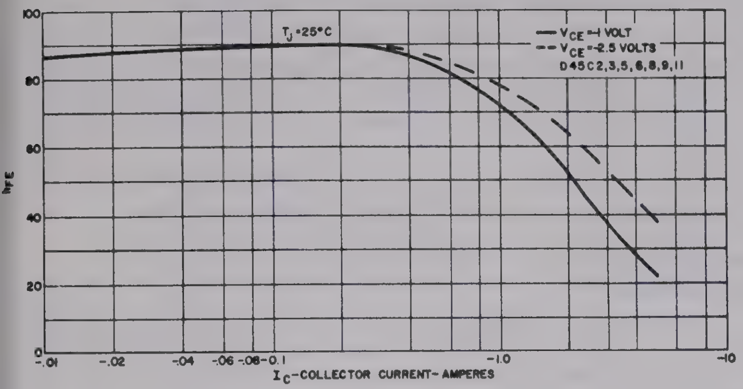
(8) Pulsed measurement, 300 μsec pulse, duty cycle ≦2%.



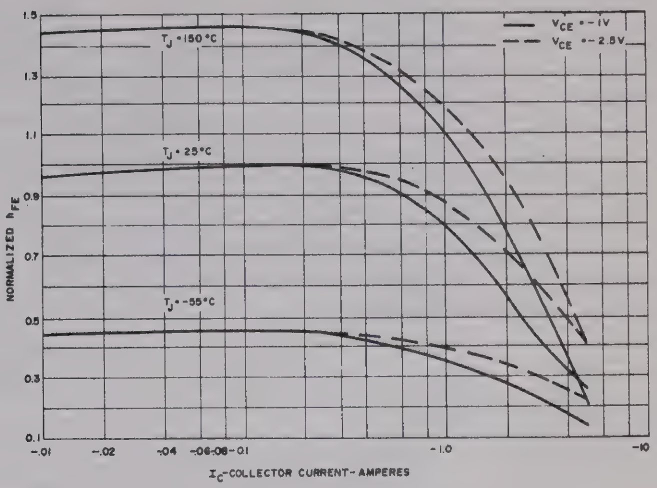
SAFE REGION OF OPERATION



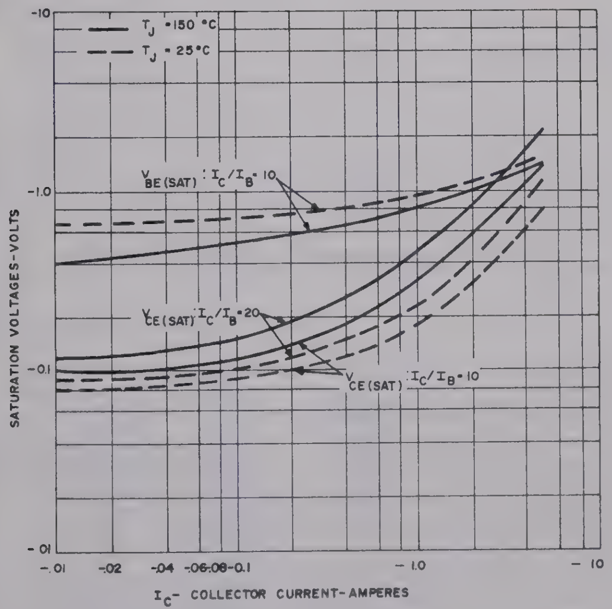
MAXIMUM PERMISSIBLE DC POWER DISSIPATION



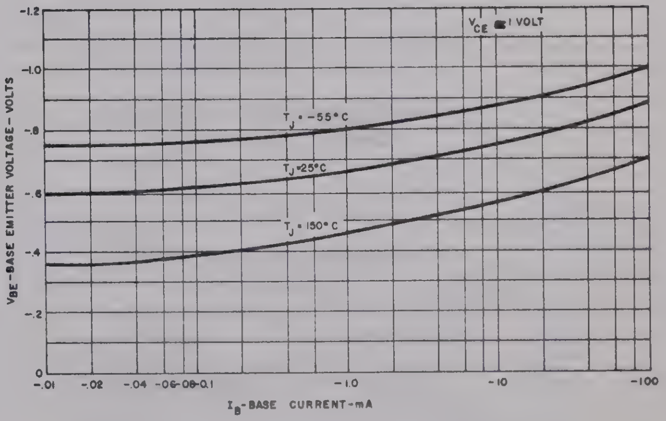
TYPICAL h_{FE} VS. I_C



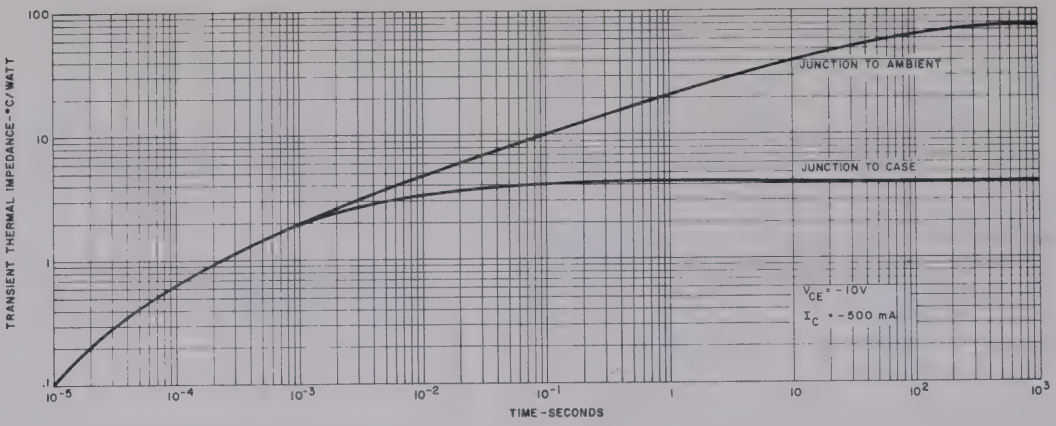
TYPICAL NORMALIZED h_{FE} VS. I_C



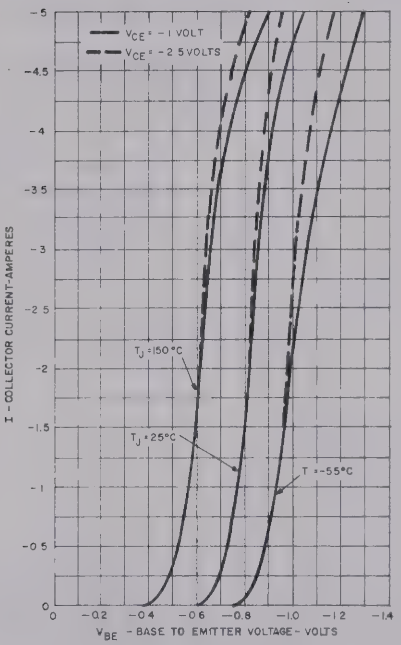
TYPICAL SATURATION VOLTAGE CHARACTERISTICS



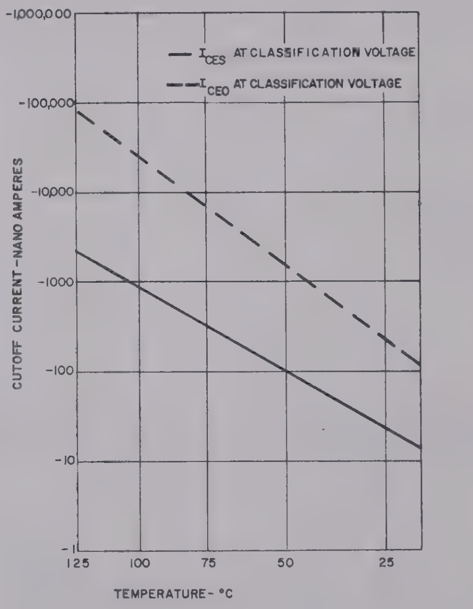
TYPICAL INPUT CHARACTERISTICS



MAXIMUM TRANSIENT THERMAL IMPEDANCE

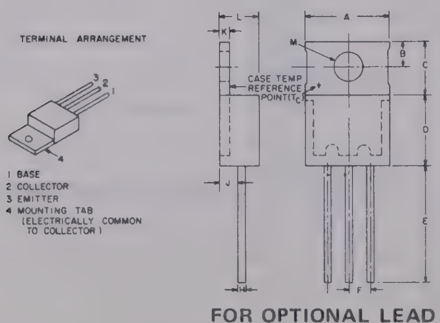


TYPICAL TRANSCONDUCTANCE CHARACTERISTICS



TYPICAL I_{CEO}, I_{CES} VS. TEMPERATURE

DIMENSIONAL OUTLINES


TERMINAL ARRANGEMENT
1
2
3
4
1 BASE
2 COLLECTOR
3 EMITTER
4 MOUNTING TAB (ELECTRICALLY COMMON TO COLLECTOR)
L
K
A
M
B
C
CASE TEMP REFERENCE POINT(T_C)
D
J
E
F

Sym.	Dec. In.		Metric MM	
	Min.	Max.	Min.	Max.
A	.390	.420	9.91	10.67
B	.110	.120	2.79	3.05
C	.240	.260	6.10	6.61
D	.325	.355	8.26	9.02
E	.500	——	12.7	——
F	.095	.105	2.41	2.67
G	.190	.210	4.82	5.34
H	.029	.035	.73	.89
J	.085	.115	2.16	2.92
K	.040	.060	1.02	1.52
L	.160	.190	4.06	4.83
M	.141	.145	3.58	3.68
N	——	.065	——	1.65

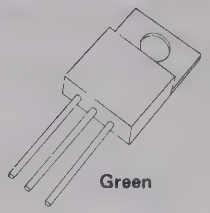
FOR OPTIONAL LEAD CONFIGURATIONS SEE SELECTOR GUIDE P. 117

Silicon
Power Pac
Transistors

"Color Molded"

PNP
D45H

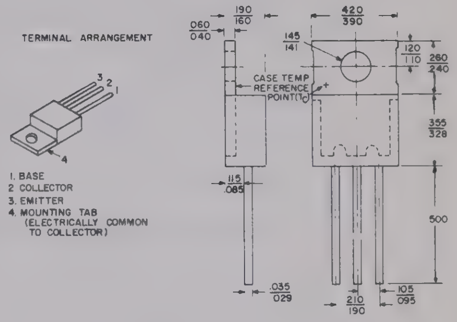
The General Electric D45H is a green, silicone plastic encapsulated, power transistor designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1.0 MHz; series, shunt and switching regulators; low and high frequency inverters/converters; and many others.


Green

JEDEC TO-220 A B

FEATURING:

- PNP complement to D44H NPN
- Green for PNP, red for NPN
- Very low collector saturation voltage (−0.37 V typ. @ −5.0 A I_C)
- Excellent linearity
- Fast switching
- Round leads
- Hard solder mount down



Dimensional Outlines

FOR OPTIONAL LEAD CONFIGURATIONS SEE SELECTOR GUIDE P. 117

absolute maximum ratings: (25°C unless otherwise specified)

		D45H1 D45H2	D45H4 D45H5	D45H7 D45H8	D45H10	
Voltages						
Collector to Emitter	V_{CEO}	−30	−45	−60	−80	Volts
Emitter to Base	V_{EBO}	− 5	− 5	− 5	− 5	Volts
Current (1)						
Collector (Continuous)	I_C	← −10 →				Amps
Collector (Peak)		← −20 →				Amps
Power Dissipation (1)						
Tab at 25°C	P_T	← 50 →				Watts
Tab at 70°C		← 32 →				Watts
Free Air at 25°C		← 1.67 →				Watts
Free Air at 50°C		← 1.33 →				Watts
Thermal Resistance (2)						
Junction to Case	$R_{\theta JC}$	← 2.5 →				°C/W
Junction to Ambient	$R_{\theta JA}$	← 75 →				°C/W
Temperature (2)						
Operating	T_J	← −55 to +150 →				°C
Storage	T_{STG}	← −55 to +150 →				°C
Lead Soldering, 1/16" ± 1/32" from case for 10 seconds max.	T_L	← +260 →				°C

NOTES:
(1) Refer to the Safe Region of Operation curve for further information
(2) Case temperature reference point is indicated on the Dimensional Outline Drawing.

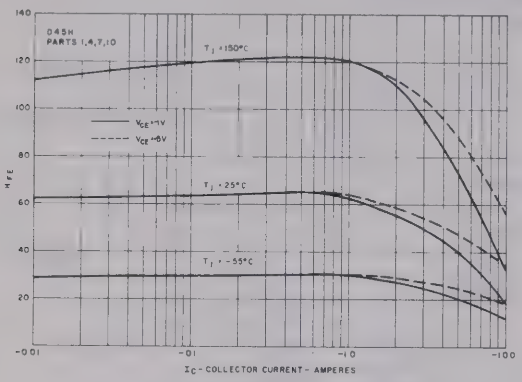
electrical characteristics: (25°C unless otherwise specified)

			Min.	Max.	
Forward Current Transfer Ratio					
(V_{CE} = −1V, I_C = −2A)	D45H1, 4, 7, 10	h_{FE}	35	–	Volts
	D45H2, 5, 8	h_{FE}	60	–	Volts
(V_{CE} = −1V, I_C = −4A)	D45H1, 4, 7, 10	h_{FE}	20	–	Volts
	D45H2, 5, 8	h_{FE}	40	–	Volts
Collector to Emitter Sustaining Voltage (3)					
(I_C = −100 mA)	D45H1, 2	$V_{CEO}(SUS)$	−30	–	Volts
	D45H4, 5		−45	–	Volts
	D45H7, 8		−60	–	Volts
	D45H10		−80	–	Volts
Collector Saturation Voltage (3)					
(I_C = −8A, I_B = −0.4A)	D45H2, 5, 8	$V_{CE}(SAT)$	–	−1.0	Volt
(I_C = −8A, I_B = −0.8A)	D45H1, 4, 7, 10	$V_{CE}(SAT)$	–	−1.0	Volt
Base Saturation Voltage (3)					
(I_C = −8A, I_B = −0.8A)		$V_{BE}(SAT)$	–	−1.5	Volts
On-Voltage					
(I_C = 10 mA, V_{CE} = 2V)		$V_{BE(on)}$	0.54	0.64	Volts
Collector Cutoff Current					
(V_{CE} = Rated V_{CEO}, T_J = 25°C)		I_{CBO}	–	−10	μA
Emitter Cutoff Current					
(V_{EB} = −5V, T_J = 25°C)		I_{EBO}	–	−100	μA

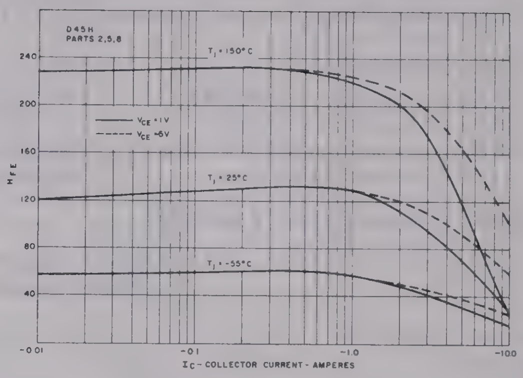
		Typ.	
Collector Capacitance			
(V_{CB} = 10V, f = 1 MHz)	C_{CBO}	230	pF
Gain Bandwidth Product			
(V_{CE} = −10V, I_C = −500 mA)	f_t	40	MHz
Switching Times			
Rise Time and Delay Time			
(I_C = −5A, I_{B1} = −0.5A)	$t_d + t_r$	135	nsec
Storage Time			
(I_C = −5A, I_{B1} = I_{B2} = −0.5A)	t_s	500	nsec
Fall Time			
(I_C = −5A, I_{B1} = I_{B2} = −0.5A)	t_f	100	nsec

NOTE:

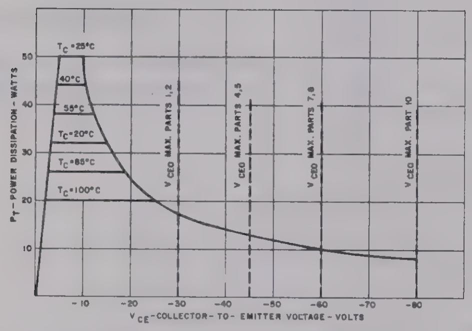
(3) Pulsed measurement, 300 μsec pulse, duty cycle ≤ 2%.



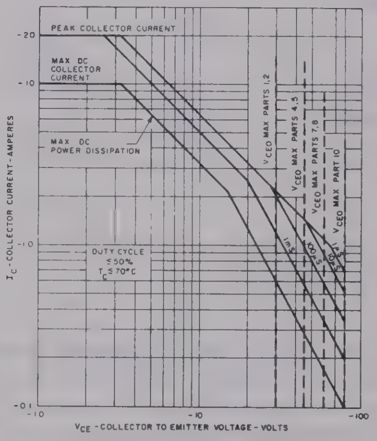
TYPICAL GAIN CHARACTERISTICS



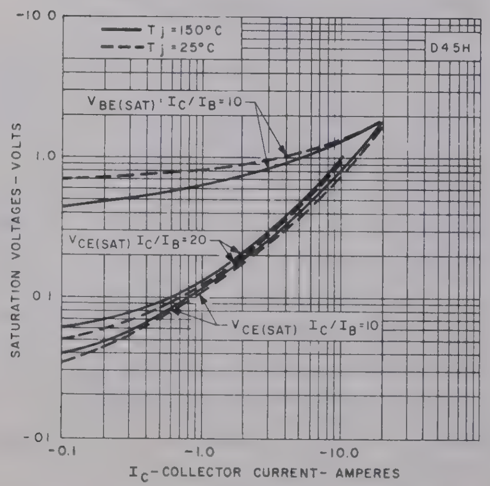
TYPICAL GAIN CHARACTERISTICS



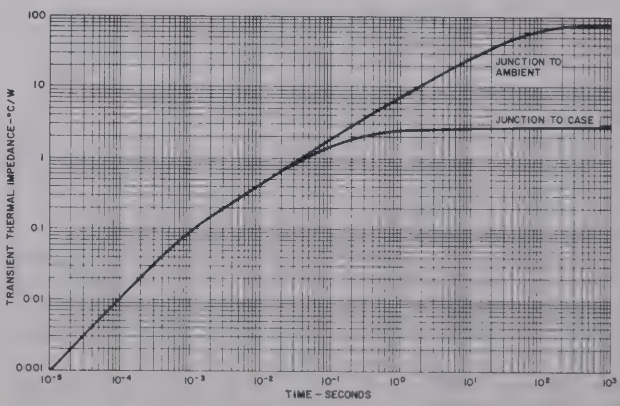
MAXIMUM PERMISSIBLE DC POWER DISSIPATION



SAFE REGION OF OPERATION



TYPICAL SATURATION VOLTAGE CHARACTERISTICS



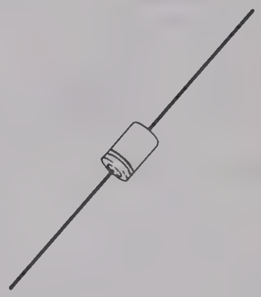
TRANSIENT THERMAL IMPEDANCE

Silicon
Diodes

DA1701-4

This family of General Electric Double Heatsink Diodes are very high speed switching diodes for computer circuits and general purpose applications. These diodes incorporate an oxide passivated epitaxial pellet with a raised solid silicon anode contact.

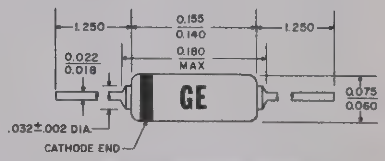
These DA-series diodes *exceed* the electrical and mechanical requirements of the following JEDEC devices:



DA1701		**DA1702**	**DA1703**
1N914	1N4153	1N4151	1N4152
1N914A	1N4154	1N4152	1N4154
1N916	1N4446	1N4153	1N4727
1N916A	1N4447	1N4154	
1N4148	1N4448	1N4454	
1N4149	1N4454	1N4727	
1N4151	1N4727		
1N4152			

Standard Cathode Band and Body Marking Colors:

DA1701 — Violet
DA1702 — Yellow
DA1703 — Green
DA1704 — Black
Body marking will consist *only* of the GE symbol



NOTE: ALL DIMENSIONS IN INCHES

absolute maximum ratings: (25°C)

<table>
<tr><th></th><th>DA1701</th><th>DA1702</th><th>DA1703</th><th>DA1704</th><th></th></tr>
<tr><td>Voltage</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Reverse</td><td>100</td><td>75</td><td>40</td><td>25</td><td>Volts</td></tr>
<tr><td>Current</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Average Rectified I_o</td><td colspan="4">200</td><td>mA</td></tr>
<tr><td>Recurrent Peak Forward I_F peak</td><td colspan="4">600</td><td>mA</td></tr>
<tr><td>Forward Steady State D-C</td><td colspan="4">150</td><td>mA</td></tr>
<tr><td>Peak Forward Surge (1μ sec)</td><td colspan="4">4</td><td>Amps</td></tr>
<tr><td>Derate above 25°C</td><td colspan="4">1.1</td><td>mA/°C</td></tr>
<tr><td>Temperature</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Operating</td><td colspan="4">−65 to +175</td><td>°C</td></tr>
<tr><td>Storage</td><td colspan="4">−65 to +200</td><td>°C</td></tr>
</table>

Power Dissipation

Heatsink Spacing From End of Diode Body	Power Dissipation at 25°C (mW) (Note 1)	Steady State Thermal Resistance (°C/mW)
0.125 inches	700	0.250
0.250 inches	550	0.319
0.500 inches	460	0.380

Note 1: The maximum power dissipation is defined as the heat dissipating capability of the diode when operated at 25°C as an A-C signal device within the absolute maximum voltage and current ratings specified above. The power rating is based on a maximum junction temperature of 200°C. The steady state thermal resistance (°C/mW) can be used to calculate the power dissipating capabilities, within the maximum voltage and current ratings, at temperatures other than 25°C.

electrical characteristics: (25°C) (unless otherwise specified)

		DA1701		DA1702		DA1703		DA1704		
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Forward Voltage	V_F									
($I_F = 0.100$mA)		0.490	0.550	0.490	0.550	0.490	0.550	0.460	0.570	Volts
($I_F = 1.0$ mA)		0.590	0.650	0.590	0.650	0.590	0.650	0.570	0.680	Volts
($I_F = 10$ mA)		0.700	0.810	0.700	0.810	0.700	0.810	0.680	0.850	Volts
($I_F = 30$ mA, Note 2)		0.780	0.930	0.780	0.930	0.780	0.930	0.740	1.00	Volts
($I_F = 50$ mA, Note 2)		0.830	1.00	0.830	1.00	0.830	1.00	0.770	1.10	Volts
($I_F = 100$ mA, Note 2)		0.935	1.10	0.935	1.10	0.935	1.10	0.820	1.30	Volts
Reverse Current	I_R									
($V_R = 15$ Volts)									50	nA
($V_R = 20$ Volts)									100	nA
($V_R = 30$ Volts)			30		30		50			nA
($V_R = 30$ Volts, $T_A = 150°C$)			30		30		50			µA
($V_R = 50$ Volts)			50		50					nA
($V_R = 50$ Volts, $T_A = 150°C$)			50		50					µA
($V_R = 75$ Volts)			5							µA
Breakdown Voltage	B_V									
($I_R = 5\mu A$)				75		40		25		Volts
($I_R = 100\mu A$)		100								Volts
Stored Charge	Q_S									
($I_F = 10$mA, Note 3)			40		40		40		40	pC
Peak Forward Voltage	V_P									
($I_F = 50$mA, tr = 10nS, Note 4)			3.0		2.75		1.75		1.75	Volts
Capacitance	C_O									
($V_R = 0V$, f = 1MHz, Signal Level = 50mV, Note 5)			1.0		1.0		2.0		3.0	pF

Note 2: Pulsed measurement with pulse width $\leq 350\mu$ Sec, duty cycle $\leq 2\%$.

Note 3: Test method per JEDEC suggested standard number for direct measurement of diode stored charge, B-Line Electronics Corporation stored charge meter Model QS-3 or equivalent.

Note 4: Measured per EIA Standard RS-286.

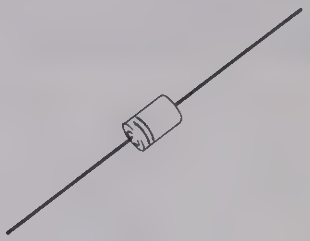
Note 5: Capacitance as measured on Boonton Electronics Model 75A Capacitance Bridge (or equivalent).

Silicon
Diodes

PN

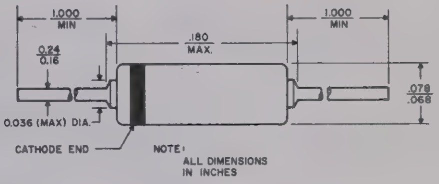
DHD800,5,6

General Electric types DHD800, DHD805 and DHD806 are high speed silicon signal diodes intended for general purpose applications. The DHD800 series has controlled conductance characteristics for stabistor applications.



absolute maximum ratings: (25°C) (unless otherwise specified)

Voltage		
Reverse DHD800	2	Volts
DHD805	15	Volts
DHD806	25	Volts
Current		
Forward Steady State DC	70	mA
Recurrent Peak Forward	135	mA
Power		
Dissipation	150	mW
Temperature		
Operating	−55 to 125°C	



electrical characteristics: (25°C) (unless otherwise specified)

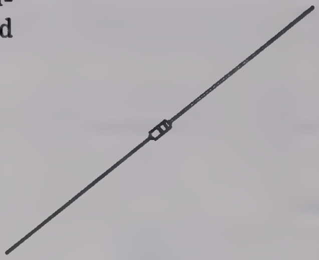
		Min.	Typ.	Max.	
Forward Voltage					
($I_F = 0.100$ mA)	V_{F1}	0.430		0.550	Volts
($I_F = 1.0$ mA)	V_{F1}	0.530		0.690	Volts
($I_F = 2.0$ mA)	V_{F1}	0.560		0.720	Volts
($I_F = 10$ mA)	V_{F1}	0.640		0.800	Volts
($I_F = 100$ mA, Pulsed)	V_{F1}	0.800		1.300	Volts
Reverse Current					
DHD800 ($V_R = 2V$)	I_R			2.0	μA
DHD805 ($V_R = 12V$)	I_R			2.0	μA
DHD806 ($V_R = 22V$)	I_R			2.0	μA
Breakdown Voltages					
DHD805 ($I_R = 5\ \mu A$)	B_V	15			Volts
DHD806 ($I_R = 5\ \mu A$)	B_V	25			Volts
Stored Charge					
($I_F = 10$ mA)	Q_s		40		pC
Capacitance					
($V_R = 0V$)*	C_o		4		pF

*Capacitance as measured on Boonton Model 75A capacitance bridge at a signal level of 50 mV and a frequency of 1 MHz.

Low Current
Rectifier

DT230 SERIES

The General Electric DT230 250 milliampere rectifier is a planar epitaxial passivated rectifier sealed in the DO35 double heatsink package. The DT230 is designed primarily for the industrial and consumer markets.

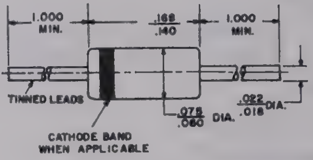


Features

Glass Package
Hermetic Seal
Capable of 15 lb. Lead Pull
Proved Design—GE innovated DHD package
Silicon Anode Contact Pellet
Eutectic Bond Between Pellet and Slugs

Typical Applications

Color Television Difference Amplifier Clamp
Arc Protection Color Television Video Output
Low Current Power Supply Rectification
Operational Amplifiers
Measurement Systems
Arc Suppression
DC to DC Converters
Free Wheeling Rectifiers
Telephone Equipment Switching

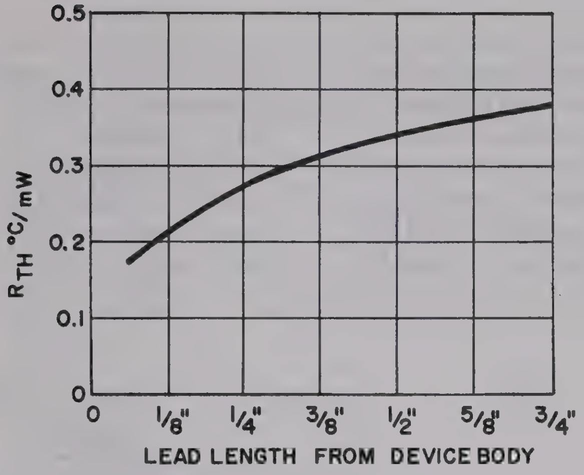


maximum ratings (25°C) (unless otherwise specified)

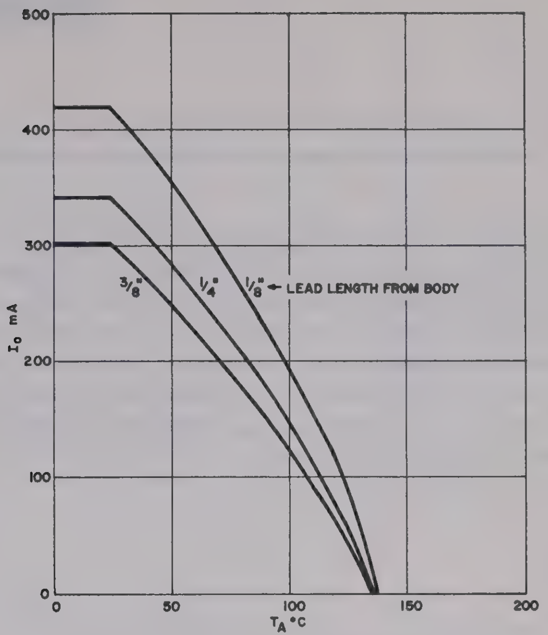
DT230	H	HI	B	G	A	F	
Reverse Voltage Working	250	250	200	150	100	50	Volts
Peak, V_{RM}, DC, V_R	250	250	200	150	100	50	Volts
Average Forward Current I_O @ 50°C	250						mA
Peak Forward Surge I_{FSM} Non-Repetitive .0083 sec. half sine wave	5						A
Maximum Average Power	350						mW
Junction Temperature Storage Tstg	−65 to 200						°C
Temperature Operating Junction T_J	−65 to 150						°C

characteristics

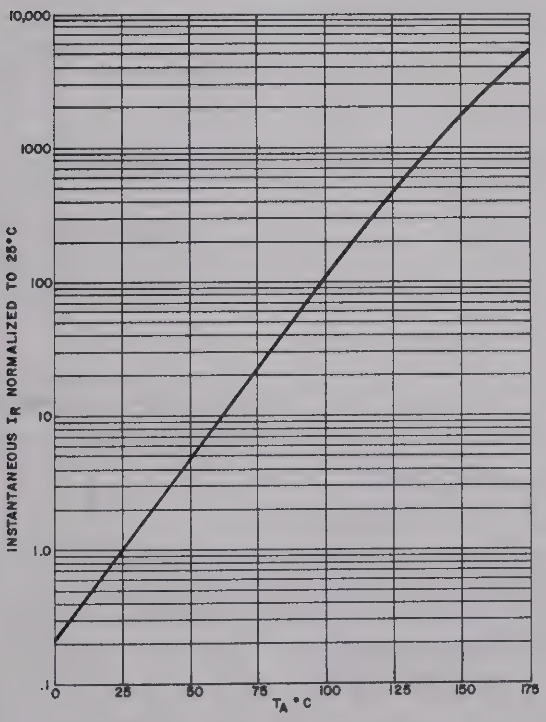
DT230 Part No.	H	HI	B	G	A	F	
Maximum Forward Voltage Drop V_F @ 25°C	—						
I_F = 250 ma		1.1	1.1	1.1	1.1	1.1	Volts
I_F 200 ma	1.0	—	—	—	—	—	Volts
Maximum Reverse Current @ V_{RM}							
I_R 25°C	1						µA
I_R 100°C	300						µA
Reverse Recovery Time, trr							
Typical	30						ηsec
Maximum	300						ηsec
Capacitance							
$V_R = 0$ C_O Typical	2						pF
Maximum	5						pF



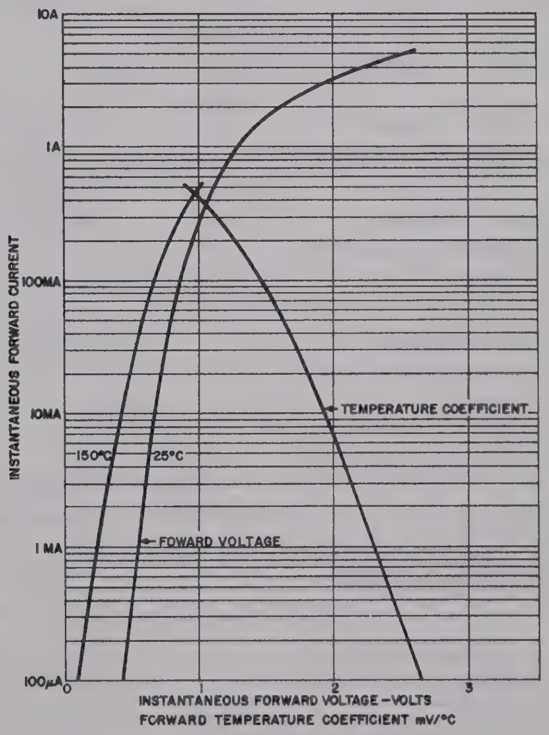
TYPICAL THERMAL IMPEDANCE
VS. LEAD LENGTH



AVERAGE FORWARD CURRENT VS.
AMBIENT TEMPERATURE
SINGLE PHASE OPERATION



TYPICAL REVERSE CURRENT
VS. TEMPERATURE AT V_{RM}



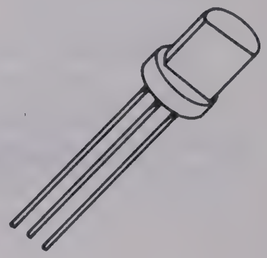
TYPICAL I_F VS. V_F AT T_A
TYPICAL I_F VS. T. C.

Silicon Diode

F16H1

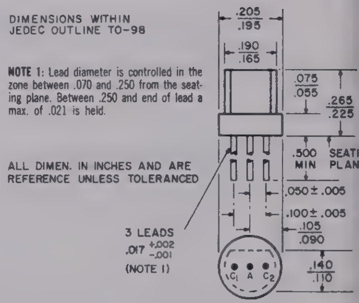
The F16H1 is an economy silicon voltage reference diode designed for general purpose voltage reference and voltage regulator applications at currents up to 15 milliamperes. This device consists of two diodes connected in series opposition to provide a reference voltage with a low temperature coefficient. A single pellet structure is used to minimize temperature differentials between the junctions. The availability of the third lead at the common point between the diodes opens the possibility of many new applications.

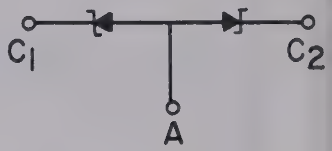
Features: Low cost, common Anode, single pellet, inherent match and high efficiency.



SPECIFICATIONS: I_Z = 5 mA, T_A = 25°C unless otherwise specified.
C_1-gnd or negative
C_2-positive

CHARACTERISTIC	Symbol	Min	Typ	Max	Units
Reference Voltage	V_Z	5.6	6.2	6.8	Volts
Reference Voltage Temperature Coefficient	$\frac{dV_Z}{dT}$			.025	%/°C
Reference Voltage change with temperature (ΔT = 25 to 55°C)	ΔV_{Z_1}			47	mV
Reference Voltage change with temperature (ΔT = 25 to 0°C)	ΔZ_2			39	mV
Dynamic Impedance	r_Z			30	ohms
Capacitance, V = 0	C_o		19		pF
MAXIMUM RATINGS					
Current Steady State (T_A = 50°C)	I_{ZM}			15	mA
Storage	T_{stg}		-55 to +125		°C
Lead soldering, 1/16 ± 1/32" from case for 10 seconds maximum	T_L			+260	°C


DIMENSIONS WITHIN JEDEC OUTLINE TO-98
NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.
ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED
.205 .195
.190 .165
.075 .055
.265 .225
.500 MIN
SEATI PLAN
.050 ± .005
.100 ± .005
.105 .090
.140 .110
3 LEADS .017 +.002 -.001 (NOTE 1)
C1 A C2

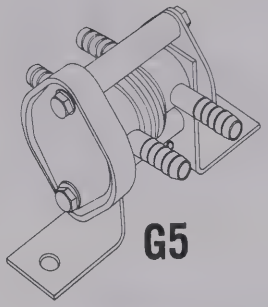


Water-cooled Heat Exchanger

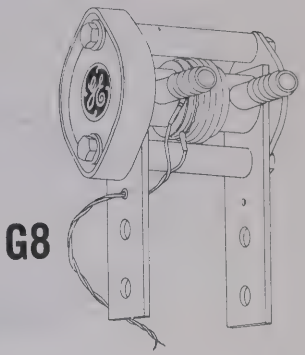
G5,8

The General Electric Type G5 and G8, water-cooled heat exchangers are designed for the efficient cooling of one Type C501 high power silicon controlled rectifier.

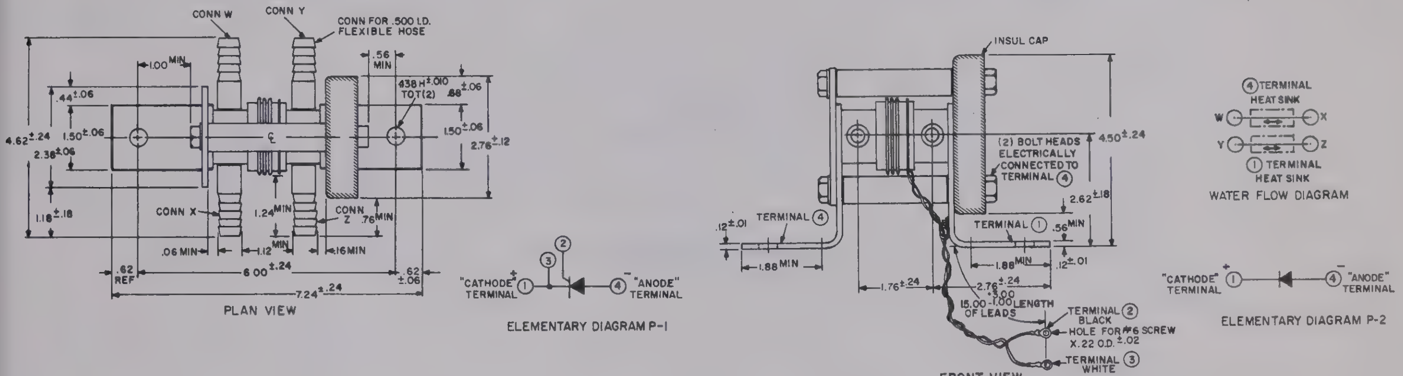
Special features of this heatsink are:
- Light weight, compact design.
- High efficiency at low coolant flow rates, due to exclusive cooling post design.
- Double-side cooling of cell for maximum current capability.
- Factory assembled and tested for high reliability.



G5



G8


CONN W
CONN Y
CONN FOR .500 I.D. FLEXIBLE HOSE
1.00 MIN
.56 MIN
.44 ±.06
.438 H ±.010 TOT(2)
.88 ±.06
4.62 ±.24
1.50 ±.06
2.38 ±.06
1.50 ±.06
2.76 ±.12
℄
1.18 ±.18
CONN X
1.24 MIN
CONN Z
.76 MIN
.06 MIN
.12 MIN
.16 MIN
.62 REF
6.00 ±.24
.62 ±.06
7.24 ±.24
PLAN VIEW
"CATHODE" TERMINAL
"ANODE" TERMINAL
①
②
③
④
ELEMENTARY DIAGRAM P-1
INSUL CAP
(2) BOLT HEADS ELECTRICALLY CONNECTED TO TERMINAL ④
4.50 ±.24
2.62 ±.18
.12 ±.01
TERMINAL ④
TERMINAL ①
.56 MIN
1.88 MIN
1.88 MIN
.12 ±.01
1.76 ±.24
2.76 ±.24
15.00 +.00 -1.00 LENGTH OF LEADS
TERMINAL ② BLACK
HOLE FOR #6 SCREW X .22 O.D. ±.02
TERMINAL ③ WHITE
FRONT VIEW
④ TERMINAL HEAT SINK
W
X
Y
Z
① TERMINAL HEAT SINK
WATER FLOW DIAGRAM
"CATHODE" TERMINAL
"ANODE" TERMINAL
ELEMENTARY DIAGRAM P-2

OUTLINE DRAWING

RATINGS AND CHARACTERISTICS

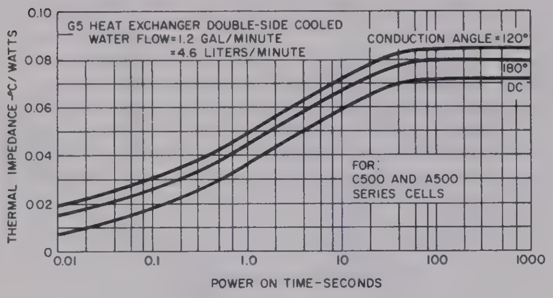
Thermal Resistance, Θ_{J-W}, 1ϕ	0.08°C/watt
Water Flow Rate	1.2 Gallons/minute (4.6 Liters/minute)
Weight	3.5 Pounds (1.6 Kilograms)
Thermal Shock	−40°C to +125°C
Shock (11 msec., ½ sine wave)	20G Max.
Vibration (Resonant frequency = 400 Hz)	1G Max.

OTHER HEAT EXCHANGERS AVAILABLE FROM GE
(For the C5__ and A5__ families of high power semiconductors)

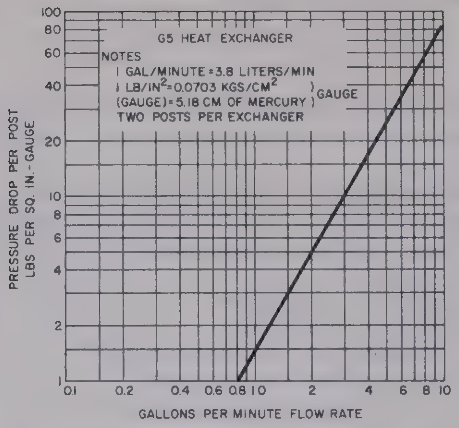
Type	Cooling Method	Description of Basic Heating Element	Configurations Available
D4, D5, D6	Forced Air	Single-side cooling using extruded aluminum fin. Anode-to-sink.	Half wave (H11)
F4, F5, F6		Same as D4 series except reverse polarity.	
E7		Double-side cooling using extruded aluminum fins.	Half wave, two cells in parallel, two cells in series, doubler and center tap.
G3	Water	Highly efficient water-cooled heatsink for two cells. Employs exclusive copper cooling posts.	AC switch, parallel and half wave.
G5		Similar to G3 heatsink, except for one cell.	Half wave.
G8		Same as G5 heatsink, except has straight electrical tangs.	Half wave, two cells in series, doubler and center tap.

Consult your nearest General Electric Semiconductor Salesman, or Authorized GE Distributor for complete ordering instructions.

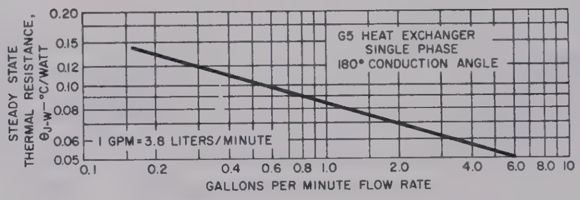
HEAT EXCHANGER DATA



1. Transient Thermal Impedance (Junction-to-Water)

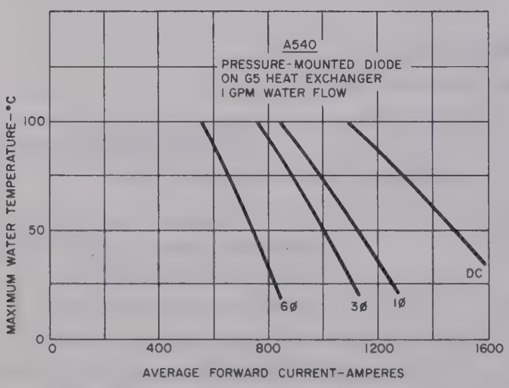


2. Pressure Drop Per Side vs. Flow Rate

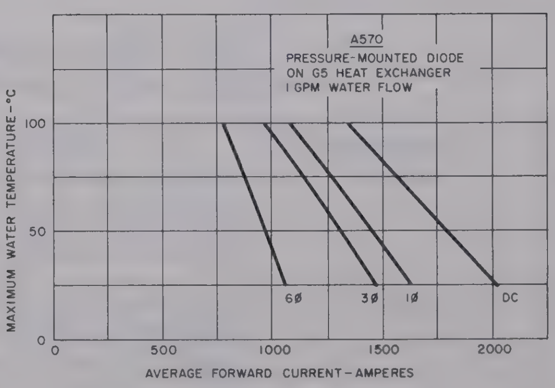


3. Steady State Thermal Resistance (Junction-to-Water)

RATINGS—PRESSURE-MOUNTED DIODES

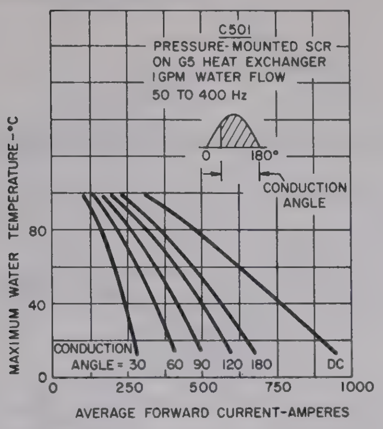


4. Maximum Allowable Water Temperature vs. Forward Current (A540, G5, H11)

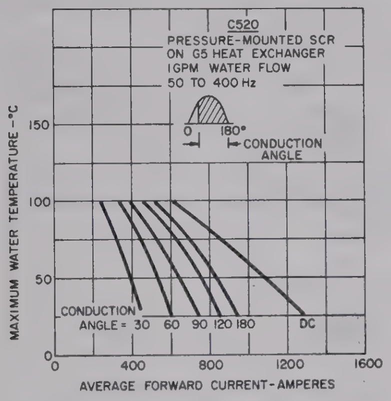


5. Maximum Allowable Water Temperature vs. Forward Current (A570, G5, H11)

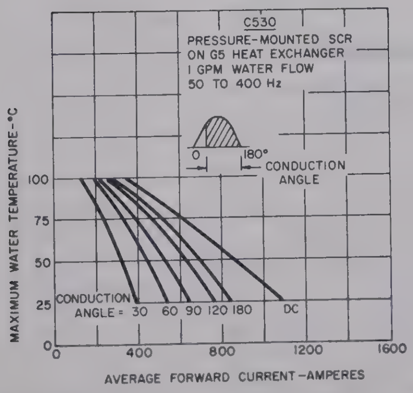
SINUSOIDAL WAVEFORMS



6. **Maximum Allowable Water Temperature vs. Average Forward Current For Sinusoidal Waveforms**

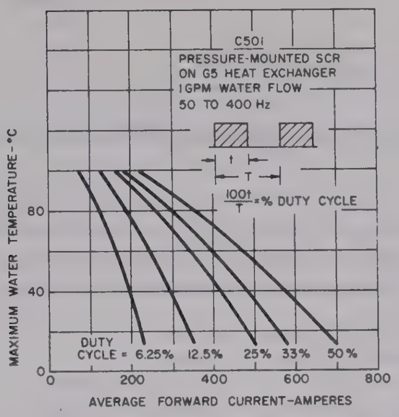


8. **Maximum Allowable Water Temperature vs. Average Forward Current For Sinusoidal Waveforms**

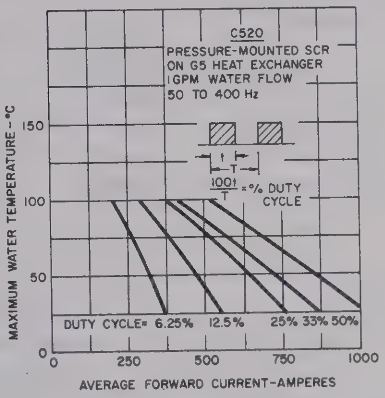


10. **Maximum Allowable Water Temperature vs. Average Forward Current For Sinusoidal Waveforms**

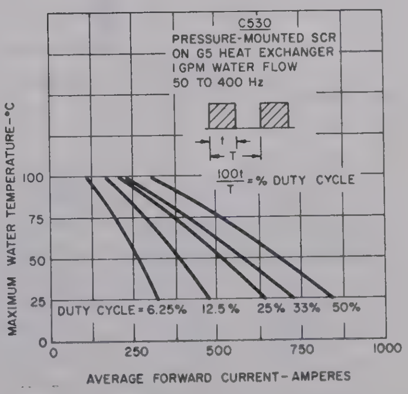
RECTANGULAR WAVEFORMS



7. **Maximum Allowable Water Temperature vs. Average Forward Current For Rectangular Waveforms**



9. **Maximum Allowable Water Temperature vs. Average Forward Current For Rectangular Waveforms**



11. **Maximum Allowable Water Temperature vs. Average Forward Current for Rectangular Waveforms**

WATER-COOLED

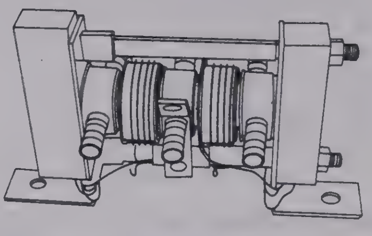
Heat Exchanger

G6 SERIES

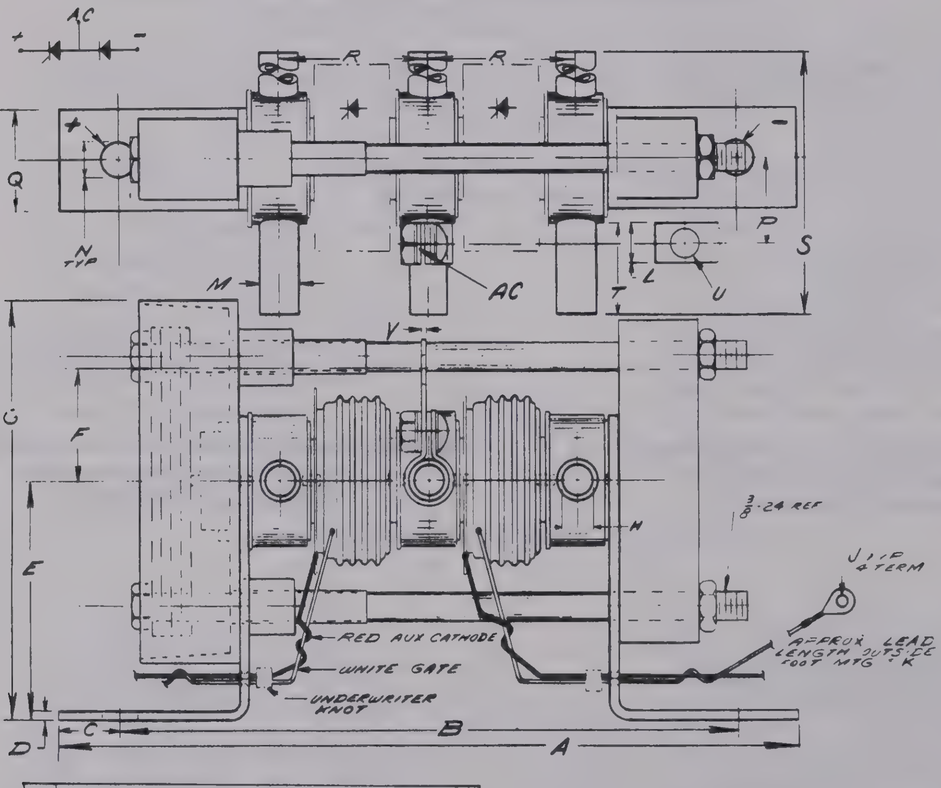
The General Electric Type G 6 water-cooled heat exchangers are designed for the efficient cooling of high power silicon controlled rectifiers

Special features of this heatsink are:

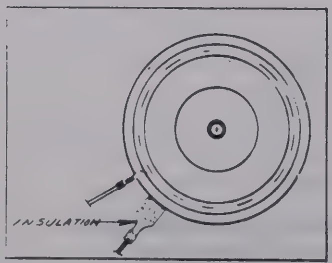
- Light weight, compact design.
- High efficiency at low coolant flow rates
- Double-side cooling of cell for maximum current capability.
- Factory assembled and tested for high reliability.

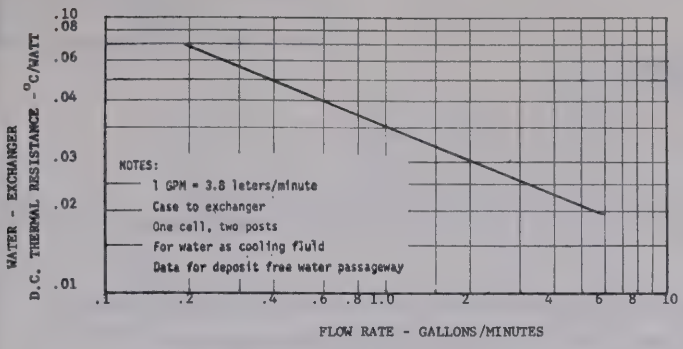


Outline Using G6 to Cool Two 1" Press Paks in Voltage Doubler Connection

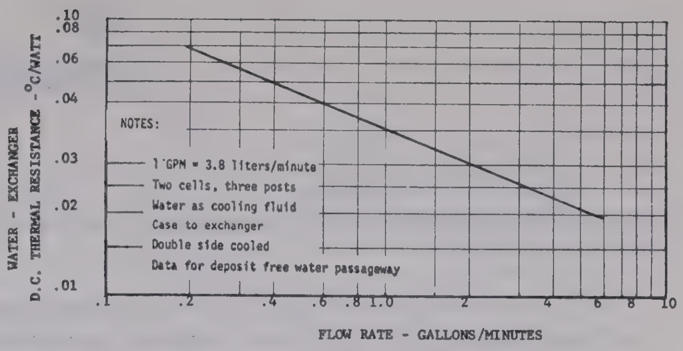

AC
+
−
R
R
+
−
Q
N TYP
M
AC
P
S
L
U
T
V
G
F
E
H
3/8·24 REF
J 1/P 4 TERM
RED AUX CATHODE
WHITE GATE
UNDERWRITER KNOT
APPROX LEAD LENGTH OUTSIDE FOOT MTG ·K
D
C
B
A

SYM	DECIMAL INCHES		METRIC MM		SYM	DECIMAL INCHES		METRIC MM	
	MIN.	MAX.	MIN.	MAX.		MIN.	MAX.	MIN.	MAX.
A	9.100	9.400	231.14	238.76	N	.432	.442	10.97	11.23
B	7.620	7.880	193.55	200.15	P	.972	1.152	24.69	29.26
C	.740	.760	18.80	19.30	Q	1.235	1.265	31.37	32.13
D	.120	.130	3.05	3.30	R	1.845	REF.	33.78	REF.
E	2.950	REF.	74.93	REF.	S	3.665	3.985	93.09	101 22
F	1.375	REF.	34.93	REF.	T	1.032	1.162	26.21	29.51
G	5.075	5.325	128.95	135.26	U	.323	.333	8.20	8.46
H	.375	REF.	9.53	REF.	V	.057	.070	1.45	1.78
J	.137	.153	3.48	3.89					
K	4.500	REF.	114.30	REF.					
L	.490	.510	12.45	12.95					
M	.490	.510	12.45	12.95					

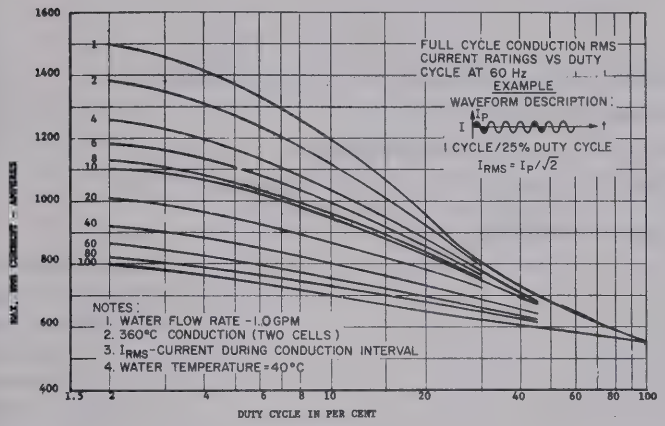

INSULATION



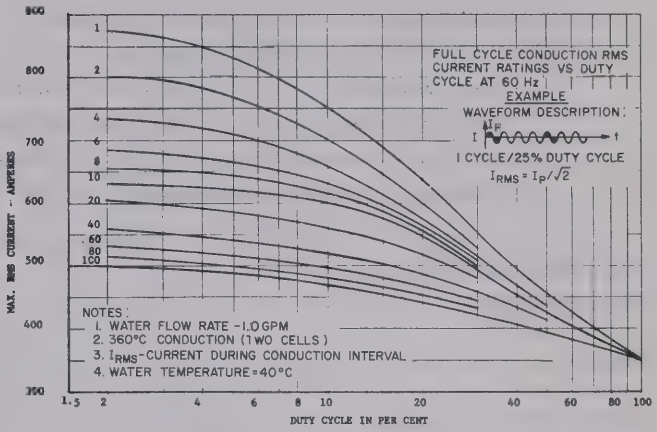
1. THERMAL RESISTANCE VS. FLOW RATE (ONE CELL, TWO POSTS)



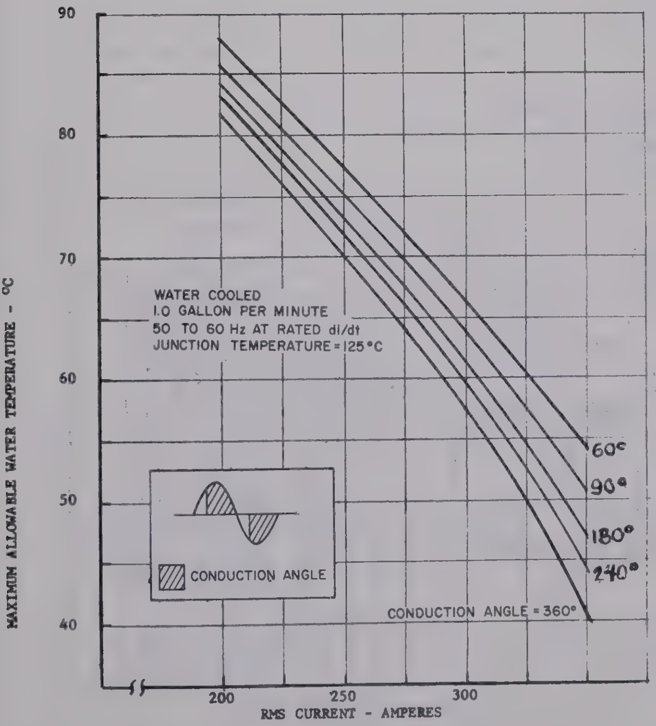
2. THERMAL RESISTANCE VS. FLOW RATE (TWO CELLS, THREE POSTS)



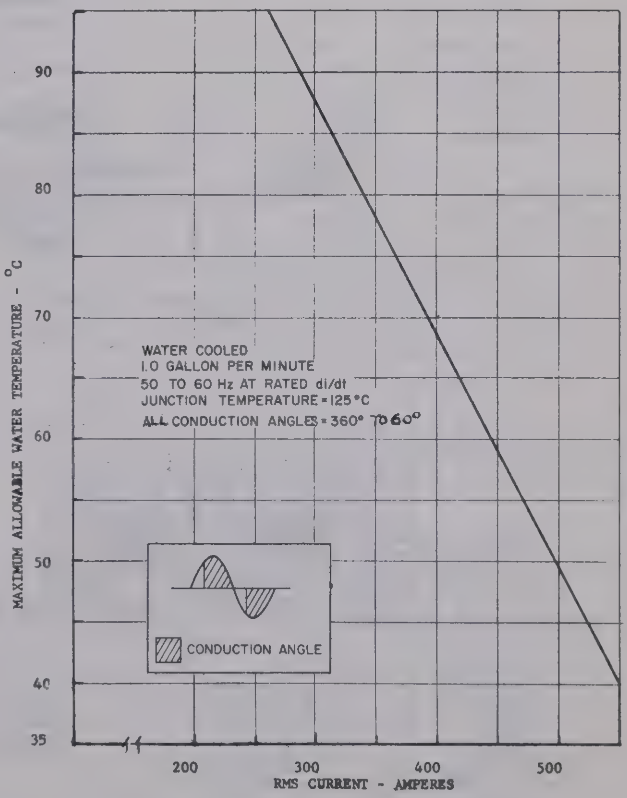
3. WELDING RATINGS - SCR TYPE C350 (TWO CELLS)



4. WELDING RATINGS - SCR TYPE C380 (TWO CELLS)



5. PHASE CONTROL RATINGS - SCR TYPE C350 (TWO CELLS)



6. PHASE CONTROL RATING - SCR TYPE C380 (TWO CELLS)

Heat Exchanger

G7

The General Electric Type G7 water-cooled heat exchanger is designed for the efficient cooling of two, Type C501 high power silicon controlled rectifiers in an AC switch arrangement. This heat exchanger is a mechanical and electrical replacement for the G2 (X7) heat exchanger which is now obsolete.

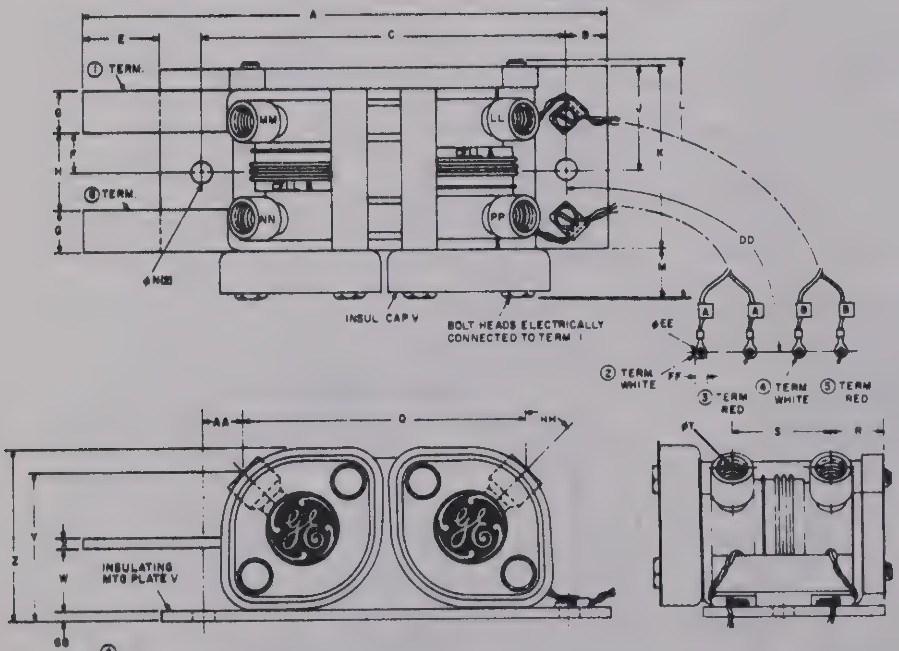
Special features of this heat exchanger are:

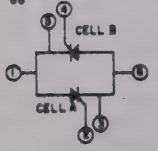
- o Light weight, compact design.
- o High efficiency at low coolant flow rates due to an exclusive cooling post design.
- o Double-side cooling of cells for maximum current capability.
- o Design is especially suited for welding duty, AC switch arrangement.
- o Factory assembled and tested for high reliability.

RATINGS AND CHARACTERISTICS

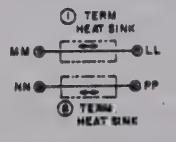
Thermal Resistance, Θ_{J-W}, 1ϕ	0.10°C/watt/cell
Water Flow Rate	1.2 Gallons/minute (4.6 Liters/minute)
Weight	6.6 Pounds (3.0 Kilograms)
Thermal Shock	−40°C to +125°C
Shock (11 msec., ½ sine wave)	20G Max.
Vibration (Resonant frequency = 400 Hz)	1G Max.

OUTLINE DRAWING


A
E
C
B
① TERM.
G
F
H
⑥ TERM.
G
J
K
L
MM
LL
NN
PP
CELL A
CELL B
DD
M
ϕN
INSUL CAP V
BOLT HEADS ELECTRICALLY CONNECTED TO TERM I
ϕEE
A
A
B
B
② TERM WHITE
FF
③ TERM RED
④ TERM WHITE
⑤ TERM RED
AA
Q
HH
Y
Z
W
X
INSULATING MTG PLATE V
GG
ϕT
S
R


②
④
CELL B
①
⑥
CELL A
③
⑤

ELEMENTARY DIAGRAM


① TERM HEAT SINK
MM
LL
NN
PP
⑥ TERM HEAT SINK

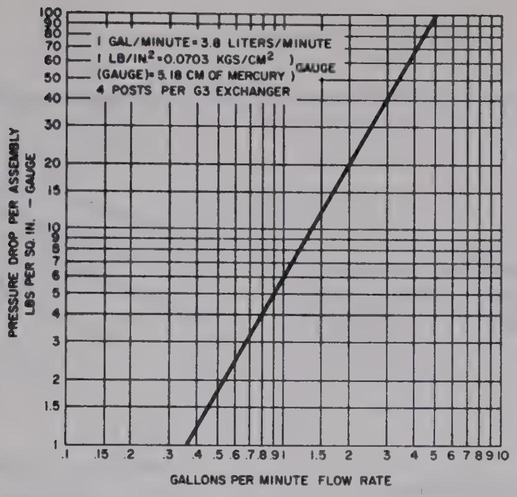
COOLANT FLOW DIAGRAM

NOTES
1 CONTOUR AND ORIENTATION OF TERMINAL LUGS IS UNDEFINED
2 .250-18 NPT (ASA B2I)
3 APPROX WT 7 I LBS (15 6 KG)
4 1.000 (25.40mm) MIN INSULATION (SURFACE CREEPAGE).

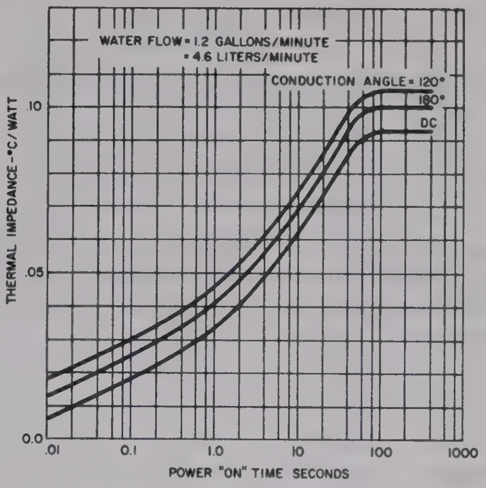
TABLE OF DIMENSIONS

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	9.260	9.500	235.20	241.30	3
AA	0.625	0.875	15.88	22.23	
B	0.720	0.780	18.29	19.81	
C	6.460	6.540	164.08	166.12	
DD	15.000	17.000	381.00	431.80	
E	1.160	1.600	29.46	40.64	
ϕEE	0.139		3.53		1
F	0.588	0.838	14.94	21.29	
FF		0.240		6.10	1
G	0.720	0.750	18.29	19.05	
GG	0.176	0.200	4.47	5.08	
H	1.316	1.406	33.43	35.71	
HH	35°	55°	35°	55°	
J	1.723	1.923	43.76	48.84	
K	3.180	3.300	80.77	83.82	
L	4.135	4.211	105.03	106.96	3
M	0.800	1.000	20.32	25.40	
ϕN	0.365	0.385	9.27	9.78	
Q	4.875	5.125	123.83	130.18	
R	0.872	0.992	22.15	25.20	
S	1.680	1.840	42.67	46.74	
ϕT					2
V					4
W	1.047	1.177	26.59	29.90	
X	0.183	0.193	4.65	4.90	
Y	2.500	2.750	63.50	69.85	
Z	2.938	3.250	74.63	82.55	3

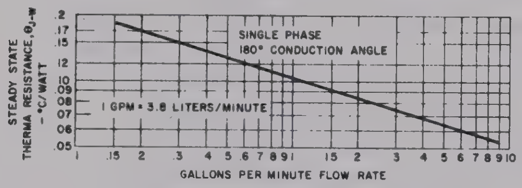
HEAT EXCHANGER DATA



1. **Pressure Drop Per G7 Assembly (4 cooling posts in series)***



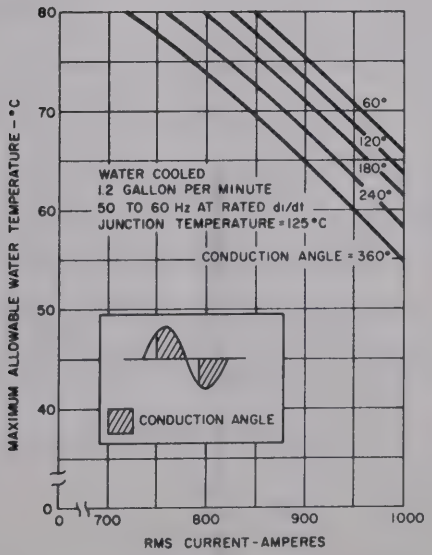
2. **Transient Thermal Impedance (Junction-to-Water)**



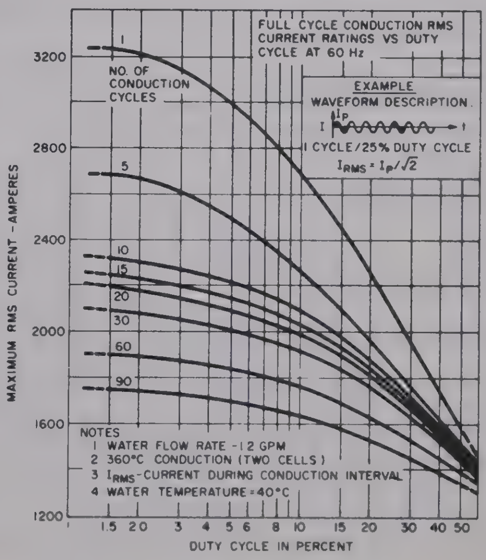
3. **Steady State Thermal Resistance (Junction-to-Water)**

*Does not include pressure drop of connecting hose between sides of heatsink.

G7 AC SWITCH USING C501 CELLS (See Pub. #170.70 for detailed specifications on C501 SCR)



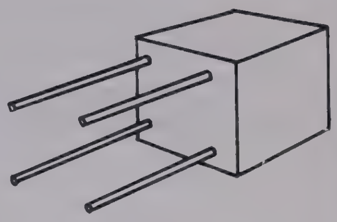
4. **Maximum Allowable RMS Current For Sinusoidal Waveform—C501G7__ A11**



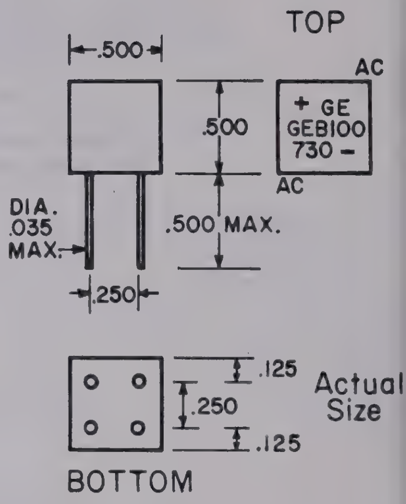
5. **Resistance Welding Ratings— C501G7__ A11**

Silicon RECTIFIER

GEB100



The General Electric *GEB 100 Series* is a General Purpose single phase full wave bridge. The four rectifiers are encapsulated into a half inch package. This modular assembly offers the features of small size and high reliability of the glass hermetic sealed A–14 rectifiers - all in one package.



FEATURES:

- Voltage ratings from 50 Volts to 1000 Volts.
- Half inch package
- Avalanche protected rectifiers
- Hermetic-sealed devices
- Wide range of operating and storage temperatures (-65°C to +150°C) (-65°C to +175°C)
- Reliability

APPLICATION:

- Power Hand Tools
- Control Circuits
- Power Supplies
- T. V.
- Business Machines
- Battery Chargers
- Aerospace
- Aircraft

RATINGS AND CHARACTERISTICS

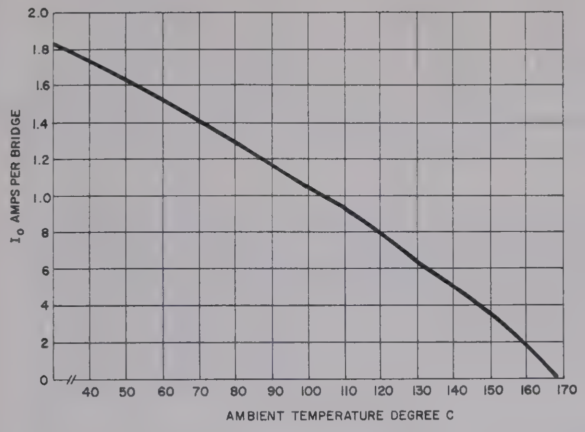
Type No.	GEB100	GEB101	GEB102	GEB104	GEB106	GEB108	GEB110	Units
Max. Pk. Rev. Volts and Max. D. C. Rev Volts. V_{Rwm} & V_R	50	100	200	400	600	800	1000	Volts
Avg. Fwd. Current I_F(AV) T_A = 50°C	1.6	1.6	1.6	1.6	1.6	1.6	1.6	Amperes
Avg. Fwd. Current I_F(AV) T_A = 100°C	1.0	1.0	1.0	1.0	1.0	1.0	1.0	Amperes
Max. D. C. Forward Voltage Drop @ 1.0A V_F per leg	1.0	1.0	1.0	1.0	1.0	1.0	1.0	Volts
Max. D. C. Rev. Current I_R @ 25°C V_{Rwm}	5	5	5	5	5	5	5	Micro-Amperes
at 150°C V_{Rwm}	100	100	100	100	100	100	100	
Min. Brkdwn Volts $V_{(BR)R}$ @ 50μA.	480	480	480	720	720	960	1200	Volts
Max. Brkdwn Volts $V_{(BR)R}$ @ 500μA.	1200	1200	1200	1200	1200	1300	1600	
Operational Temp. Range Storage Temp. Range	-65°C to +150°C -65°C to +175°C							

Lead Material - Tin Plated Copper .035 Max. Diam.

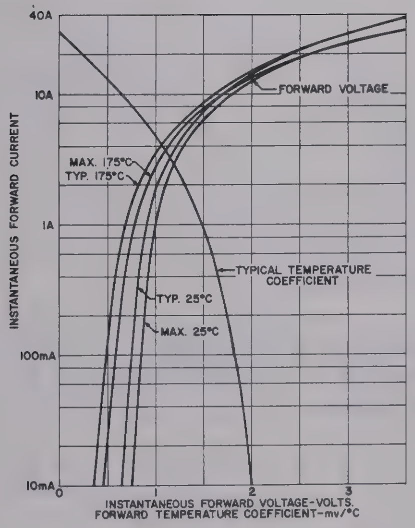
Polarity Coded on top of unit with (+) and (–) for easy orientation of connections

t_{RR} = 5μsec per cell per Mil-S-19500/286 circuit.

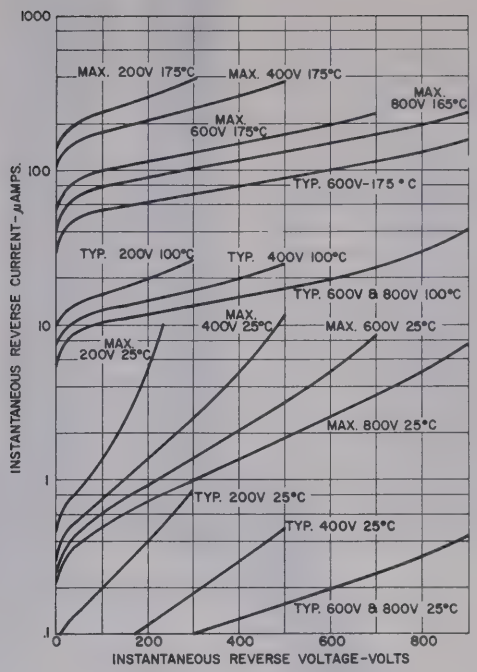
I^2t_1 RMS (for fusing), .001 to .01 sec = 4.0 Amps^2 sec. (per cell)



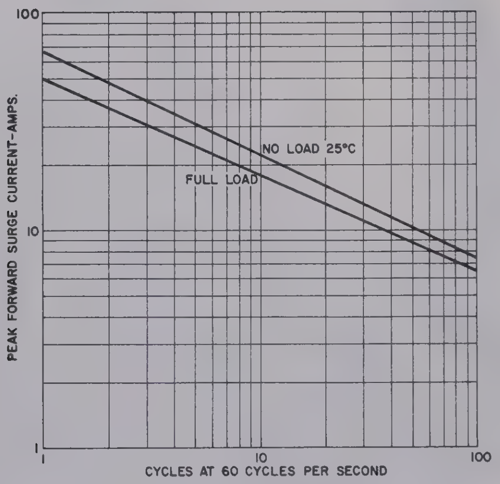
BRIDGE OUTPUT CURRENT



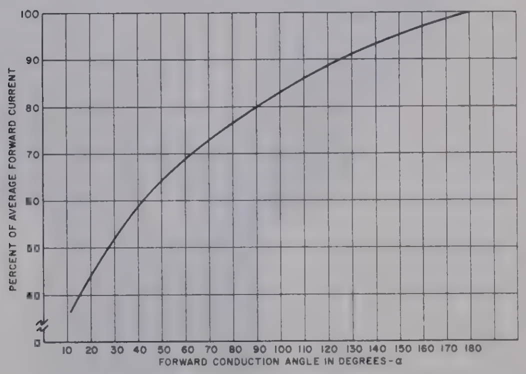
FORWARD CHARACTERISTICS (PER CELL)



REVERSE CHARACTERISTICS AT SELECTED JUNCTION TEMPERATURES (PER CELL)



MAXIMUM NON-REPETITIVE MULTICYCLE FORWARD SURGE CURRENT (PER CELL)



DERATING FOR SHORTENED CONDUCTION ANGLE (PER CELL)

The reliable rectifier

The best way to assure reliability in a low-current rectifier pellet is to put it in a package that really protects it. Protects it from shock, humidity, vibration and temperature.

And that's just what we do with General Electric's glassivated 1-amp (A14) and 3-amp (A15) rectifiers. Solid glass provides passivation and protection of the silicon pellet's P-N junction—no organic material is present within the hermetically sealed package. In addition, rigid mechanical support and excellent thermal characteristics are provided by the dual heat sink construction.

For high-frequency applications, GE offers a fast-recovery rectifier, the 1-amp A114, with a 200 nsec. max. reverse recovery.

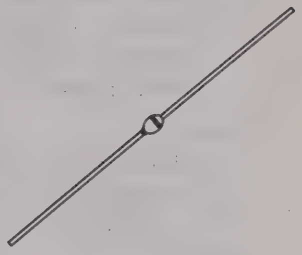
Passivated Rectifier

REPLACEMENT FOR 1N4001-4007

GER SERIES

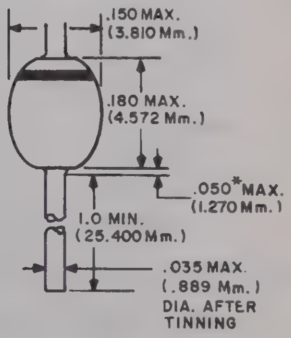
GER4001
GER4002
GER4003
GER4004
GER4005
GER4006
GER4007

THE GENERAL ELECTRIC GER SERIES IS A 2 AMPERE RATED, AXIAL LEADED GENERAL PURPOSE RECTIFIER. DUAL HEATSINK CONSTRUCTION PROVIDES RIGID MECHANICAL SUPPORT FOR THE PELLET AND EXCELLENT THERMAL CHARACTERISTICS. PASSIVATION AND PROTECTION OF THE SILICON PELLETS PN JUNCTION ARE PROVIDED BY SOLID GLASS; NO ORGANIC MATERIALS ARE PRESENT WITHIN THE HERMETICALLY SEALED PACKAGE.



absolute maximum ratings: (25°C unless otherwise specified)

Ratings	Symbol	GER 4001	GER 4002	GER 4003	GER 4004	GER 4005	GER 4006	GER 4007
Reverse Volt Working Peak, DC, V_R	$V_{RM(wkg)}$	50	100	200	400	600	800	1000
Ave Half Wave 75°C	I_O • mA	1000	1000	1000	1000	1000	1000	1000
Rectified Forward Current 25°C	mA	2000	2000	2000	2000	2000	2000	2000
Peak Forward Current 25°C	I_{FM} (surge A)	30	30	30	30	30	30	30
½ Cycle Surge 60 Hz	I_{FM} (Rep)	10	10	10	10	10	10	10
Max. Junction Temperature	T_j	175°C	175°C	175°C	175°C	175°C	175°C	175°C



ALL DIMENTIONS ARE IN INCHES AND (METRIC)

*WELD AND SOLDER FLASH NOT CONTROLLED IN THIS AREA

electrical characteristics:

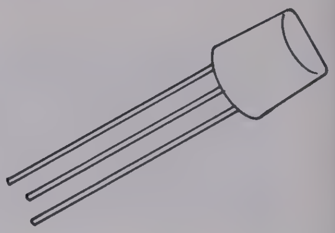
Max. Forward Volt Drop 1 Amp Continuous DC 25°C	V_F	← 1.1 Volts →	
Max. Full Cycle Average Forward Voltage Drop (Rated Current @ 25°C)	$V_{F(av)}$	← .8 Volts →	
Maximum Reverse Current @ Rated V_R (25°C)	I_R	.01	mA
(100°C)	I_R	.05	mA
Maximum Full Cycle Average Reverse Current	I_R (av)	.03	mA
Operating & Storage Temperature Range	Tj, Tstg	−65 to +175	°C

Silicon
Transistors

NPN

GET706,8
GET914

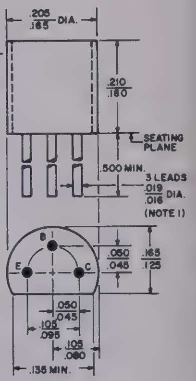
Features:
- Performance comparable to Hermetic Units
- High Speed
- High Frequency $f_t = 300\text{MHz}$ (min) @ 10mA



The General Electric GET706, GET708, and GET914 are planar epitaxial passivated NPN silicon transistors intended for high speed, medium current, industrial switching applications.

absolute maximum ratings: ($T_A = 25°C$, unless otherwise specified)

		GET706	GET708	GET914	
Voltages					
Collector to Emitter	V_{CEO}	15	15	15	
Collector to Emitter	V_{CES}	20	20	20	Volts
Collector to Base	V_{CBO}	25	40	40	Volts
Emitter to Base	V_{EBO}	3.0	5.0	5.0	Volts
Current					
Collector (steady state)	I_C	200	200	200	mA
Collector (peak, pulsed 10 μsec, 2% duty cycle)	I_C	500	500	500	mA
Dissipation					
Total Power ($T_C \leqq 25°C$)	P_T	0.650	0.650	0.650	Watts
Total Power ($T_A \leqq 25°C$)	P_T	0.360	0.360	0.360	Watts
Derate Factor ($T_C \geqq 25°C$)		6.5	6.5	6.5	mW/°C
Derate Factor ($T_A \geqq 25°C$)		3.6	3.6	3.6	mW/°C
Temperature					
Storage	T_{STG}	←— −65 to +150 —→			°C
Operating	T_J	←— −65 to +125 —→			°C
Lead (1/16″ ± 1/32″ from case for 10 seconds)	T_L	←— +260 —→			°C



NOTE 1:
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND .250 FROM THE SEATING PLANE. BETWEEN .250 AND END OF LEAD A MAX. OF .021 IS HELD.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.

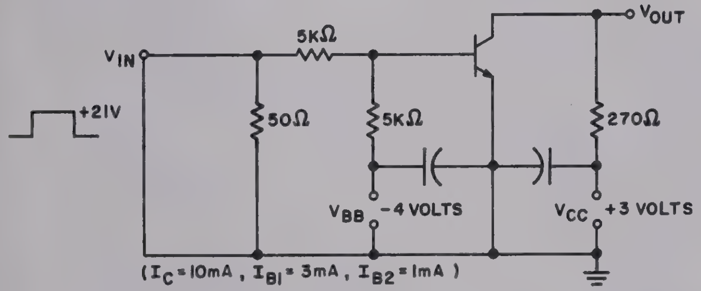
electrical characteristics: ($T_A=25°C$, unless otherwise specified)

		GET706		GET708		GET914		
STATIC CHARACTERISTICS	**Symbol**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	
Collector-Emitter Breakdown Voltage ($I_C = 10\text{mA}, I_B = 0$)	$V_{(BR)CEO}$*	15		15		15		Volts
Collector-Emitter Breakdown Voltage ($I_C = 10\mu\text{A}, V_{BE} = 0$)	$V_{(BR)CES}$	20		20		20		Volts
Emitter-Base Breakdown Voltage ($I_E = 10\mu\text{A}, I_C = 0$)	$V_{(BR)EBO}$	3.0		5.0		5.0		Volts
Collector-Base Breakdown Voltage ($I_C = 10\mu\text{A}, I_E = 0$)	$V_{(BR)CBO}$	25		40		40		Volts
Collector-Emitter Saturation Voltage ($I_C = 10\text{mA}, I_B = 1.0\text{mA}$)	$V_{CE(SAT)}$*		0.25		0.25		0.25	Volts
($I_C = 200\text{mA}, I_B = 20\text{mA}$)	$V_{CE(SAT)}$*						0.70	Volts
Base-Emitter Saturation Voltage ($I_C = 10\text{mA}, I_B = 1.0\text{mA}$)	$V_{BE(sat)}$*	0.70	0.85	0.72	0.80	0.70	0.80	Volts

*Pulse conditions of 300 μsec, 2% duty cycle

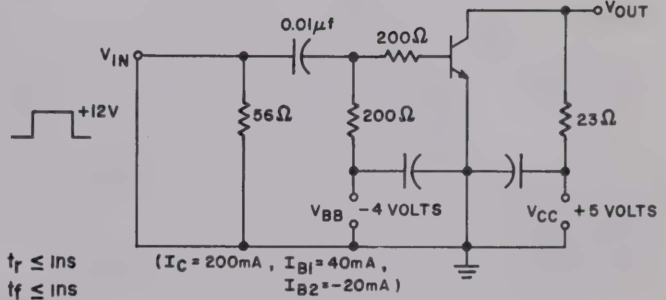
GET706,8
GET914

STATIC CHARACTERISTICS (Continued)	Symbol	GET706 Min.	GET706 Max.	GET708 Min.	GET708 Max.	GET914 Min.	GET914 Max.	
Forward Current Transfer Ratio								
($V_{CE} = 1.0V$, $I_C = 10mA$)	h_{FE}	20		30	120	30	120	
($V_{CE} = 1.0V$, $I_C = 0.5mA$)	h_{FE}			15				
Collector Cutoff Current								
($V_{CB} = 20V$, $I_E = 0$)	I_{CBO}		50		50		50	nA
Collector Cutoff Current								
($V_{CE} = 15V$, $V_{BE} = 0$)	I_{CES}		50		50		50	nA
Collector Cutoff Current								
($V_{CB} = 20V$, $I_E = 0$, $T_A = 100°C$)	I_{CBO}		10		10		10	μA
DYNAMIC CHARACTERISTICS								
Collector-Base Capacitance								
($V_{CB} = 10V$, $I_E = 0$, $f = 1$ MHz)	C_{cb}		6.0		5.5		5.5	pF
Emitter-Base Capacitance								
($V_{EB} = 0.5V$, $I_C = 0$, $f = 1$ MHz)	C_{eb}		10.0		10.0		9.0	pF
Small Signal Forward Current Transfer Ratio								
($V_{CE} = 10V$, $I_C = 10mA$, $f = 100MHz$)	$\lvert h_{fe} \rvert$	2.0		3.0		3.0		
Base spreading resistance	r_b'			75				ohms
($V_{CE} = 10V$, $I_C = 10mA$)								
SWITCHING CHARACTERISTICS								
Turn On Time (See fig. I)	t_{on}		40		40			nsec
Turn Off Time (See fig. I)	t_{off}		75		75			nsec
Turn On Time (See fig. II)	t_{on}						40	nsec
Turn Off Time (See fig. II)	t_{off}						40	nsec
Storage Time (See fig. III)	t_s		35		25			nsec
Storage Time (See fig. IV)	t_s						20	nsec


VIN
+21V
5KΩ
50Ω
5KΩ
270Ω
VOUT
VBB -4 VOLTS
VCC +3 VOLTS
(IC = 10mA , IB1 = 3mA , IB2 = 1mA)

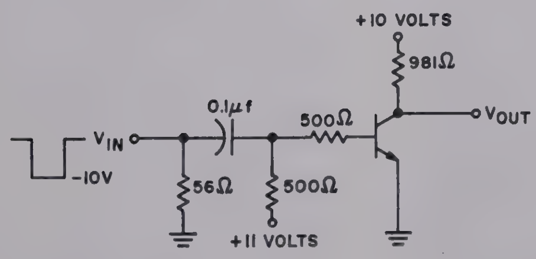
$t_r \leq 1ns$
$t_f \leq 1ns$
PW ≥ 300ns, DC ≤ 2%

Figure 1. t_{on}-t_{off} Test Circuit


VIN
+12V
0.01μf
200Ω
56Ω
200Ω
23Ω
VOUT
VBB -4 VOLTS
VCC +5 VOLTS
(IC = 200mA , IB1 = 40mA ,
IB2 = -20mA)

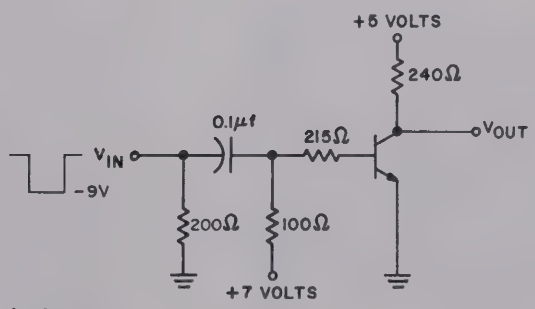
$t_r \leq 1ns$
$t_f \leq 1ns$
PW > 300ns, DC ≤ 2%

Figure 2. t_{on}-t_{off} Test Circuit


+10 VOLTS
981Ω
0.1μf
500Ω
VIN
VOUT
-10V
56Ω
500Ω
+11 VOLTS

$t_r \leq 1ns$
$t_f \leq 1ns$
PW = ≥ 300ns, DC ≤ 2%
($I_C = I_{B1} = -I_{B2} = 10mA$)

Figure 3. Storage Time Test Circuit


+5 VOLTS
240Ω
0.1μf
215Ω
VIN
VOUT
-9V
200Ω
100Ω
+7 VOLTS

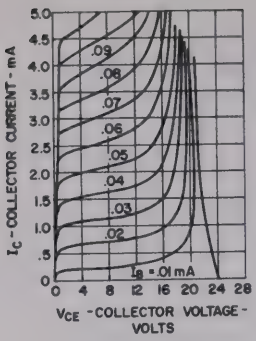
$t_r \leq 1ns$
$t_f \leq 1ns$
PW = ≥ 300ns, DC ≤ 2%
($I_C = I_{B1} = -I_{B2} = 20mA$)

Figure 4. Storage Time Test Circuit

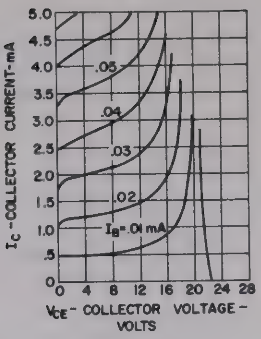
GET706,8
GET914

COLLECTOR CHARACTERISTICS

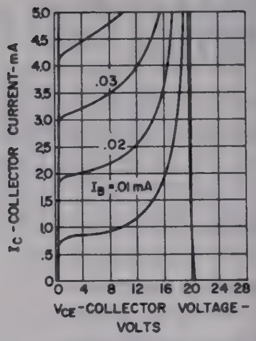
$T_A = -25°C$



$T_A = 25°C$

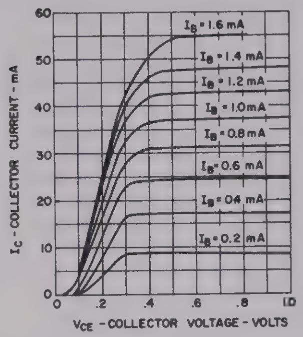


$T_A = 75°C$

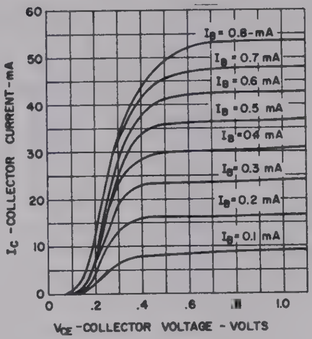


COLLECTOR CHARACTERISTICS

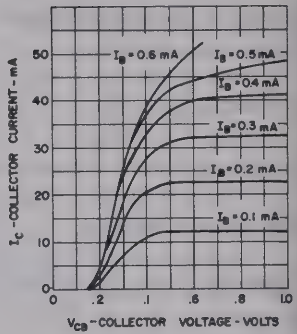
$T_A = -25°C$



$T_A = 25°C$

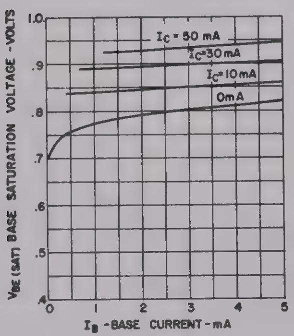


$T_A = 75°C$

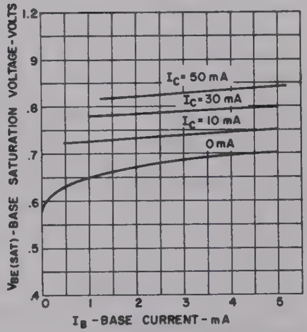


V_{BE} (SAT)

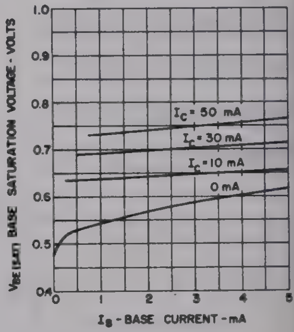
$T_A = -25°C$



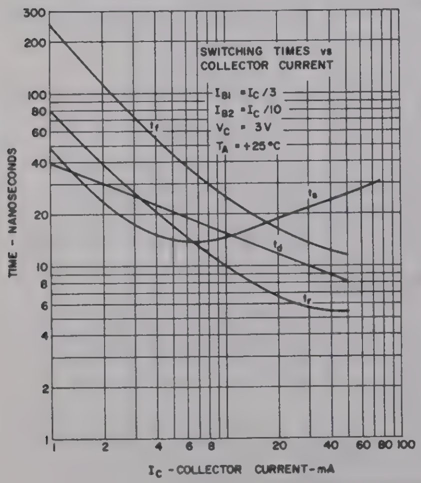
$T_A = 25°C$



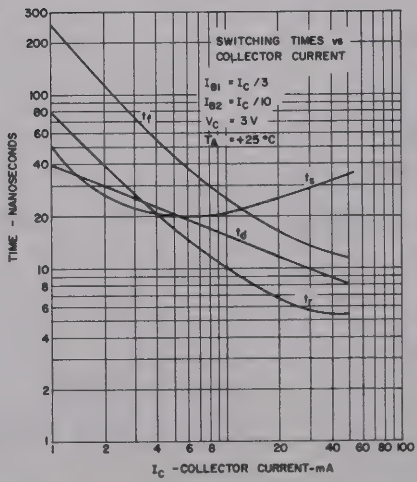
$T_A = 75°C$



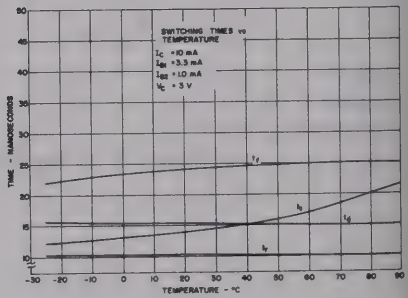
GET914



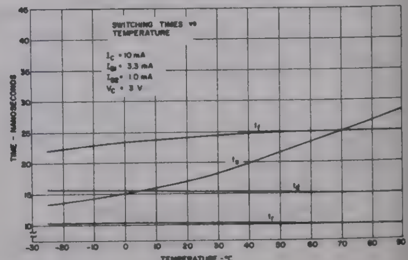
GET706/GET708

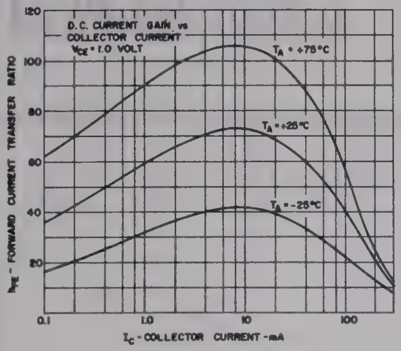


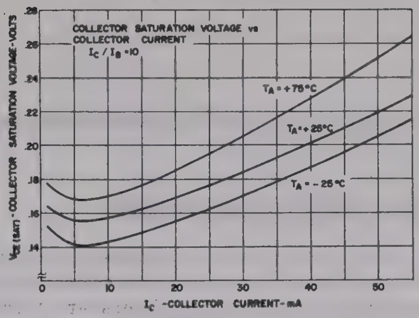
GET914

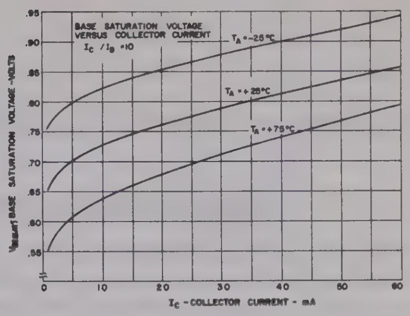


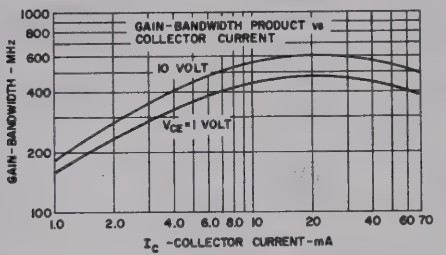
GET706/GET708

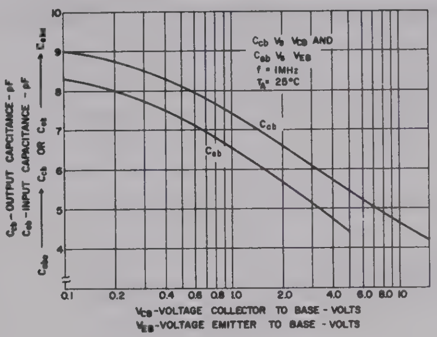


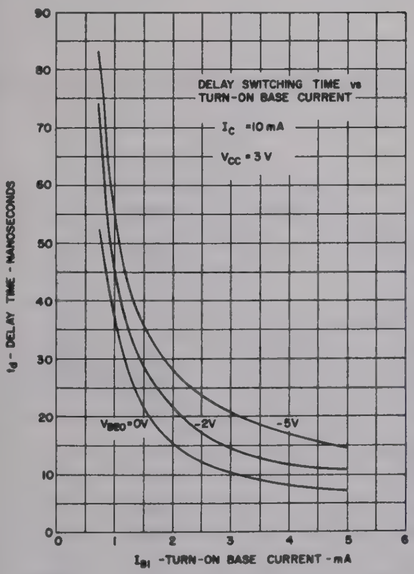

D.C. CURRENT GAIN vs
COLLECTOR CURRENT
V_{CE} = 1.0 VOLT
T_A = +75°C
T_A = +25°C
T_A = −25°C
h_{FE} - FORWARD CURRENT TRANSFER RATIO
120
100
80
60
40
20
0.1
1.0
10
100
I_C - COLLECTOR CURRENT - mA

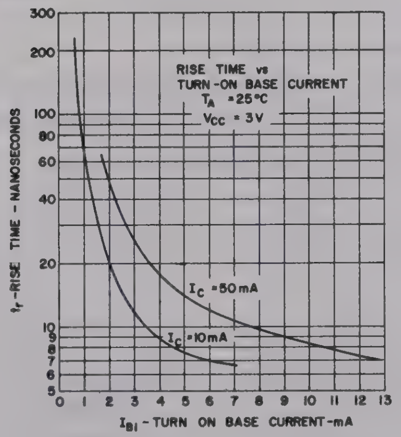

COLLECTOR SATURATION VOLTAGE vs
COLLECTOR CURRENT
I_C / I_B = 10
T_A = +75°C
T_A = +25°C
T_A = −25°C
$V_{CE(SAT)}$ - COLLECTOR SATURATION VOLTAGE - VOLTS
.28
.26
.24
.22
.20
.18
.16
.14
0
10
20
30
40
50
I_C - COLLECTOR CURRENT - mA

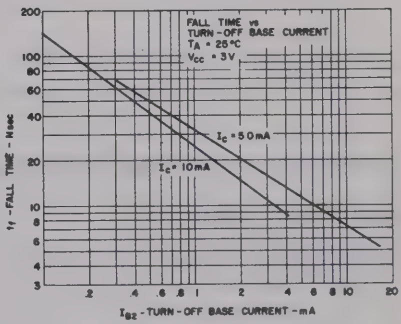

BASE SATURATION VOLTAGE
VERSUS COLLECTOR CURRENT
I_C / I_B = 10
T_A = −25°C
T_A = +25°C
T_A = +75°C
$V_{BE(SAT)}$ BASE SATURATION VOLTAGE - VOLTS
.95
.90
.85
.80
.75
.70
.65
.60
.55
0
10
20
30
40
50
60
I_C - COLLECTOR CURRENT - mA

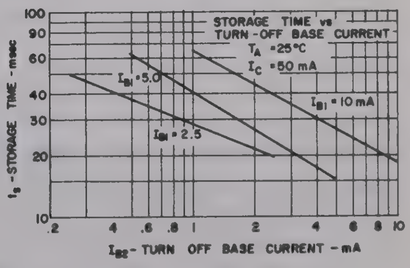

GAIN-BANDWIDTH PRODUCT vs
COLLECTOR CURRENT
10 VOLT
V_{CE} = 1 VOLT
GAIN-BANDWIDTH - MHz
1000
800
600
400
200
100
1.0
2.0
4.0
6.0
8.0
10
20
40
60
70
I_C - COLLECTOR CURRENT - mA

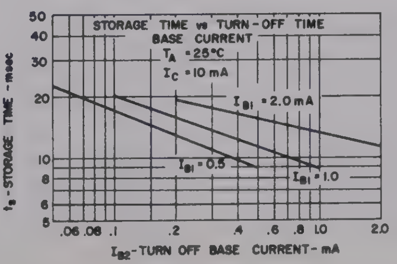

C_{cb} Vs V_{CB} AND
C_{eb} Vs V_{EB}
f = 1MHz
T_A = 25°C
C_{cb}
C_{eb}
C_{cb} - OUTPUT CAPACITANCE - pF
C_{eb} - INPUT CAPACITANCE - pF
C_{obo} ⟶ C_{cb} OR C_{eb} ⟶ C_{eibo}
10
9
8
7
6
5
4
0.1
0.2
0.4
0.6
0.8
1.0
2.0
4.0
6.0
8.0
10
V_{CB} - VOLTAGE COLLECTOR TO BASE - VOLTS
V_{EB} - VOLTAGE EMITTER TO BASE - VOLTS


DELAY SWITCHING TIME vs
TURN-ON BASE CURRENT
I_C = 10 mA
V_{CC} = 3 V
V_{BEO} = 0V
−2V
−5V
t_d - DELAY TIME - NANOSECONDS
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
I_{B1} - TURN-ON BASE CURRENT - mA


RISE TIME vs
TURN-ON BASE CURRENT
T_A = 25°C
V_{CC} = 3V
I_C = 50 mA
I_C = 10 mA
t_r - RISE TIME - NANOSECONDS
300
200
100
80
60
40
20
10
9
8
7
6
5
0
1
2
3
4
5
6
7
8
9
10
11
12
13
I_{B1} - TURN ON BASE CURRENT - mA


FALL TIME vs
TURN-OFF BASE CURRENT
T_A = 25°C
V_{CC} = 3V
I_C = 50 mA
I_C = 10 mA
t_f - FALL TIME - Nsec
200
100
80
60
40
20
10
8
6
4
3
.2
.4
.6
.8
1
2
4
6
8
10
20
I_{B2} - TURN-OFF BASE CURRENT - mA


STORAGE TIME vs
TURN-OFF BASE CURRENT
T_A = 25°C
I_C = 50 mA
I_{B1} = 5.0
I_{B1} = 2.5
I_{B1} = 10 mA
t_s - STORAGE TIME - nsec
100
90
80
60
40
30
20
10
.2
.4
.6
.8
1
2
4
6
8
10
I_{B2} - TURN OFF BASE CURRENT - mA


STORAGE TIME vs TURN-OFF TIME
BASE CURRENT
T_A = 25°C
I_C = 10 mA
I_{B1} = 2.0 mA
I_{B1} = 0.5
I_{B1} = 1.0
t_s - STORAGE TIME - nsec
50
40
30
20
10
8
6
5
.06
.08
.1
.2
.4
.6
.8
1.0
2.0
I_{B2} - TURN OFF BASE CURRENT - mA

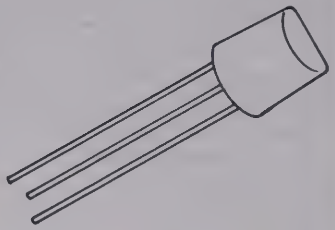
Silicon
Transistors

N P N

GET 929,30

Electrical replacements for 2N929 and 2N930

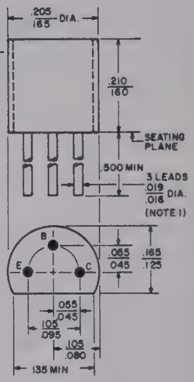
The General Electric GET929 and GET930 are NPN, silicon, planar, epitaxial, passivated transistors. These devices feature very high gain at extremely low collector currents, low leakage currents and inherent low noise characteristics. These transistors are ideally suited for low level amplifier applications and, with leads in a TO-18 pin configuration, are epoxy replacements for the 2N929 and 2N930 type devices.



absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	50	Volts
Emitter to Base	V_{EBO}	5	Volts
Collector to Base	V_{CBO}	70	Volts
Current			
Collector (Steady State)	I_C	100	mA
Dissipation			
Total Power (Free Air @ 25°C)†	P_T	360	mW
Total Power (Free Air @ 55°C)†	P_T	250	mW
Temperature			
Storage	T_{STG}		−65 to +150°C
Operating	T_J		+125°C
Lead Soldering, 1/16″ ± 1/32″ from case for 10 sec. max.	T_L		+260°C

†Derate 3.6 mW/°C increase in ambient temperature above 25°C.



NOTE 1:
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND .250 FROM THE SEATING PLANE. BETWEEN .250 AND END OF LEAD A MAX. OF .021 IS HELD.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.

electrical characteristics: (25°C) (unless otherwise specified)

Static Characteristics				**Min.**	**Max.**	
Collector Cutoff Current ($V_{CB} = 50V$)			I_{CBO}		10	nA
($V_{CB} = 50V$, TA = 100°C)			I_{CBO}		10	μA
($V_{CB} = 50V$)			I_{CES}		10	nA
Emitter Cutoff Current ($V_{EB} = 5V$)			I_{EBO}		50	nA
Forward Current Transfer Ratio	($V_{CE} = 5V$, $I_C = 10\ \mu A$)	GET929	h_{FE}	60	120	
		GET930	h_{FE}	100	300	
	($V_{CE} = 5V$, $I_C = 0.5$ mA)	GET929	h_{FE}	90	—	
		GET930	h_{FE}	150	—	
	($V_{CE} = 5V$, $I_C = 10$ mA)	GET929	h_{FE}	—	350	
		GET930	h_{FE}	—	600	
Collector Emitter Breakdown Voltage ($I_C = 10$ mA)‡			$V_{(BR)CEO}$	50		Volts
Collector Base Breakdown Voltage ($I_C = 10\ \mu A$)			$V_{(BR)CBO}$	70		Volts
Emitter Base Breakdown Voltage ($I_E = 10\ \mu A$)			$V_{(BR)EBO}$	5		Volts
Collector Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)‡			$V_{CE(sat)}$		.125	Volts
Base Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)‡			$V_{BE(sat)}$		.78	Volts
Base Emitter Voltage ($V_{CE} = 10V$, $I_C = 2$ mA)			V_{BE}	.5	.9	Volts

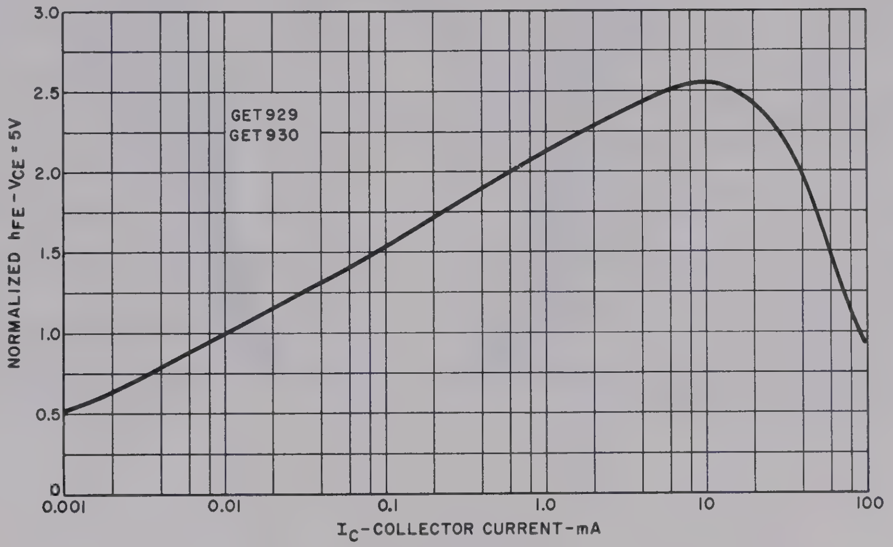
‡Pulse conditions 300 μsec. 2% duty cycle.

GET 929,30

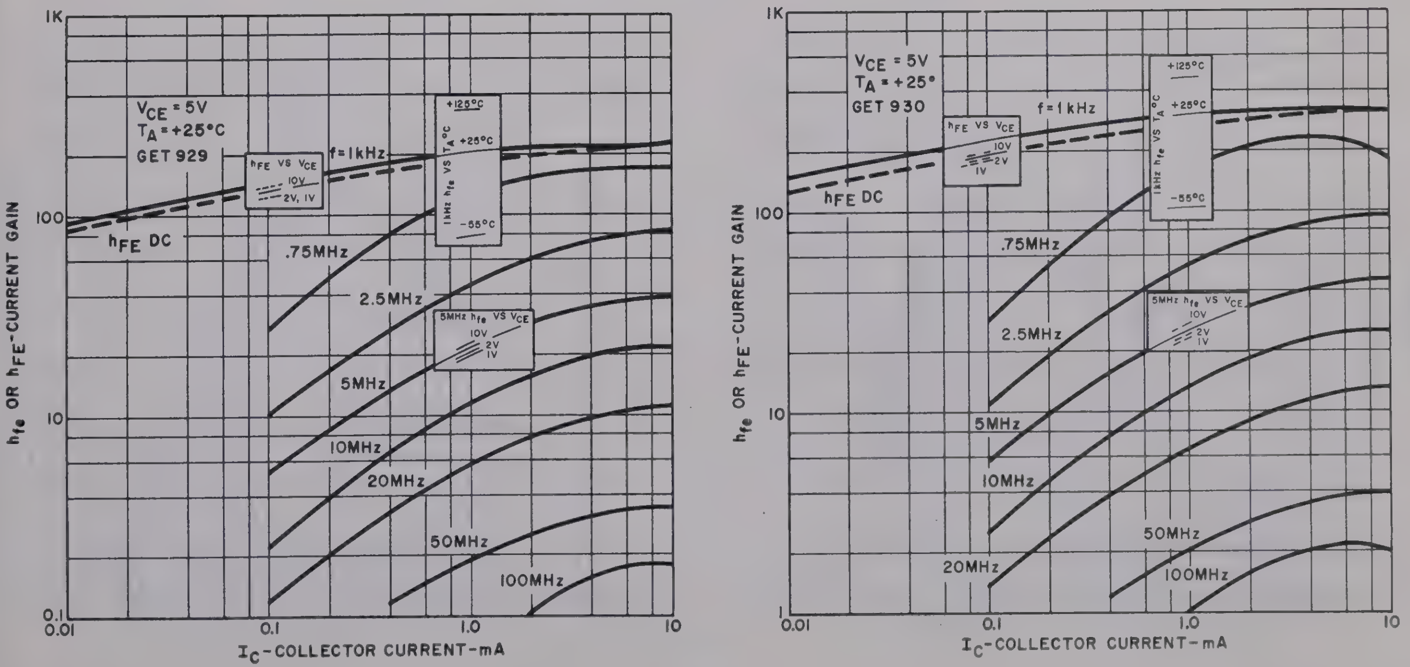
Dynamic Characteristics

				Min.	Max.	
Gain Bandwidth Product	($V_{CE} = 10V, I_C = 2$ mA, f = 10 mHz)		f_T	90	350	mHz
Noise Figure	($V_{CE} = 5V, I_C = 10\ \mu A, R_g = 10$ k, BW = 15.7 kHz)	GET929	NF		4	dB
		GET930	NF		3	dB
Output Capacitance, Common Base	($V_{CB} = 10V, I_E = 0$, f = 1 MHz)		C_{cb}	1.0	4.0	pF

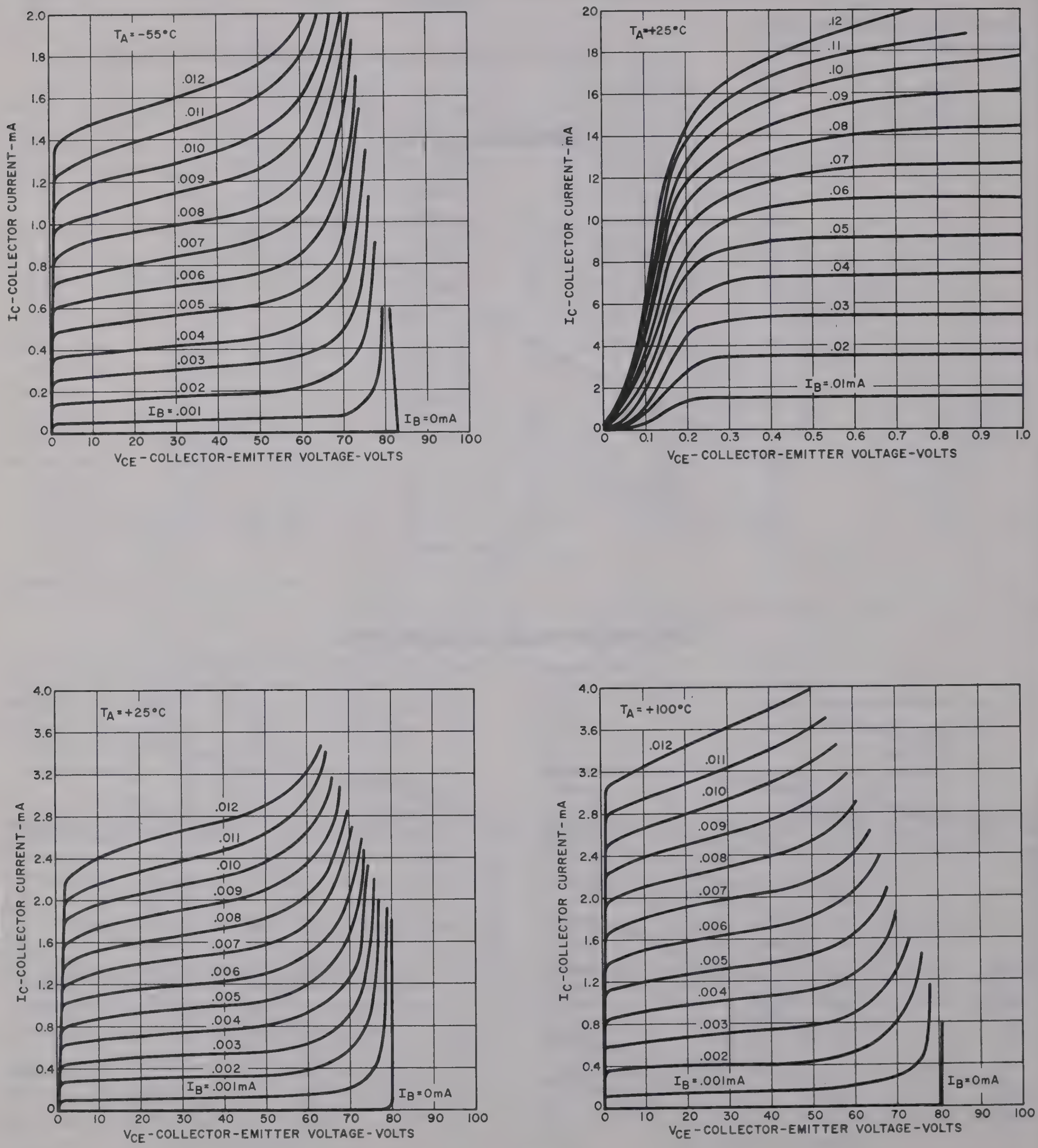
Normalized h_{FE} vs. I_C



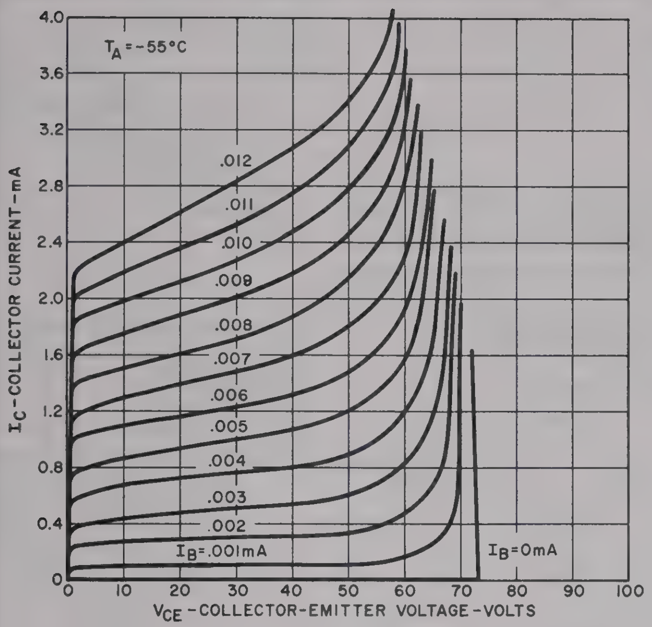
Small Signal Current Gain vs. Collector Current

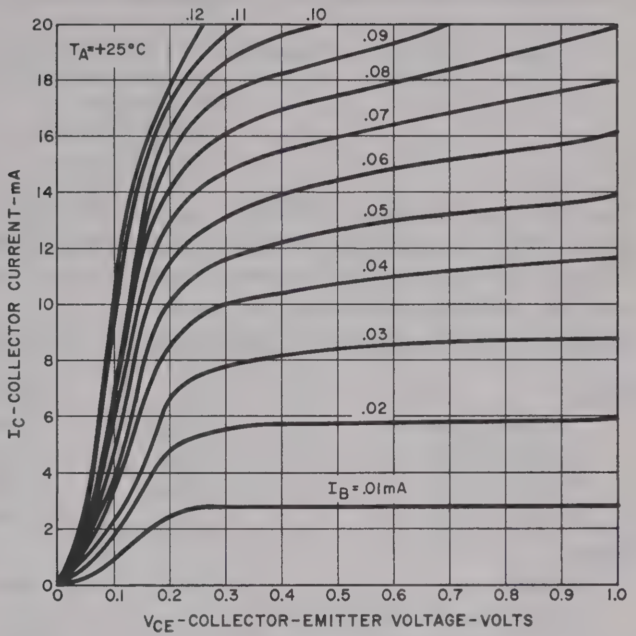


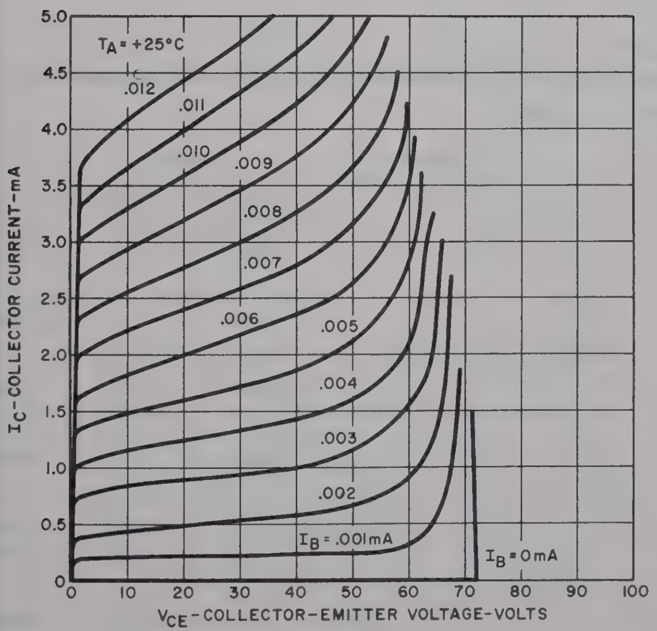
Typical Collector Characteristics
GET929

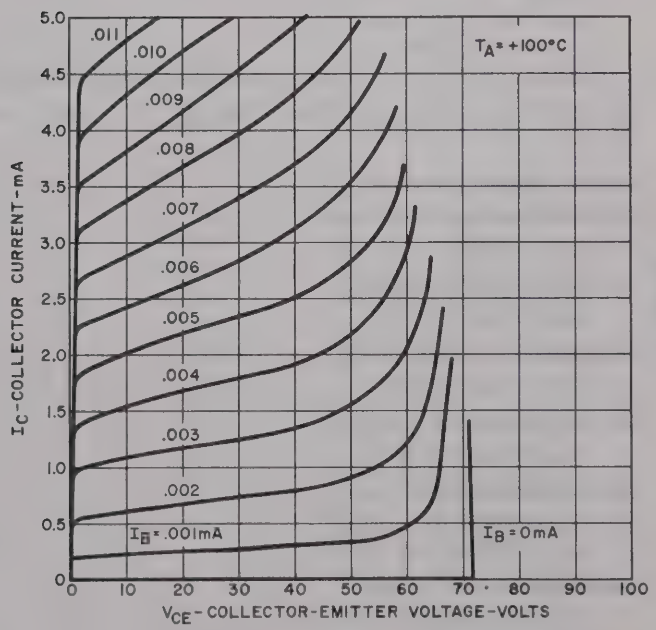


Typical Collector Characteristics
GET930







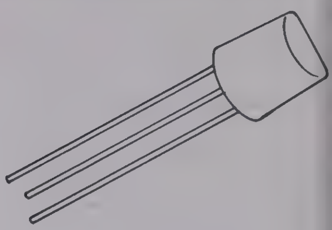


Silicon
Transistors

NPN

GET2221,2

Features:
- Performance comparable to hermetic units
- High Gain
- Medium Voltage
- Low $V_{CE(SAT)}$
- High Frequency



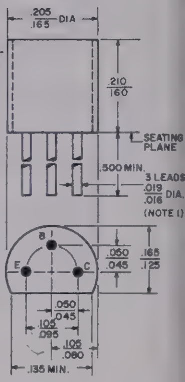
The General Electric GET2221 and GET2222 units are silicon, NPN, planar passivated, epitaxial devices specifically developed for high speed switching, amplifier and core driver applications. These devices feature excellent switching speeds and low collector saturation voltages.

absolute maximum ratings: (T_A=25°C,unless otherwise specified)

		GET2221	GET2222	
Voltages				
Collector to Emitter	V_{CEO}	30	30	Volts
Collector to Emitter	V_{CES}	40	40	Volts
Emitter to Base	V_{EBO}	5	5	Volts
Collector to Base	V_{CBO}	60	60	Volts
Current				
Collector	I_C	400	400	mA
Collector (peak, pulsed 10 μsec, ≤2% duty cycle)	I_C	800	800	mA
Dissipation				
Total Power ($T_C \leqq 25°C$)	P_T	1.0	1.0	Watts
Total Power ($T_A \leqq 25°C$)	P_T	0.360	0.360	Watts
Derate Factor ($T_C \geqq 25°C$)		10.0	10.0	mW/°C
Derate Factor ($T_A \geqq 25°C$)		3.6	3.6	mW/°C
Temperature				
Storage	T_{stg}	← −65 to +150 →		°C
Operating	T_J	← −65 to +125 →		°C
Lead (1/16″ ± 1/32″ from case for 10 sec.)	T_L	← +260 →		°C

NOTE 1:
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND .250 FROM THE SEATING PLANE. BETWEEN .250 AND END OF LEAD A MAX. OF .021 IS HELD.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.



electrical characteristics: (T_A = 25°C,unless otherwise specified)

		GET2221		GET2222		
STATIC CHARACTERISTICS	**Symbol**	**Min.**	**Max.**	**Min.**	**Max.**	
Collector-Emitter Breakdown Voltage						
(I_C = 10mA, I_B = 0)	$V_{(BR)CEO}$*	30		30		Volts
Emitter-Base Breakdown Voltage						
(I_E = 10μA, I_C = 0)	$V_{(BR)EBO}$	5		5		Volts
Collector-Base Breakdown Voltage						
(I_C = 10μA, I_E = 0)	$V_{(BR)CBO}$	60		60		Volts
Collector-Emitter Breakdown Voltage						
(I_C = 10μA, V_{BE} = 0)	$V_{(BR)CES}$	40		40		Volts
Collector-Emitter Saturation Voltage						
(I_C = 150mA, I_B = 15mA)	$V_{CE(SAT)}$*		.3		.3	Volts
(I_C = 500mA, I_B = 50mA)	$V_{CE(SAT)}$*		1.2		1.2	Volts
Base-Emitter Saturation Voltage						
(I_C = 150mA, I_B = 15mA)	$V_{BE(SAT)}$*		1.1		1.1	Volts
(I_C = 500mA, I_B = 50mA)	$V_{BE(SAT)}$*		2.4		2.4	Volts

		GET2221		GET2222		
STATIC CHARACTERISTICS (Continued)	Symbol	Min.	Max.	Min.	Max.	
Forward Current Transfer Ratio						
($V_{CE} = 1.0V$, $I_C = 150mA$)	h_{FE}*	20		50		
($V_{CE} = 10V$, $I_C = 0.1mA$)	h_{FE}	20		35		
($V_{CE} = 10V$, $I_C = 1.0mA$)	h_{FE}	25		50		
($V_{CE} = 10V$, $I_C = 10mA$)	h_{FE}*	35		75		
($V_{CE} = 10V$, $I_C = 150mA$)	h_{FE}*	40	120	100	300	
($V_{CE} = 10V$, $I_C = 500mA$)	h_{FE}*	20		30		
Collector Cutoff Current						
($V_{CB} = 50V$, $I_E = 0$)	I_{CBO}		10		10	nA
($V_{CB} = 50V$, $I_E = 0$, $T_A = 100°C$)	I_{CBO}		10		10	μA
Emitter-Base Reverse Current						
($V_{EB} = 3.0V$, $I_C = 0$)	I_{EBO}		50		50	nA

*Pulsed, 300 μsec, ≤ 2% duty cycle

DYNAMIC CHARACTERISTICS

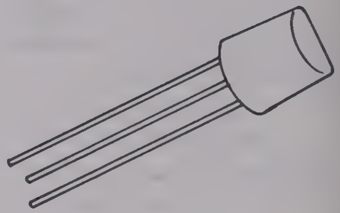
		GET2221 Min.	GET2221 Max.	GET2222 Min.	GET2222 Max.	
Gain Bandwidth Product						
($V_{CE} = 20V$, $I_C = 20mA$, $f = 100MHz$)	f_t	250		250		MHz
Collector-Base Capacitance						
($V_{CB} = 10V$, $I_E = 0$, $f = 1\ MHz$)	C_{cb}		8.0		8.0	pF
Emitter-Base Capacitance						
($V_{EB} = 0.5V$, $I_C = 0$, $f = 1\ MHz$)	C_{eb}		25		25	pF

Silicon
Transistors

NPN

GET2221A,2A

The General Electric GET2221A and GET2222A units are silicon, NPN, planar passivated, epitaxial devices specifically developed for high speed switching, amplifier and core driver applications.

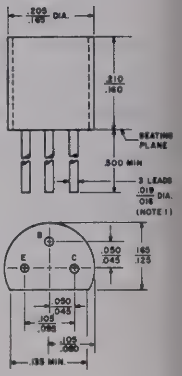


FEATURES:

- Performance comparable to hermetic units
- High gain
- Medium voltage
- Excellent switching speeds
- Low saturation voltages
- High frequency

absolute maximum ratings: (T$_A$ = 25°C, unless otherwise specified)

		GET2221A GET2222A	
Voltages			
Collector to Emitter	V_{CEO}	40	Volts
Collector to Emitter	V_{CES}	40	Volts
Emitter to Base	V_{EBO}	5	Volts
Collector to Base	V_{CBO}	75	Volts
Current			
Collector	I_C	400	mA
Collector (peak, pulsed 10 μsec, ≦ 2% duty cycle)	I_C	800	mA
Dissipation			
Total Power ($T_C \leqq 25°C$)	P_T	1.0	Watts
Total Power ($T_A \leqq 25°C$)	P_T	0.360	Watts
Derate Factor ($T_C \geqq 25°C$)		10.0	mW/°C
Derate Factor ($T_A \geqq 25°C$)		3.6	mW/°C
Temperature			
Storage	T_{STG}	−65 to +150	°C
Operating	T_J	−65 to +125	°C
Lead (1/16″ ± 1/32″ from case for 10 sec.)	T_L	+260	°C



NOTE 1:
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND .250 FROM THE SEATING PLANE BETWEEN .250 AND END OF LEAD A MAX. OF .021 IS HELD.

ALL DIMENSIONS ARE IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.

electrical characteristics: (T$_A$ = 25°C, unless otherwise specified)

STATIC CHARACTERISTICS	Symbol	GET2221A GET2222A Min.	Max.	
Collector-Emitter Breakdown Voltage				
($I_C = 10mA, I_B = 0$)	$V_{(BR)CEO}$*	40	—	Volts
Emitter-Base Breakdown Voltage				
($I_E = 10\mu A, I_C = 0$)	$V_{(BR)EBO}$	5	—	Volts
Collector-Base Breakdown Voltage				
($I_C = 10\mu A, I_E = 0$)	$V_{(BR)CBO}$	75	—	Volts
Collector-Emitter Breakdown Voltage				
($I_C = 10\mu A, V_{BE} = 0$)	$V_{(BR)CES}$	40	—	Volts
Collector-Emitter Saturation Votage				
($I_C = 150mA, I_B = 15mA$)	$V_{CE(SAT)}$*	—	0.3	Volts
($I_C = 500mA, I_B = 50mA$)	$V_{CE(SAT)}$*	—	1.0	Volts
Base-Emitter Saturation Voltage				
($I_C = 150mA, I_B = 15mA$)	$V_{BE(SAT)}$*	0.6	1.1	Volts
($I_C = 500mA, I_B = 50mA$)	$V_{BE(SAT)}$*	—	2.0	Volts

GET2221A,2A

STATIC CHARACTERISTICS (Continued)	Symbol	GET2221A Min.	GET2221A Max.	GET2222A Min.	GET2222A Max.	
Forward Current Transfer Ratio						
($V_{CE} = 1.0V, I_C = 150mA$)	h_{FE}*	20	—	50	—	
($V_{CE} = 10V, I_C = 0.1mA$)	h_{FE}	20	—	35	—	
($V_{CE} = 10V, I_C = 1.0mA$)	h_{FE}	25	—	50	—	
($V_{CE} = 10V, I_C = 10mA$)	h_{FE}*	35	—	75	—	
($V_{CE} = 10V, I_C = 150mA$)	h_{FE}*	40	120	100	300	
($V_{CE} = 10V, I_C = 500mA$)	h_{FE}*	20	—	30	—	
Collector Cutoff Current						
($V_{CB} = 60V, I_E = 0$)	I_{CBO}	—	10	—	10	nA
($V_{CB} = 60V, I_E = 0, T_A = 100°C$)	I_{CBO}	—	10	—	10	μA
Emitter-Base Reverse Current						
($V_{EB} = 3.0V, I_C = 0$)	I_{EBO}	—	50	—	50	nA

*Pulsed, 300 μsec, $\leqq 2\%$ duty cycle

DYNAMIC CHARACTERISTICS	Symbol	GET2221A Min.	GET2221A Max.	GET2222A Min.	GET2222A Max.	
Gain Bandwidth Product						
($V_{CE} = 20V, I_C = 20mA, f = 100$ MHz)	f_t	250	—	300	—	MHz
Collector-Base Capacitance						
($V_{CB} = 10V, I_E = 0, f = 1$ MHz)	C_{cb}	—	8.0	—	8.0	pF
Emitter-Base Capacitance						
($V_{EB} = 0.5V, I_C = 0, f = 1$ MHz)	C_{eb}	—	25	—	25	pF
Collector-Base Time Constant						
($V_{CE} = 20V, I_C = 20mA, f = 31.9$ MHz)	$r_b'C_c$	—	150	—	150	psec
Input Admittance						
($I_C = 20mA, V_{CE} = 20V, f = 300$ MHz)	h_{ie}	—	60	—	60	ohms
SWITCHING CHARACTERISTICS						
Turn-On Time						
($I_C = 150mA, V_{CC} = 30V, I_{B1} = 15mA$, Figure 1)	t_{on}	—	35	—	35	nsec
Turn-Off Time						
($I_C = 150mA, V_{CC} = 30V, I_{B1} = -I_{B2} = 15mA$, Figure 2)	t_{off}	—	285	—	285	nsec

*Pulse width $\leqq 300\mu$ sec., duty cycle $\leqq 2\%$

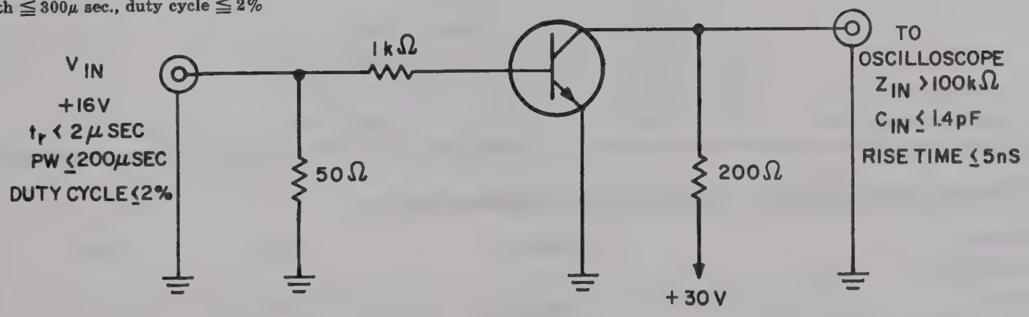

V IN
+16V
tr < 2µSEC
PW ≤200µSEC
DUTY CYCLE ≤2%
1kΩ
50Ω
200Ω
+30V
TO OSCILLOSCOPE
ZIN >100kΩ
CIN ≤ 1.4pF
RISE TIME ≤5nS

FIGURE 1. TEST CIRCUIT FOR DETERMINING TURN-ON TIME

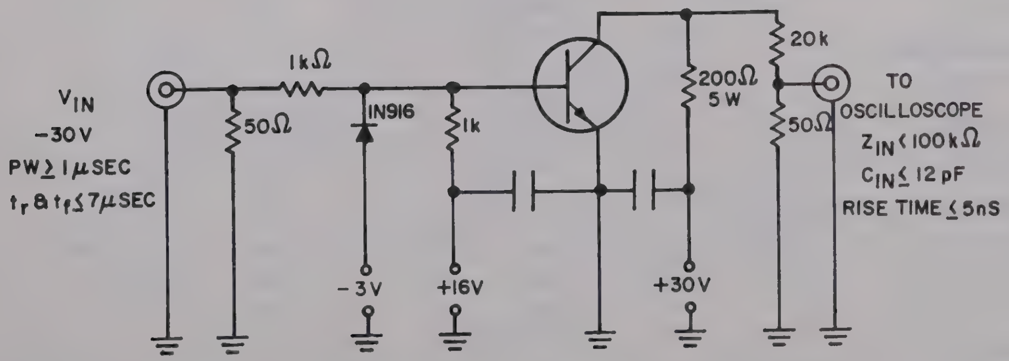

VIN
-30V
PW ≥ 1µSEC
tr & tf ≤ 7µSEC
1kΩ
50Ω
1N916
1k
-3V
+16V
200Ω
5W
+30V
20k
50Ω
TO OSCILLOSCOPE
ZIN < 100kΩ
CIN ≤ 12 pF
RISE TIME ≤ 5nS

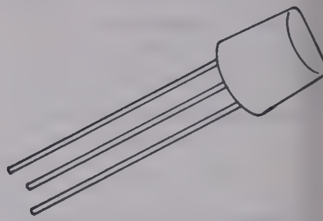
FIGURE 2. TEST CIRCUIT FOR DETERMINING TURN-OFF TIME

Silicon Transistor

NPN

GET2369

Features:
- Environmental performance comparable to hermetic units
- Low saturation voltage
- Ultra high speed



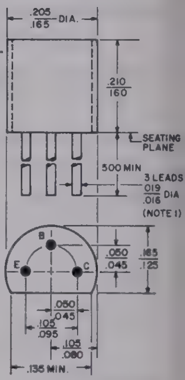
The General Electric GET2369 is an epoxy, silicon, NPN, planar, epitaxial passivated transistor designed primarily for ultra fast saturated switching applications for industrial service.

absolute maximum ratings ($T_A = 25°C$, unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	15	Volts
Collector to Emitter	V_{CES}	40	Volts
Emitter to Base	V_{EBO}	5	Volts
Collector to Base	V_{CBO}	40	Volts
Current			
Collector (steady state)	I_C	200	mA
Collector (peak, pulsed 10 μsec, ≤2% duty cycle)	I_C	500	mA
Dissipation			
Total Power ($T_C \leqq 25°C$)	P_T	0.500	Watts
Total Power ($T_A \leqq 25°C$)	P_T	0.360	Watts
Derate Factor ($T_C \geqq 25°C$)		5.0	mW/°C
Derate Factor ($T_A \geqq 25°C$)		3.6	mW/°C
Temperature			
Storage	T_{stg}	−65 to +150	°C
Operating	T_J	−65 to +125	°C
Lead Soldering, 1⁄16″ ± 1⁄32″ from case for 10 seconds max.	T_L	+260	°C

NOTE 1:
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND .250 FROM THE SEATING PLANE. BETWEEN .250 AND END OF LEAD A MAX. OF .021 IS HELD.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.



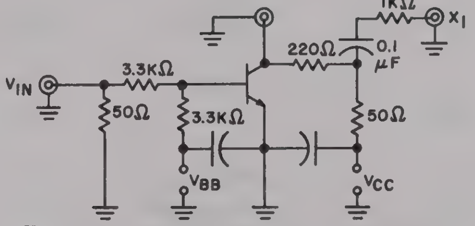
electrical characteristics: ($T_A = 25°C$, unless otherwise specified)

STATIC CHARACTERISTICS	Symbol	Min.	Max.	Units
Collector Base Breakdown Voltage				
($I_C = 10\mu a$, $I_E = 0$)	$V_{(BR)CBO}$	40		Volts
Collector Emitter Breakdown Voltage				
($I_C = 10\mu A$, $I_E = 0$)	$V_{(BR)CES}$	40		Volts
Collector Emitter Breakdown Voltage				
($I_C = 10mA$, $I_B = 0$)	$V_{(BR)CEO}$*	15		Volts
Emitter Base Breakdown Voltage				
($I_E = 10\mu A$, $I_C = 0$)	$V_{(BR)EBO}$	5		Volts
Forward Current Transfer Ratio				
($I_C = 10mA$, $V_{CE} = 1V$)	h_{FE}	40	120	
($I_C = 30mA$, $V_{CE} = .4V$)	h_{FE}*	30		
($I_C = 100mA$, $V_{CE} = 2V$)	h_{FE}*	20		
Collector Saturation Voltage				
($I_C = 10mA$, $I_B = 1mA$)	$V_{CE(SAT)}$		.25	Volts

STATIC CHARACTERISTICS (Continued)	Symbol	Min.	Max.	Units
Base Saturation Voltage				
($I_C = 10mA$, $I_B = 1mA$)	$V_{BE(SAT)}$	.70	.85	Volts
Collector Cutoff Current				
($V_{CE} = 20V$, $V_{BE} = 0$)	I_{CES}		100	nA
($V_{CE} = 20V$, $V_{BE} = 0$, $T_A = 100°C$)	I_{CES}		20	μA

*Pulsed, 300 μsec, ≤ 2% duty cycle

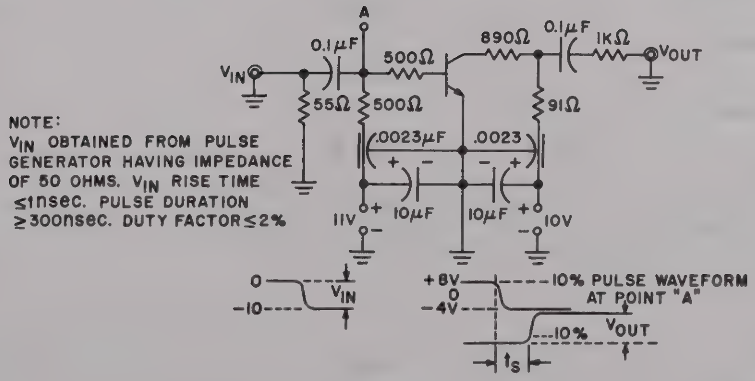
DYNAMIC CHARACTERISTICS	Symbol	Min.	Max.	Units
Gain Bandwidth Product				
($V_{CE} = 10V$, $I_C = 30mA$, f = 100MHz)	f_t	350		MHz
Output Capacitance, Common Base				
($V_{CB} = 10V$, f = 1MHz)	C_{cb}		4.5	pF
Input Capacitance, Common Base				
($V_{EB} = .5V$, f = 1MHz)	C_{eb}		7.5	pF
Turn-on Time (see Figure 1)				
($I_C = 10mA$, $I_{B1} = 3mA$, $I_{B2} = -1.5mA$)	t_{on}		15	nsec
Turn-off Time (see Figure 1)				
($I_C = 10mA$, $I_{B1} = 3mA$, $I_{B2} = -1.5mA$)	t_{off}		22	nsec
Storage Time (see Figure 2)				
($I_C = I_{B1} = 10mA$, $I_{B2} = -10mA$)	t_s		18	nsec


1KΩ
X1
220Ω
0.1 μF
3.3KΩ
VIN
50Ω
3.3KΩ
50Ω
VBB
VCC

	V_{CC}	V_{BB}	V_{IN}	$V_{BB(C)}$	I_C	I_{B1}	I_{B2}
t_{ON}	3	−3	15	-1.5	10	3	-1.5
t_{OFF}	3	12	−15	-1.5	10	3	-1.5

PW-300 nsec, DUTY CYCLE ≤ 2%
PULSE t_r AND t_s ≤ 1 nsec

Figure 1.


A
0.1μF
500Ω
890Ω
0.1μF
1KΩ
VOUT
VIN
55Ω
500Ω
91Ω
.0023μF
.0023
+
−
−
+
11V
+
−
10μF
10μF
+
−
10V
0
−10
VIN
+8V
0
−4V
10% PULSE WAVEFORM AT POINT "A"
10%
VOUT
tS

NOTE:
V_{IN} OBTAINED FROM PULSE GENERATOR HAVING IMPEDANCE OF 50 OHMS. V_{IN} RISE TIME ≤1nsec. PULSE DURATION ≥300nsec. DUTY FACTOR≤2%

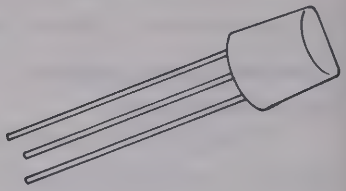
Figure 2.

Silicon
Transistor

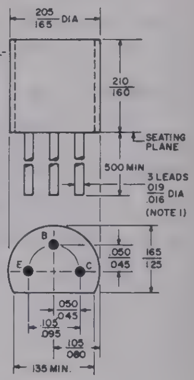
NPN

GET2484

The General Electric GET2484 is a silicon, NPN, planar, epitaxial, passivated transistor. This transistor is ideally suited for low-level amplifier applications. With leads in a TO-18 configuration, this device is an epoxy replacement for the 2N2484.



FEATURES:
- Very high gain at extremely low collector currents
- Low leakage currents
- Inherent low noise characteristics
- Epoxy encapsulation with proved reliability — excellent characteristic stability under environmental stresses, 85°C-85% RH



NOTE 1
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND .250 FROM THE SEATING PLANE BETWEEN .250 AND END OF LEAD A MAX OF .021 IS HELD

ALL DIMEN IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.

absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	60	Volts
Emitter to Base	V_{EBO}	6	Volts
Collector to Base	V_{CBO}	60	Volts
Current			
Collector (continuous)	I_C	100	mA
Dissipation			
Total Power (Free Air @ 25°C) ⁽¹⁾	P_T	360	mW
Total Power (Free Air @ 55°C)	P_T	250	mW
Temperature			
Storage	T_{STG}	−65 to +150	°C
Operating	T_J	−65 to +125	°C
Lead soldering, 1/16" ± 1/32" from case for 10 secs. max.	T_L	+260	°C

(1) Derate 3.60 mW/°C increase in ambient temperature above 25°C.

electrical characteristics: (25°C) (unless otherwise specified)

STATIC CHARACTERISTICS	Symbol	Min.	Max.	Units
Collector-Emitter Breakdown Voltage				
($I_C = 10mA$, $I_B = 0$)	$V_{(BR)CEO}$*	60	—	Volts
Emitter-Base Breakdown Voltage				
($I_E = 10\mu A$, $I_C = 0$)	$V_{(BR)EBO}$	6	—	Volts
Collector-Base Breakdown Voltage				
($I_C = 10\mu A$, $I_E = 0$)	$V_{(BR)CBO}$	60	—	Volts
Collector-Base Cutoff Current				
($V_{CB} = 45V$, $I_E = 0$)	I_{CBO}	—	50	nA
($V_{CB} = 45V$, $I_E = 0$, $T_A = 100°C$)	I_{CBO}	—	10	μA
Emitter-Base Cutoff Current				
($V_{EB} = 5.0V$, $I_C = 0$)	I_{EBO}	—	50	nA
Base-Emitter Voltage				
($I_C = 100\mu A$, $V_{CE} = 5V$)	$V_{BE(ON)}$	0.50	0.70	Volts
Collector-Emitter Saturation Voltage				
($I_C = 1mA$, $I_B = 0.1mA$)	$V_{CE(SAT)}$	—	0.350	Volts

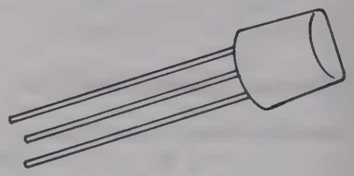
STATIC CHARACTERISTICS (Continued)	Symbol	Min.	Max.	Units
Forward Current Transfer Ratio				
($V_{CE} = 5V, I_C = 1\mu A$)	h_{FE}	30	—	
($V_{CE} = 5V, I_C = 10\mu A$)	h_{FE}	100	—	
($V_{CE} = 5V, I_C = 100\mu A$)	h_{FE}	175	—	
($V_{CE} = 5V, I_C = 500\mu A$)	h_{FE}	200	—	
($V_{CE} = 5V, I_C = 1mA$)	h_{FE}	250	—	
($V_{CE} = 5V, I_C = 10mA$)	h_{FE}*	—	800	
DYNAMIC CHARACTERISTICS				
Forward Current Transfer Ratio				
($I_C = 1mA, V_{CE} = 5V$, f = 1KHz)	h_{fe}	150	900	
Wide Band Noise Figure				
($I_C = 10\mu A, V_{CE} = 5V, R_g = 10K\Omega$, f = 10Hz to 10KHz, B.W. = 15.7 KHz)	NF	—	3	dB
Spot Noise Figure				
($I_C = 10\mu A, V_{CE} = 5V, R_g = 10K\Omega$, f = 1KHz)	NF	—	3	dB
($I_C = 10\mu A, V_{CE} = 5V, R_g = 10K\Omega$, f = 10KHz)	NF	—	2	dB
($I_C = 10\mu A, V_{CE} = 5V, R_g = 10K\Omega$, f = 100 Hz)	NF	—	10	dB
Forward Current Transfer Ratio				
($I_C = 50\mu A, V_{CE} = 5V$, f = 5MHz)	$\lvert h_{fe} \rvert$	2.0	—	
($I_C = 500\mu A, V_{CE} = 5V$, f = 30MHz)	$\lvert h_{fe} \rvert$	2.0	—	
Output Capacitance				
($V_{CB} = 10V$, f = 1MHz, Emitter connected to Guard Terminal on 3-Terminal Bridge)	C_{cb}	1.0	4.0	pF
Input Capacitance				
($V_{EB} = 0.5V$, f = 1MHz, Collector connected to Guard Terminal on 3-Terminal Bridge	C_{eb}	—	12	pF

*Pulsed Test — Pulse width $\leqq$ 300 μsec., duty cycle $\leqq$ 2%.

Silicon
Transistors

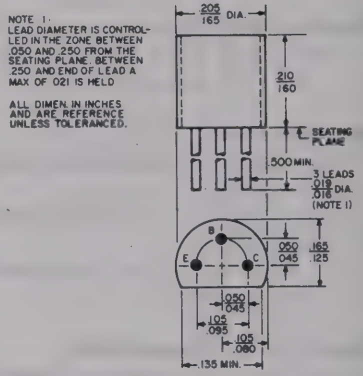
PNP
GET2904,6

The GET2904 and GET2906 are planar, epitaxial, passivated, PNP, silicon transistors intended for general purpose, amplifier, saturated switching, and core driver applications.



Features:

- Low leakage currents
- Low collector saturation voltages
- High speed switching
- Epoxy encapsulation with proved reliability—excellent characteristic stability under environmental stresses, 85°C @ 85% RH

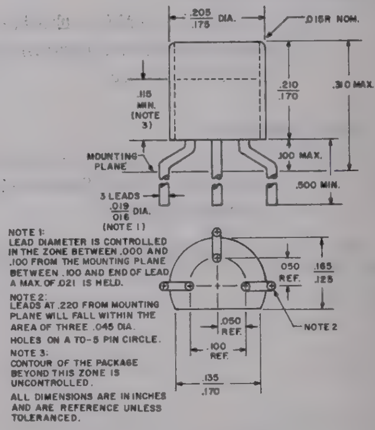


.205
165
DIA.
.210
160
SEATING PLANE
.500 MIN.
3 LEADS
.019
.016
DIA.
(NOTE 1)
B
E
C
.050
.045
.165
.125
.050
.045
.105
.095
.105
.080
.135 MIN.

NOTE 1·
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND .250 FROM THE SEATING PLANE. BETWEEN .250 AND END OF LEAD A MAX OF .021 IS HELD

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.

TO-18 LEAD SPACING
GET2906



.205
.175
DIA.
.018R NOM.
.115
MIN.
(NOTE 3)
.210
.170
.310 MAX.
MOUNTING PLANE
.100 MAX.
.500 MIN.
3 LEADS
.019
.016
DIA.
(NOTE 1)
.050
REF.
.165
.125
.050
REF.
.100
REF.
.135
.170
NOTE 2

NOTE 1:
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .000 AND .100 FROM THE MOUNTING PLANE BETWEEN .100 AND END OF LEAD A MAX. OF .021 IS HELD.

NOTE 2:
LEADS AT .220 FROM MOUNTING PLANE WILL FALL WITHIN THE AREA OF THREE .045 DIA. HOLES ON A TO-5 PIN CIRCLE.

NOTE 3:
CONTOUR OF THE PACKAGE BEYOND THIS ZONE IS UNCONTROLLED.

ALL DIMENSIONS ARE IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.

TO-5 LEAD SPACING
GET2904

absolute maximum ratings: ($T_A = 25°C$, unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	−40	Volts
Emitter to Base	V_{EBO}	−5	Volts
Collector to Base	V_{CBO}	−60	Volts
Current			
Collector	I_C	−350	mA
Collector (peak, pulsed 10 μsec, ≦ 2% duty cycle)	I_C	−700	mA
Dissipation			
Total Power ($T_C \leqq 25°C$)	P_T	0.700	Watts
Total Power ($T_A \leqq 25°C$)	P_T	0.360	Watts
Derate Factor ($T_C \geqq 25°C$)		7.0	mW/°C
Derate Factor ($T_A \geqq 25°C$)		3.6	mW/°C
Temperature			
Storage	T_{STG}	−65 to +150	°C
Operating	T_J	−65 to +125	°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	+260	°C

electrical characteristics: ($T_A = 25°C$, unless otherwise specified)

STATIC CHARACTERISTICS	Symbol	Min.	Max.	
Collector-Emitter Breakdown Voltage				
($I_C = -10MA, I_B = 0$)	$V_{(BR)CEO}$*	−40	—	Volts
Emitter-Base Breakdown Voltage				
($I_E = -10\mu A, I_C = 0$)	$V_{(BR)EBO}$	−5	—	Volts

electrical characteristics: (cont.)

	Symbol	Min.	Max.	
Collector-Base Breakdown Voltage				
($I_C = -10\mu A$, $I_E = 0$)	$V_{(BR)CBO}$	−60	—	Volts
Collector-Base Cutoff Current				
($V_{CB} = -50V$, $I_E = 0$)	I_{CBO}	—	−20	nA
($V_{CB} = -50V$, $I_E = 0$, $T_A = +100°C$)	I_{CBO}	—	−20	µA
Collector-Emitter Cutoff Current				
($V_{CE} = -30V$, $I_B = 0$)	I_{CES}	—	−50	nA
Collector-Emitter Saturation Voltage				
($I_C = -150mA$, $I_B = -15mA$)	$V_{CE(SAT)}$*	—	−0.4	Volts
($I_C = -500mA$, $I_B = -50mA$)	$V_{CE(SAT)}$*	—	−1.6	Volts
Base-Emitter Saturation Voltage				
($I_C = -150mA$, $I_B = -15mA$)	$V_{BE(SAT)}$*	—	−1.3	Volts
($I_C = -500mA$, $I_B = -50mA$)	$V_{BE(SAT)}$*	—	−2.6	Volts
Forward Current Transfer Ratio				
($V_{CE} = -10V$, $I_C = -0.1mA$)	h_{FE}	20	—	
($V_{CE} = -10V$, $I_C = -1.0mA$)	h_{FE}	25	—	
($V_{CE} = -10V$, $I_C = -10mA$)	h_{FE}	35	—	
($V_{CE} = -10V$, $I_C = -150mA$)	h_{FE}*	40	120	
($V_{CE} = -10V$, $I_C = -500mA$)	h_{FE}*	20	—	
DYNAMIC CHARACTERISTICS				
Output Capacitance, common base				
($V_{CB} = -10V$, $f = 1$ MHz, Emitter connected to Guard Terminal on 3-Terminal Bridge)	C_{cb}	—	8	pF
Input Capacitance, common base				
($V_{EB} = -0.5V$, $f = 1MHz$, Collector connected to Guard Terminal on 3-Terminal Bridge)	C_{eb}	—	30	pF
High Frequency Current Gain				
($I_C = -50mA$, $V_{CE} = -20V$, $f = 100MHz$)	$\lvert h_{fe} \rvert$	2.0	—	
Delay Time				
($I_{CS} = -150mA$, $I_{B1} = -15mA$, see Fig. 1)	t_d	—	10	nsec
Rise Time				
($I_{CS} = -150mA$, $I_{B1} = -15mA$, see Fig. 1)	t_r	—	40	nsec
Storage Time				
($I_{CS} = -150mA$, $I_{B1} = I_{B2} = -15mA$, see Fig. 2)	t_s	—	80	nsec
Fall Time				
($I_{CS} = -150mA$, $I_{B1} = I_{B2} = -15mA$, see Fig. 2)	t_f	—	30	nsec

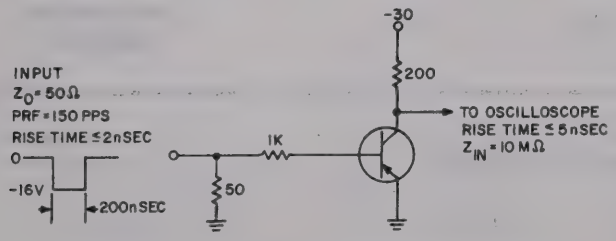

-30
200
INPUT
Z0=50Ω
PRF=150 PPS
RISE TIME ≤2nSEC
0
-16V
200nSEC
50
1K
TO OSCILLOSCOPE
RISE TIME ≤ 5nSEC
ZIN=10MΩ

Figure 1 Test Circuit For Determining Delay Time and Rise Time

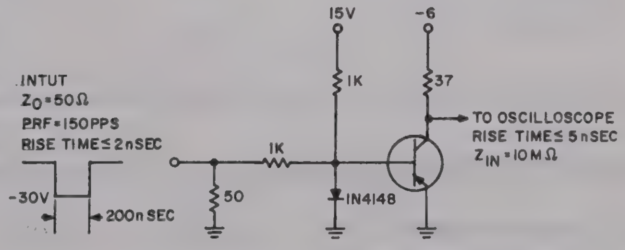

15V
-6
1K
37
INTUT
Z0=50Ω
PRF=150PPS
RISE TIME≤2nSEC
-30V
200nSEC
50
1K
1N4148
TO OSCILLOSCOPE
RISE TIME≤5nSEC
ZIN=10MΩ

Figure 2 Test Circuit For Determining Storage Time and Fall Time

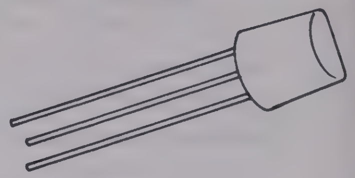
*Pulse conditions of 300 µsec duration, 2% duty cycle.

Silicon Transistors

PNP

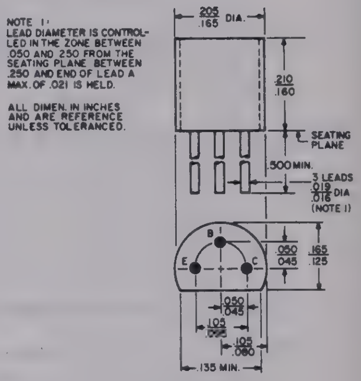
GET2905,7

The GET2905 and GET2907 are planar, epitaxial, passivated, PNP, silicon, transistors intended for general purpose, amplifiers, saturated switching, and core driver applications.



Features:

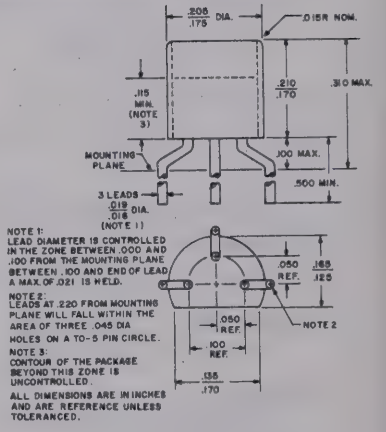
- Low leakage currents
- Low collector saturation voltages
- High speed switching
- Epoxy encapsulation with proved reliability—excellent characteristic stability under environmental stresses, 85°C @ 85% RH


NOTE 1:
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND 250 FROM THE SEATING PLANE BETWEEN .250 AND END OF LEAD A MAX. OF .021 IS HELD.
ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.
.205/.165 DIA.
.210/.160
SEATING PLANE
.500 MIN.
3 LEADS .019/.016 DIA (NOTE 1)
B
E
C
.050/.045
.165/.125
.050/.045
.105/.095
.105/.080
.135 MIN.

TO-18
LEAD SPACING
GET2907

absolute maximum ratings: (T$_A$ = 25°C, unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	−40	Volts
Emitter to Base	V_{EBO}	−5	Volts
Collector to Base	V_{CBO}	−60	Volts
Current			
Collector	I_C	−350	mA
Collector (peak, pulsed 10 μsec, ≦ 2% duty cycle)	I_C	−700	mA
Dissipation			
Total Power ($T_C \leqq 25°C$)	P_T	0.700	Watts
Total Power ($T_A \leqq 25°C$)	P_T	0.360	Watts
Derate Factor ($T_C \geqq 25°C$)		7.0	mW/°C
Derate Factor ($T_A \geqq 25°C$)		3.6	mW/°C
Temperature			
Storage	T_{STG}	−65 to +150	°C
Operating	T_J	−65 to +125	°C
Lead (1/16″ ± 1/32″ from case for 10 sec.)	T_L	+260	°C


.205/.175 DIA.
.015R NOM.
.115 MIN. (NOTE 3)
.210/.170
.310 MAX.
MOUNTING PLANE
.100 MAX.
.500 MIN.
3 LEADS .019/.016 DIA. (NOTE 1)
NOTE 1:
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .000 AND .100 FROM THE MOUNTING PLANE BETWEEN .100 AND END OF LEAD A MAX. OF .021 IS HELD.
NOTE 2:
LEADS AT .220 FROM MOUNTING PLANE WILL FALL WITHIN THE AREA OF THREE .045 DIA HOLES ON A TO-5 PIN CIRCLE.
NOTE 3:
CONTOUR OF THE PACKAGE BEYOND THIS ZONE IS UNCONTROLLED.
ALL DIMENSIONS ARE IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.
.050 REF.
.165/.125
NOTE 2
.050 REF.
.100 REF.
.135/.170

TO-5
LEAD SPACING
GET2905

electrical characteristics: (T$_A$ = 25°C, unless otherwise specified)

STATIC CHARACTERISTICS	Symbol	Min.	Max.	
Collector-Emitter Breakdown Voltage				
($I_C = -10mA, I_B = 0$)	$V_{(BR)CEO}$*	−40	—	Volts
Emitter-Base Breakdown Voltage				
($I_E = -10\mu A, I_C = 0$)	$V_{(BR)EBO}$	−5	—	Volts

electrical characteristics: (cont.)

	Symbol	Min.	Max.	
Collector-Base Breakdown Voltage				
($I_C = -10\mu A$, $I_E = 0$)	$V_{(BR)CBO}$	−60	—	Volts
Collector-Base Cutoff Current				
($V_{CB} = -50V$, $I_E = 0$)	I_{CBO}	—	−50	nA
($V_{CB} = -50V$, $I_E = 0$, $T_A = +100°C$)	I_{CBO}	—	−20	μA
Collector-Emitter Cutoff Current				
($V_{CE} = -30V$, $I_B = 0$)	I_{CES}	—	−50	nA
Collector-Emitter Saturation Voltage				
($I_C = -150mA$, $I_B = -15mA$)	$V_{CE(SAT)}$*	—	−0.4	Volts
($I_C = -500mA$, $I_B = -50mA$)	$V_{CE(SAT)}$*	—	−1.6	Volts
Base-Emitter Saturation Voltage				
($I_C = -150mA$, $I_B = -15mA$)	$V_{BE(SAT)}$*	—	−1.3	Volts
($I_C = -500mA$, $I_B = -50mA$)	$V_{BE(SAT)}$*	—	−2.6	Volts
Forward Current Transfer Ratio				
($V_{CE} = -10V$, $I_C = -0.1mA$)	h_{FE}	35	—	
($V_{CE} = -10V$, $I_C = -1.0mA$)	h_{FE}	50	—	
($V_{CE} = -10V$, $I_C = -10mA$)	h_{FE}	75	—	
($V_{CE} = -10V$, $I_C = -150mA$)	h_{FE}*	100	300	
($V_{CE} = -10V$, $I_C = -500mA$)	h_{FE}*	30	—	
DYNAMIC CHARACTERISTICS				
Output Capacitance, common base				
($V_{CB} = -10V$, $f = 1MHz$, Emitter connected to Guard Terminal on 3-Terminal Bridge)	C_{cb}	—	8	pF
Input Capacitance, common base				
($V_{EB} = -0.5V$, $f = 1MHz$, Collector connected to Guard Terminal on 3-Terminal Bridge)	C_{eb}	—	30	pF
High Frequency Current Gain				
($I_C = -50mA$, $V_{CE} = -20V$, $f = 100$ MHz)	$\lvert h_{fe} \rvert$	2.0	—	
Delay Time				
($I_{CS} = -150mA$, $I_{B1} = -15mA$, see Fig. 1)	t_d	—	10	nsec
Rise Time				
($I_{CS} = -150mA$, $I_{B1} = -15mA$, see Fig. 1)	t_r	—	40	nsec
Storage Time				
($I_{CS} = -150mA$, $I_{B1} = I_{B2} = -15mA$, see Fig. 2)	t_s	—	80	nsec
Fall Time				
($I_{CS} = -150mA$, $I_{B1} = I_{B2} = -15mA$, see Fig. 2)	t_f	—	30	nsec

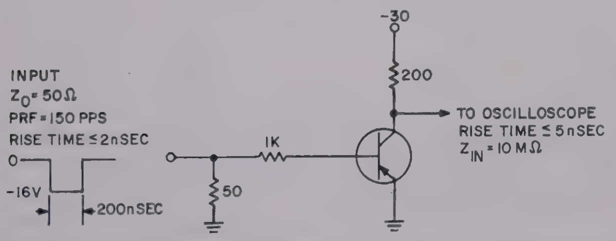

-30
200
INPUT
Z0 = 50Ω
PRF = 150 PPS
RISE TIME ≤ 2nSEC
0
-16V
200nSEC
1K
50
TO OSCILLOSCOPE
RISE TIME ≤ 5nSEC
ZIN = 10MΩ

Figure 1 Test Circuit For Determining Delay Time and Rise Time

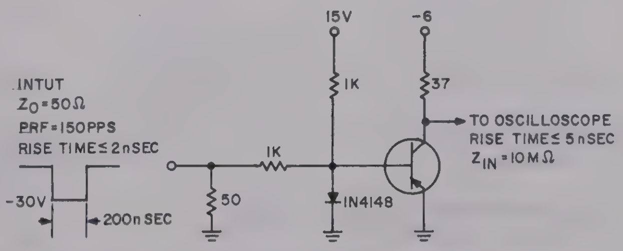

15V
-6
1K
37
INTUT
Z0 = 50Ω
PRF = 150PPS
RISE TIME ≤ 2nSEC
-30V
200nSEC
1K
50
1N4148
TO OSCILLOSCOPE
RISE TIME ≤ 5nSEC
ZIN = 10MΩ

Figure 2 Test Circuit For Determining Storage Time and Fall Time

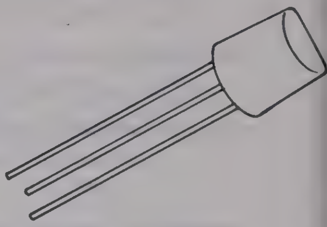
*Pulse conditions of 300 μsec duration, 2% duty cycle.

Silicon
Transistors

NPN

GET3013,4

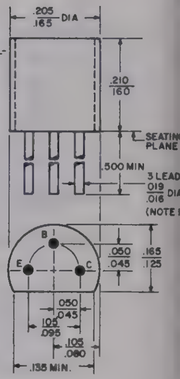
Features:
- Performance comparable to hermetic units
- High speed ($T_s = 18$ nsec at 10mA)
- Low Saturation Voltage



The General Electric GET3013 and GET3014 are epoxy, silicon, NPN, planar epitaxial passivated transistors specifically designed for high speed switching applications.

absolute maximum ratings: ($T_A = 25°C$, unless otherwise specified)

		GET3013	GET3014
Voltages			
Collector to Emitter	V_{CEO}	15V	20V
Collector to Emitter	V_{CES}	40V	40V
Emitter to Base	V_{EBO}	5V	5V
Collector to Base	V_{CBO}	40V	40V
Current			
Collector (steady state)	I_C	200mA	200mA
Collector (peak, pulsed 10μsec, 2% duty cycle)	I_C	500mA	500mA
Dissipation			
Total Power ($T_C \leqq 25°C$)	P_T	0.500 Watts	0.500 Watts
Total Power ($T_A \leqq 25°C$)	P_T	0.360 Watts	0.360 Watts
Derate Factor ($T_C \geqq 25°C$)		5.0 mW/°C	5.0 mW/°C
Derate Factor ($T_A \geqq 25°C$)		3.6 mW/°C	3.6 mW/°C
Temperature			
Storage	T_{stg}	← −65 to +150°C →	
Operating	T_J	← −65 to +125°C →	
Lead Soldering, 1/16" ± 1/32" from case for 10 seconds max.	T_L	← +260°C →	



NOTE 1:
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND 250 FROM THE SEATING PLANE BETWEEN .250 AND END OF LEAD A MAX. OF .021 IS HELD.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.

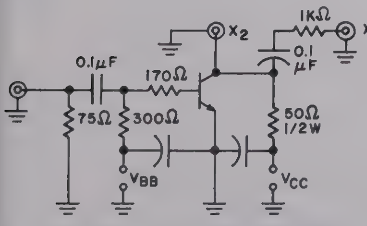
electrical characteristics: ($T_A = 25°C$, unless otherwise specified)

		GET3013		GET3014		
STATIC CHARACTERISTICS	**Symbol**	**Min.**	**Max.**	**Min.**	**Max.**	**Units**
Collector Base Breakdown Voltage						
($I_C = 100\mu A$, $I_E = 0$)	$V_{(BR)CBO}$	40		40		Volts
Collector Emitter Breakdown Voltage						
($I_C = 100\mu A$, $V_{BE} = 0$)	$V_{(BR)CES}$	40		40		Volts
Collector Emitter Breakdown Voltage						
($I_C = 10mA$, $I_B = 0$)	$V_{(BR)CEO}$*	15		20		Volts
Emitter Base Breakdown Voltage						
($I_E = 10\mu A$, $I_C = 0$)	$V_{(BR)EBO}$	5		5		
Forward Current Transfer Ratio						
($I_C = 10mA$, $V_{CE} = 0.4V$)	h_{FE}			25		
($I_C = 30mA$, $V_{CE} = 0.4V$)	h_{FE}*	30	120	30	120	
($I_C = 100mA$, $V_{CE} = 0.5V$)	h_{FE}*	25				
($I_C = 100mA$, $V_{CE} = 1.0V$)	h_{FE}*			25		
($I_C = 300mA$, $V_{CE} = 1.0V$)	h_{FE}*	15				

	Symbol	GET3013 Min.	GET3013 Max.	GET3014 Min.	GET3014 Max.	Units
STATIC CHARACTERISTICS (Continued)						
Collector Saturation Voltage						
($I_C = 10mA$, $I_B = 1.0mA$)	$V_{CE(SAT)}$				.18	Volts
($I_C = 30mA$, $I_B = 3.0mA$)	$V_{CE(SAT)}$*		.18		.18	Volts
($I_C = 100mA$, $I_B = 10mA$)	$V_{CE(SAT)}$*		.28		.35	Volts
($I_C = 300mA$, $I_B = 30mA$)	$V_{CE(SAT)}$*		.500			Volts
Base Saturation Voltage						
($I_C = 10mA$, $I_B = 1.0mA$)	$V_{BE(SAT)}$			.700	.800	Volts
($I_C = 30mA$, $I_B = 3.0mA$)	$V_{BE(SAT)}$*	.750	.900	.750	.900	Volts
($I_C = 100mA$, $I_B = 10mA$)	$V_{BE(SAT)}$*		.950		.950	Volts
($I_C = 300mA$, $I_B = 30mA$)	$V_{BE(SAT)}$*		1.7			Volts
Collector Cutoff Current						
($V_{CE} = 20V, V_{BE} = 0$)	I_{CES}		100		100	nA
($V_{CE} = 20V$, $V_{BE} = 0$), $T_A = 100°C$)	I_{CES}		20		20	μA
Emitter Cutoff Current						
($V_{EB} = 5V$)	I_{EBO}		10		10	μA

*Pulsed, 300 μsec, ≤2% duty cycle.

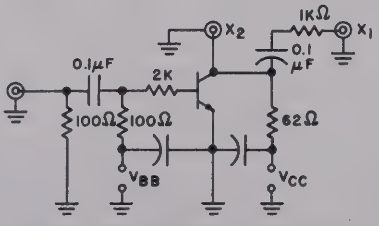
	Symbol	GET3013 Min.	GET3013 Max.	GET3014 Min.	GET3014 Max.	Units
DYNAMIC CHARACTERISTICS						
Forward Current Transfer Ratio						
($I_C = 30mA$, $V_{CE} = 10V$, $f = 100MHz$)	$\|h_{fe}\|$	3.5		3.5		
Gain Bandwidth Product						
($V_{CE} = 10V$, $I_C = 30mA$, $f = 100MHz$)	f_t	350		350		MHz
Output Capacitance, Common Base						
($V_{CB} = 10V$, $f = 1MHz$)	C_{cb}		4.5		4.5	pF
Input Capacitance, Common Base						
($V_{EB} = .5V$, $f = 1MHz$)	C_{eb}		7.5		7.5	pF
Turn-on Time						
GET3013 (see Figure 1)	t_{on}		15			nsec
GET3014 (see Figure 2)	t_{on}				16	nsec
Turn-off Time						
GET3013 (see Figure 1)	t_{off}		25			nsec
GET3014 (see Figure 2)	t_{off}				25	nsec
Storage Time (see Figure 3)						
($I_C = I_{B1} = 10mA$, $I_{B2} = -10mA$)	t_s		18		18	nsec


X2
1KΩ
X1
0.1 μF
0.1μF
170Ω
75Ω
300Ω
50Ω 1/2W
VBB
VCC

	V_{CC}	V_{BB}	V_{IN}	I_C	I_{B1}	I_{B2}
t_{ON}	15	-5	+11	300	30	-30
t_{OFF}	15	-5	+11	300	30	-30

PW=300nsec, DUTY CYCLE ≤ 2%
PULSE t_r AND t_s ≤ 1 nsec

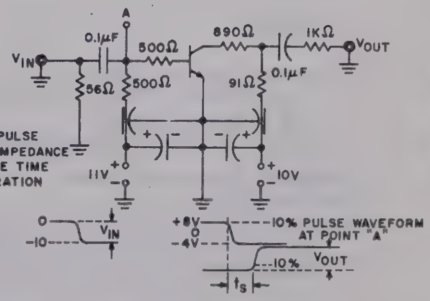
Figure 1. GET3013


X2
1KΩ
X1
0.1 μF
0.1μF
2K
100Ω
100Ω
62Ω
VBB
VCC

	V_{CC}	V_{BB}	V_{IN}	I_C	I_{B1}	I_{B2}
t_{ON}	2	GRD	7	30	3	–
t_{OFF}	2	7	-13	30	3	-3

PW-300nsec, DUTY CYCLE ≤ 2%
PULSE t_r AND t_s ≤ 1 nsec

Figure 2. GET3014


A
0.1μF
500Ω
890Ω
1KΩ
VOUT
VIN
56Ω
500Ω
91Ω
0.1μF
11V
10V
0
-10
VIN
+8V
0
-4V
10% PULSE WAVEFORM AT POINT "A"
10%
VOUT
tS

NOTE:
V_{IN} OBTAINED FROM PULSE GENERATOR HAVING IMPEDANCE OF 50 OHMS. V_{IN} RISE TIME ≤1nsec. PULSE DURATION ≥300nsec.
DUTY FACTOR ≤2%

Figure 3. GET3013 and GET3014

Silicon

Transistors

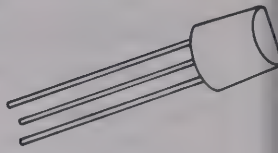
NPN

GET3563

TIS62 TIS6

The GET3562, TIS62 and TIS63 are NPN silicon planar epitaxial transistors in the TO-18 lead configuration package. The devices were designed for low level, high frequency amplifier applications.

FEATURES:
- Epoxy encapsulation with proven reliability
- Performance comparable to hermetic units—excellent characteristic stability under environmental stresses −85°C −85% relative humidity
- f_T – 500MHz min.
- Low capacitance – 1pF typical



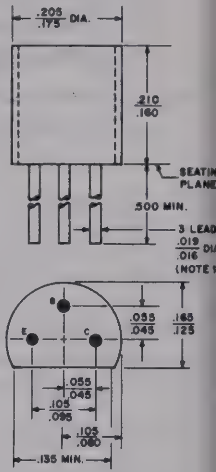
absolute maximum ratings: (T_A = 25°C unless otherwise specified)

		GET3563	TIS62	TIS63	
VOLTAGES					
Collector to Emitter	V_{CEO}	12	12	12	Volts
Collector to Base	V_{CBO}	30	30	30	Volts
Emitter to Base	V_{EBO}	2	3	3	Volts
CURRENT					
Collector	I_c	50	50	50	mA
DISSIPATION					
Total Power ($T_A \leq 25°C$)	P_T	250	250	250	mW
Total Power ($T_C \leq 25°C$)	P_T	500			mW
Derate Factor ($T_A > 25°C$)		2	2	2	mW/°C
Derate Factor ($T_C > 25°C$)		5			mW/°C
TEMPERATURE					
Storage	T_{stg}	−55°C to +125°C	−65°C to +150°C		
Operating	T_j	+125°C max.	+150°C max.		
Lead Soldering (1/16" ± 1/32" from case for 10 sec. max.)	T_L		+260°C		

NOTE 1:
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND .250 FROM THE SEATING PLANE BETWEEN .250 AND END OF LEAD A MAX. OF .021 IS HELD.

ALL DIMENSIONS ARE IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.

TO-18 LEAD SPACING



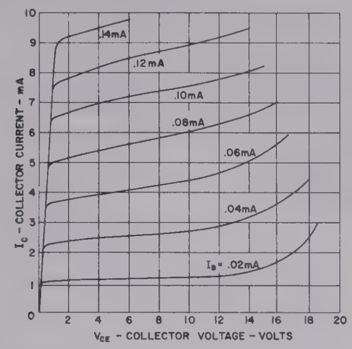
electrical characteristics: (T_A = 25°C unless otherwise specified)

		GET3563		TIS62		TIS63		
		MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
STATIC								
Collector Cutoff Current	I_{CBO}							
(V_{CB} = 15 V, I_E = 0)			50					nA
(V_{CB} = 10 V, I_E = 0)					100		100	nA
Forward Current Transfer Ratio	h_{FE}							
(I_c = 8 mA, V_{CE} = 10 V)		20	200					
(I_c = 4 mA, V_{CE} = 10 V)				30		20		
Collector Base Breakdown Voltage (I_c = 100 uA, I_E = 0)	$V_{(BR)CBO}$	30		30		30		Volts
Emitter Base Breakdown Voltage								
(I_E = 10 uA, I_c = 0)	$V_{(BR)EBO}$	2						Volts
(I_E = 100 uA, I_c = 0)	$V_{(BR)EBO}$			3		3		Volts
Collector Emitter Breakdown Voltage								
(I_c = 3 mA, I_B = 0)	$V_{(BR)CEO}$	12						Volts
(I_c = 4 mA, I_B = 0)	$V_{(BR)CEO}$			12		12		Volts
DYNAMIC								
Forward Current Transfer Ratio (I_c = 8 mA, V_{CE} = 10 V, f = 10 KHz)	h_{fe}	20	250					
Collector Base Capacitance (V_{CB} = 10 V, I_E = 0, f = 1 MHz)	C_{cb}		1.7		1.6		1.6	pF
Magnitude of Forward Current Transfer Ratio								
(I_c = 8 mA, V_{CE} = 10 V, f = 100 MHz)	$\lvert h_{fe} \rvert$	6	15					
(I_c = 4 mA, V_{CE} = 10 V, f = 455 KHz)	$\lvert h_{fe} \rvert$					27		dB
(I_c = 4 mA, V_{CE} = 10 V, f = 10 MHz)	$\lvert h_{fe} \rvert$					27		dB
(I_c = 4 mA, V_{CE} = 10 V, f = 100 MHz)	$\lvert h_{fe} \rvert$			5	18	4	18	dB
Collector Base Time Constant	$r_b'C_c$							
(I_c = 8 mA, V_{CB} = 10 V, f = 79.8 MHz)		8	25					psec.
(I_c = 4 mA, V_{CB} = 10 V, f = 79.8 MHz)					20		26	psec.
Small Signal Power Gain—See Circuit Figure 1 (I_c = 8 mA, V_{CE} = 10 V, f = 200 MHz)	G_{pe}	14	26					dB
Spot Noise Figure (I_c = 2 mA, V_{CE} = 10 V, R_g = 300 Ω, f = 100 MHz)	N_F				6			dB

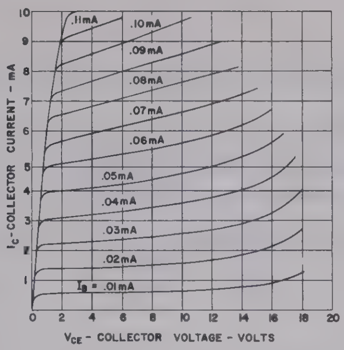
(Pages 1311-1378 reserved for future use)

TYPICAL ELECTRICAL CHARACTERISTICS

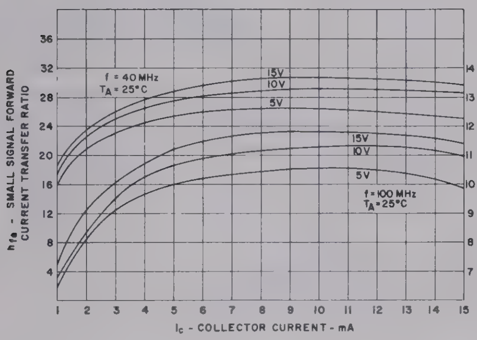
Collector Characteristics $T_A = 25°C$



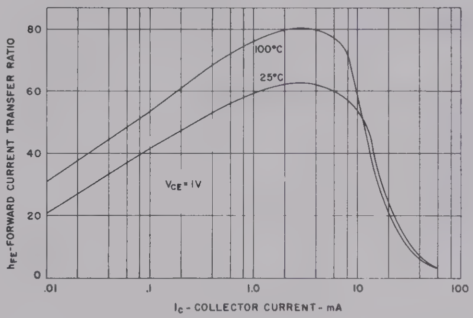
Collector Characteristics $T_A = 100°C$



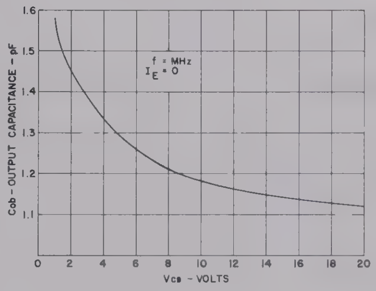
h_{fe} vs. Collector Current, f = 100 MHz f = 40 MHz



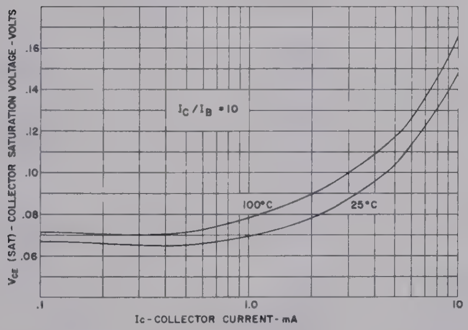
h_{FE} vs. Collector Current



Output Capacity vs. Reverse Voltage Bias



$V_{CE(SAT)}$ vs. Collector Current



Contours of Gain Bandwidth Product, f_T vs. Collector Current

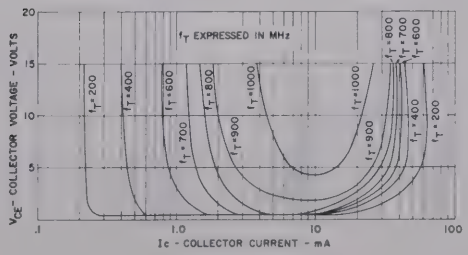
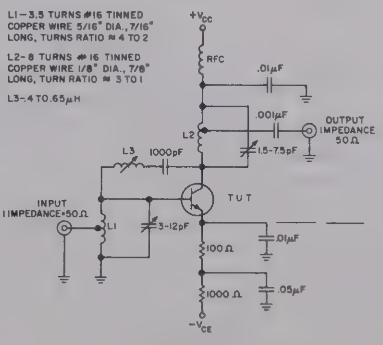


Figure 1


L1—3.5 TURNS #16 TINNED COPPER WIRE 5/16" DIA., 7/16" LONG, TURNS RATIO ≈ 4 TO 2
L2—8 TURNS #16 TINNED COPPER WIRE 1/8" DIA., 7/8" LONG, TURN RATIO ≈ 3 TO 1
L3—4 TO .65μH
$+V_{CC}$
RFC
.01μF
.001μF
OUTPUT IMPEDANCE 50Ω
L2
1.5-7.5pF
L3
1000pF
TUT
INPUT IMPEDANCE=50Ω
L1
3-12pF
.01μF
100Ω
1000Ω
.05μF
$-V_{CE}$

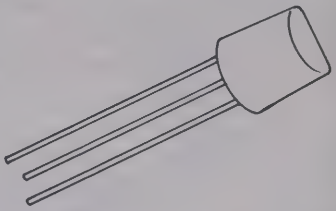
NEUTRALIZED 200 MHz POWER GAIN AMPLIFIER TEST CIRCUIT (G_{PE})

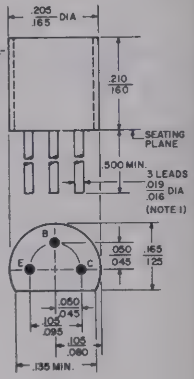
Silicon
Transistors

PNP

GET3638,A

The GET3638 and GET3638A are planar, epitaxial, passivated PNP silicon transistors intended for general purpose applications. The units feature low collector saturation voltage, controlled current gain, and excellent frequency response.





NOTE 1:
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND .250 FROM THE SEATING PLANE. BETWEEN .250 AND END OF LEAD A MAX. OF .021 IS HELD.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.

absolute maximum ratings: (T_A=25°C, unless otherwise specified)

Voltages		
Collector to Emitter	V_{CEO}	−25V
Emitter to Base	V_{EBO}	−4V
Collector to Base	V_{CBO}	−25V
Collector to Emitter	V_{CES}	−25V
Current		
Collector (steady state)	I_C	−350mA
Collector (peak, pulsed 10 μusec, 2% Duty Cycle)	I_C	−700mA
Dissipation		
Total Power ($T_C \leqq 25$°C)	P_T	0.700 Watts
Total Power ($T_A \leqq 25$°C)	P_T	0.360 Watts
Derate Factor ($T_C \geqq 25$°C)		7.0 mW/°C
Derate Factor ($T_A \geqq 25$°C)		3.6 mW/°C
Temperature		
Storage	T_{STG}	−65 to +150°C
Operating	T_J	−65 to +125°C
Lead Soldering, 1/16" ± 1/32" from case for 10 seconds max.	T_L	+260°C

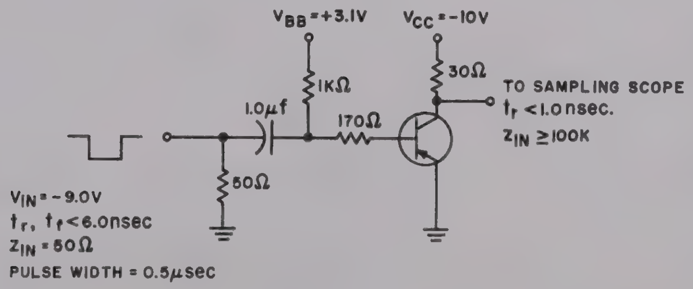
electrical characteristics: (T_A=25°C, unless otherwise specified)

STATIC CHARACTERISTICS	Symbol		Min.	Max.	Units
Collector-Base Breakdown Voltage					
($I_C = -100\mu A$, $I_E = 0$)	$V_{(BR)CBO}$		−25		Volts
Collector-Emitter Breakdown Voltage					
($I_C = 10mA$, $I_B = 0$)	$V_{(BR)CEO}$*		−25		Volts
($I_C = 100\mu A$, $V_{BE} = 0$)	$V_{(BR)CES}$		−25		Volts
Emitter-Base Breakdown Voltage					
($I_E = 10\mu A$, $I_C = 0$)	$V_{(BR)EBO}$		−4		Volts
Forward Current Transfer Ratio					
($I_C = -1mA$, $V_{CE} = -10V$)	h_{FE}	GET3638A	80		
($I_C = -10mA$, $V_{CE} = -10V$)	h_{FE}*	GET3638	20		
		GET3638A	100		
($I_C = -50mA$, $V_{CE} = -1V$)	h_{FE}*	GET3638	30	70 (Typ.)	
		GET3638A	100		
($I_C = -300mA$, $V_{CE} = -2V$)	h_{FE}*	GET3638	20	40 (Typ.)	
		GET3638A	20	50 (Typ.)	
Collector Saturation Voltage					
($I_C = -50mA$, $I_B = -2.5mA$)	$V_{CE(SAT)}$ *			−.250	Volts
($I_C = -300mA$, $I_B = -30mA$)	$V_{CE(SAT)}$ *			−1.0	Volts
Base Saturation Voltage					
($I_C = -50mA$, $I_B = -2.5mA$)	$V_{BE(SAT)}$ *			−1.1	Volts
($I_C = -300mA$, $I_B = -30mA$)	$V_{BE(SAT)}$ *		−.80	−2.0	Volts

STATIC CHARACTERISTICS (Continued)	Symbol		Min.	Max.	Units
Collector Cutoff Current					
($V_{CE} = -15V, V_{BE} = 0$	I_{CES}			-35	nA
($V_{CB} = -15V$, $V_{BE} = 0$, $T_A = 100°C$)	I_{CES}			-10	μA

*Pulse conditions of 300 μsec duration, 2% duty cycle

DYNAMIC CHARACTERISTICS					
Forward Current Transfer Ratio					
($I_C = -10mA$, $V_{CE} = -10V$, $f = 1kHz$)	h_{fe}	GET3638	25		
		GET3638A	100		
Input Impedance					
($I_C = -10mA$, $V_{CE} = -10V$, $f = 1kHz$)	h_{ie}	GET3638 GET3638A	480 (Typ.)	2000	ohms
Output Admittance					
($I_C = -10mA$, $V_{CE} = -10V$, $f = 1kHz$)	h_{oe}	GET3638 GET3638A	80 (Typ.)	1200	umhos
Reverse Voltage Transfer Ratio					
($I_C = -10mA$, $V_{CE} = -10V$, $f = 1kHz$)	h_{re}	GET3638	162 (Typ.)	2600	10^{-6}
		GET3638A		1500	10^{-6}
Output Capacitance, common base					
($V_{CB} = -10V$, $f = 1MHz$)	C_{cb}			10	pF
Input Capacitance, common base					
($V_{EB} = -0.5V$, $f = 1MHz$)	C_{eb}			35	pF
Gain bandwidth product					
($V_{CE} = -3V$, $I_C = -50mA$)	f_t		100 (Typ.)		MHz
Delay Time					
($V_{CC} = -10V$, $I_C = -300mA$, $I_{B1} = -30mA$, $V_{BB(off)} = +3.1V$) (See Test Circuit)	t_d			20	nsec
Rise Time					
($V_{CC} = -10V$, $I_C = -300mA$, $I_{B1} = -30mA$, $V_{BB(off)} = +3.1V$) (See Test Circuit)	t_r			70	nsec
Turn-on Time					
($I_C = -300mA$, $I_{B1} = -30mA$) (See Test Circuit)	t_{on}			75	nsec
Storage Time					
($V_{CC} = -10V$, $I_C = -300mA$, $I_{B1} = -30mA$, $I_{B2} = 30mA$) (See Test Circuit)	t_s			140	nsec
Fall Time					
($V_{CC} = -10V$, $I_C = -300mA$, $I_{B1} = -30mA$, $I_{B2} = 30mA$) (See Test Circuit)	t_f			70	nsec
Turn-off Time					
($I_C = -300mA$, $I_{B1} = -30mA$, $I_{B2} = 30mA$) (See Test Circuit)	t_{off}			170	nsec

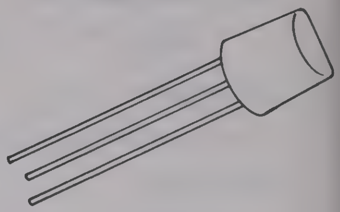


Silicon
Transistor

NPN

GET3646

Features:
- Performance comparable to Hermetic units
- High speed
- Low saturation voltage



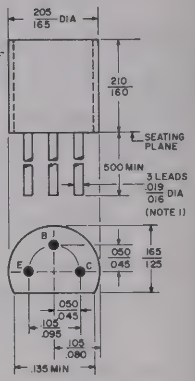
The General Electric GET3646 is an epoxy, silicon, NPN, planar, epitaxial passivated transistor specifically designed for high speed switching applications.

absolute maximum ratings: (T$_A$=25°C unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	15	Volts
Collector to Emitter	V_{CES}	40	Volts
Emitter to Base	V_{EBO}	5	Volts
Collector to Base	V_{CBO}	40	Volts
Current			
Collector (steady state)	I_C	200	mA
Collector (peak, pulsed10 μsec 2% duty cycle)	I_C	500	mA
Dissipation			
Total Power ($T_C \leqq 25°C$)	P_T	0.500	Watts
Total Power ($T_A \leqq 25°C$)	P_T	0.360	Watts
Derate Factor ($T_C \geqq 25°C$)		5.0	mW/°C
Derate Factor ($T_A \geqq 25°C$)		3.6	mW/°C
Temperature			
Storage	T_{STG}	−65 to +150°C	
Operating	T_J	−65 to +125°C	
Lead Soldering, 1/16" ± 1/32" from case for 10 seconds max.	T_L	+260°C	

NOTE 1:
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND 250 FROM THE SEATING PLANE BETWEEN .250 AND END OF LEAD A MAX. OF .021 IS HELD.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.

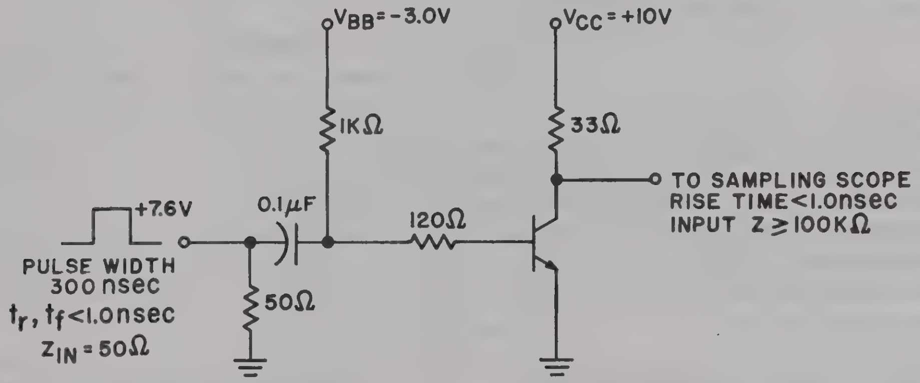


electrical characteristics: (T$_A$ = 25°C unless otherwise specified)

STATIC CHARACTERISTICS	Symbol	Min.	Max.	Units
Collector-Base Breakdown Voltage				
($I_C = 100\mu A$, $I_E = 0$)	$V_{(BR)CBO}$	40		Volts
Collector-Emitter Breakdown Voltage				
($I_C = 100\mu A$, $V_{BE} = 0$)	$V_{(BR)CES}$	40		Volts
Collector-Emitter Breakdown Voltage				
($I_C = 10mA$, $I_B = 0$)	$V_{(BR)CEO}{}^*$	15		Volts
Emitter-Base Breakdown Voltage				
($I_E = 10\mu A$, $I_C = 0$)	$V_{(BR)EBO}$	5		Volts
Forward Current Transfer Ratio				
($I_C = 30mA$, $V_{CE} = 0.4V$)	h_{FE}	30	120	
($I_C = 100mA$, $V_{CE} = 0.5V$)	h_{FE}	25		
($I_C = 300mA$, $V_{CE} = 1.0V$)	h_{FE}	15		
Collector Saturation Voltage				
($I_C = 30mA$, $I_B = 3.0mA$)	$V_{CE(SAT)}{}^*$		.2	Volts
($I_C = 100mA$, $I_B = 10mA$)	$V_{CE(SAT)}{}^*$		.28	Volts
($I_C = 300mA$, $I_B = 30mA$)	$V_{CE(SAT)}{}^*$		.500	Volts
Base Saturation Voltage				
($I_C = 30mA$, $I_B = 3.0mA$)	$V_{BE(sat)}{}^*$	.750	.950	Volts
($I_C = 100mA$, $I_B = 10mA$)	$V_{BE(sat)}{}^*$		1.2	Volts
($I_C = 300mA$, $I_B = 30mA$)	$V_{BE(sat)}{}^*$		1.7	Volts

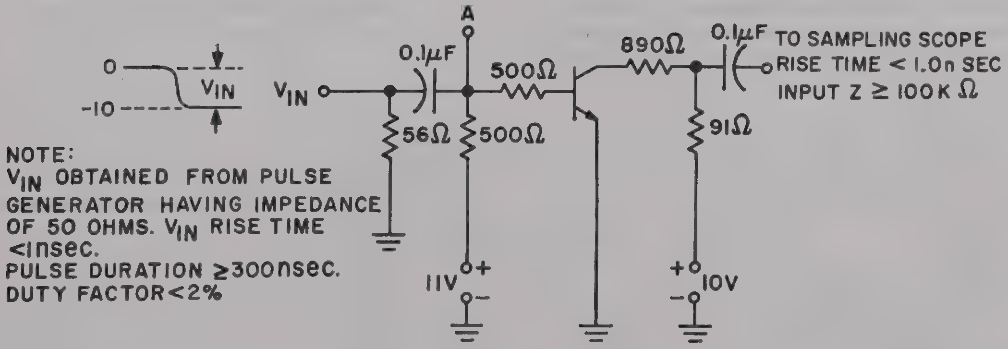
GET3646

STATIC CHARACTERISTICS (Continued)	Symbol	Min.	Max.	Units
Collector Cutoff Current				
$V_{CE} = 20V,\ V_{BE} = 0)$	I_{CES}		100	nA
$V_{CE} = 20V,\ V_{BE} = 0, T_A = 100°C$	I_{CES}		20	μA
Emitter Cutoff Current				
$V_{EB} = 5V$	I_{EBO}		10	μA
*Pulsed, 300 μsec, 2% duty cycle.				
DYNAMIC CHARACTERISTICS				
Forward Current Transfer Ratio				
$I_C = 30mA,\ V_{CE} = 10V,\ f = 100MHz$	$\lvert h_{fe} \rvert$	3.5		
Gain Bandwidth Product				
$V_{CE} = 10V,\ I_C = 30mA,\ f=100MHz$	f_t	350		MHz
Output Capacitance Common Base				
$V_{CB} = 10V,\ f = 1MHz$	C_{cb}		4.5	pF
Input Capacitance Common Base				
$V_{EB} = .5V,\ f = 1MHz$	C_{eb}		7.5	pF
Turn-on Time (See Figure 1)	t_{on}		18	nsec
Turn-off Time (See Figure 1)	t_{off}		28	nsec
Storage Time (See Figure 2) $I_C, I_{B1} = -I_{B2} = 10mA)$	t_s		18	nsec



VBB = -3.0V
VCC = +10V
1KΩ
33Ω
+7.6V
0.1μF
120Ω
TO SAMPLING SCOPE
RISE TIME<1.0nsec
INPUT Z ≥ 100KΩ
PULSE WIDTH
300 nsec
tr, tf<1.0nsec
ZIN = 50Ω
50Ω

Figure 1.



A
0
-10
VIN
VIN
0.1μF
500Ω
890Ω
0.1μF
TO SAMPLING SCOPE
RISE TIME < 1.0n SEC
INPUT Z ≥ 100K Ω
56Ω
500Ω
91Ω
+
11V
-
+
10V
-

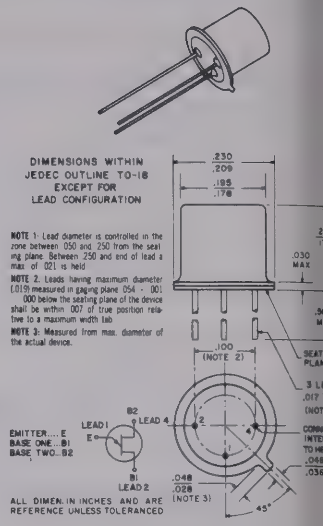
NOTE:
VIN OBTAINED FROM PULSE GENERATOR HAVING IMPEDANCE OF 50 OHMS. VIN RISE TIME <1nsec.
PULSE DURATION ≥300nsec.
DUTY FACTOR<2%

Figure 2.

Silicon Unijunction Transistor

GET4870
GET4871

The General Electric GET4870-71 Silicon Unijunction Transistors are intended for general purpose industrial applications where circuit economy is of primary importance. The GET4870-71 are ideal for use in firing circuits for Silicon Controlled Rectifiers, timing circuits, relaxation oscillators and other typical unijunction transistor applications.


DIMENSIONS WITHIN JEDEC OUTLINE TO-18 EXCEPT FOR LEAD CONFIGURATION

NOTE 1- Lead diameter is controlled in the zone between .050 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held

NOTE 2. Leads having maximum diameter (.019) measured in gaging plane .054 + .001 − .000 below the seating plane of the device shall be within .007 of true position relative to a maximum width tab

NOTE 3: Measured from max. diameter of the actual device.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

absolute maximum ratings: (25°C)

Power Dissipation (Note 1)	300 mW
RMS Emitter Current	50 mA
Peak Emitter Current (Note 2)	2 Amperes
Emitter Reverse Voltage	30 Volts
Interbase Voltage	35 Volts
Operating Temperature Range	−65°C to +125°C
Storage Temperature Range	−65°C to +150°C

electrical characteristics: (25°C)

		GET4870			GET4871			
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	UNITS
Intrinsic Standoff Ratio (V_{BB} = 10V)	η	0.56	–	0.75	0.70	–	0.85	
Interbase Resistence (V_{BB} = 3V, I_E = 0)	R_{BBO}	4.0	6.0	9.1	4.0	6.0	9.1	K ohms
Emitter Saturation Voltage (V_{BB} = 10V, I_E = 50 mA)	$V_{E(SAT)}$	–	2.5	–	–	2.5	–	Volts
Modulated Interbase Current (V_{BB} = 10V, I_E = 50 mA)	$I_{B2(MOD)}$	–	15	–	–	15	–	mA
Emitter Reverse Current (V_{B2E} = 30V, I_{B1} = 0)	I_{EO}	–	0.05	1.0	–	0.05	1.0	μA
Peak Point Emitter Current (V_{BB} = 25V)	I_P	–	1.0	5.0	–	1.0	5.0	μA
Valley Point Current (V_{BB} = 20V, R_{B2} = 100 Ω)	I_V	2.0	5.0	–	4.0	7.0	–	mA
Base-One Peak Pulse Voltage (Note 3)	V_{OB1}	3.0	6.0	–	5.0	8.0	–	Volts

NOTES:

1. Derate 3.0 MW/°C increase in ambient temperature. The total power dissipation (available power to Emitter and Base-Two) must be limited by the external circuitry.
2. Capacitor discharge–10μfd or less, 30 volts or less.
3. The Base-One Peak Pulse Voltage is measured in the circuit below. This specification is used to ensure a minimum pulse amplitude for applications in SCR firing circuits and other types of pulse circuits.
4. The intrinsic standoff ratio, η, is essentially constant with temperature and interbase voltage. η is defined by the equation:

$$V_P = \eta V_{BB} + V_D$$

Where V_P = Peak Point Emitter Voltage

V_{BB} = Interbase Voltage

V_D = Junction Diode Drop (Approx. .5V)

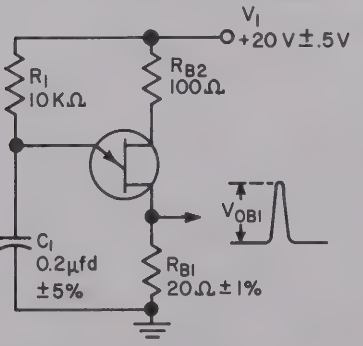


FIGURE 1

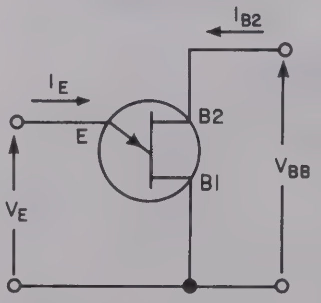


FIGURE 2
Unijunction Transistor Symbol with Nomenclature used for voltage and currents.

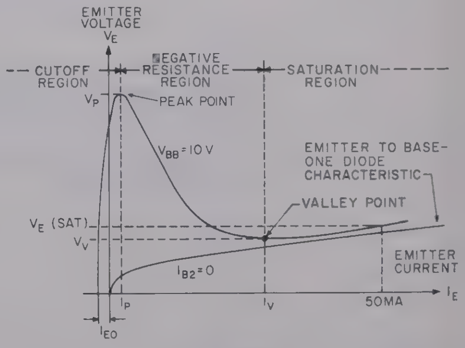


FIGURE 3
Static Emitter Characteristics curves showing important parameters and measurement points (exaggerated to show details).

TYPICAL ELECTRICAL CHARACTERISTICS

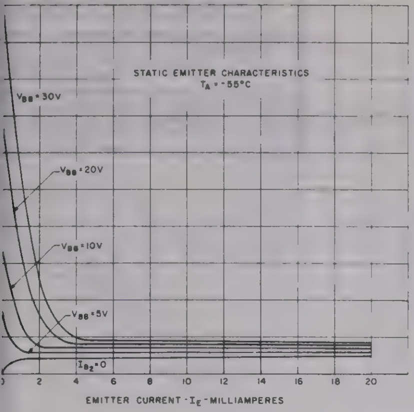


FIGURE 4

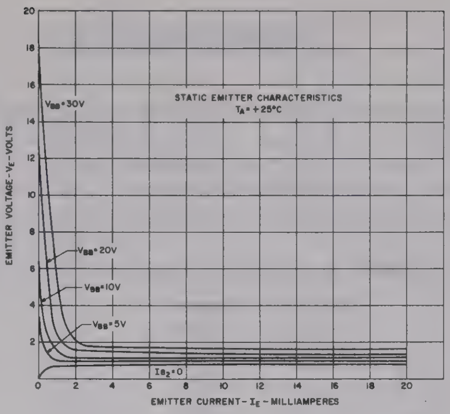


FIGURE 5

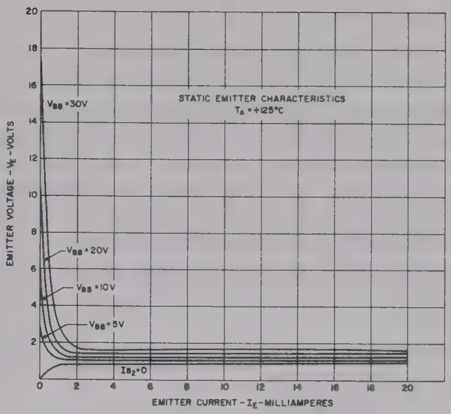


FIGURE 6

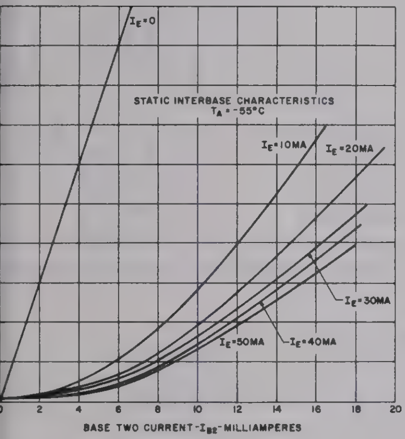


FIGURE 7

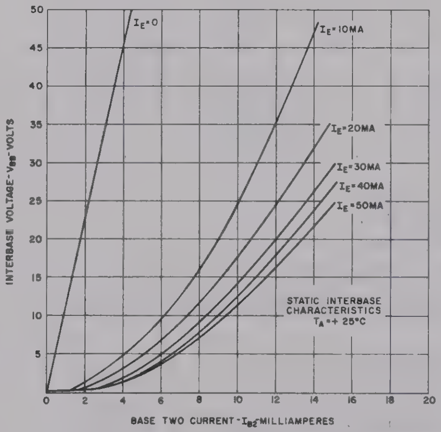


FIGURE 8

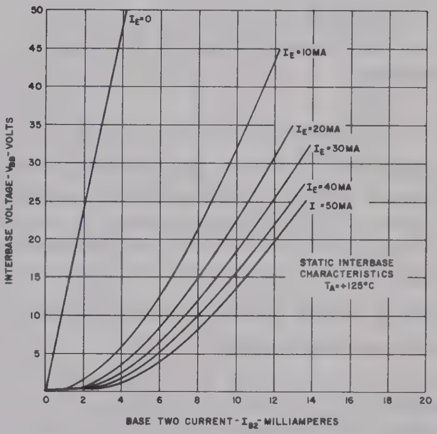


FIGURE 9

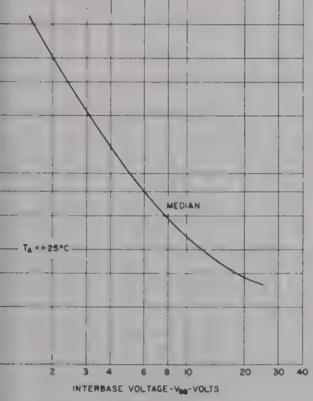


FIGURE 10

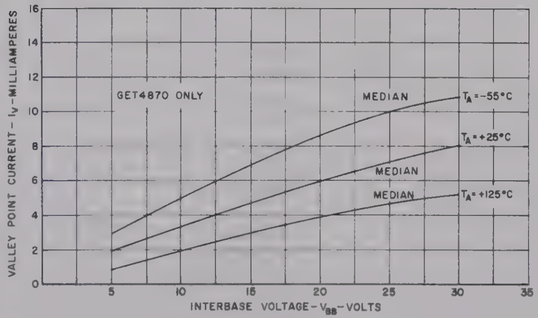


FIGURE 11

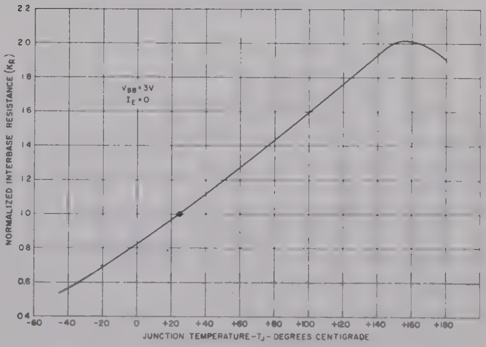


FIGURE 12

Silicon Monolithic
Darlington Amplifiers
CONSUMER-INDUSTRIAL

NPN

GET5305,GET5307
GET5306,GET5308
GET5306A,GET5308A

The General Electric GET5305, 6, 6A, 7, 8, 8A are NPN, silicon, planar, epitaxial, passivated Darlington monolithic amplifiers. These devices are especially suited for preamplifier input stages requiring input impedances of several megohms or extremely low level, high gain, low noise amplifier applications. Additional applications include medium speed switching circuits in consumer and industrial control applications.

absolute maximum ratings: (25°C) (unless otherwise specified)

		GET5305 GET5306 GET5306A	GET5307 GET5308 GET5308A	
Voltages				
Collector to Base	V_{CBO}	25	40	Volts
Collector to Emitter	V_{CEO}	25	40	Volts
Emitter to Base	V_{EBO}	12	12	Volts
Current				
Collector (Steady State)	I_C	300		mA
Collector (Pulsed)*	I_C	500		mA
Base (Steady State)	I_B	50		mA
Dissipation				
Total Power ($T_A \leqq 25$°C)†	P_T	400		mW
Total Power with Heatsink ($T_A \leqq 25$°C)††	P_T	600		mW
Total Power with Heatsink ($T_C \leqq 25$°C)†††	P_T	900		mW
Temperature				
Storage	T_{stg}	−65 to +150°C		
Operating	T_J	−65 to +125°C		
Lead, 1/16" ± 1/32" from case for 10 sec. max.	T_L	+260°C		

*Pulse conditions: 300 μsec. pulse width, 2% duty cycle.

†Derate 4.0 mW/°C for increase in ambient temperature above 25°C.

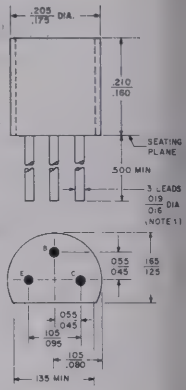
††Derate 6.0 mW/°C for increase in ambient temperature above 25°C.

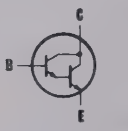
†††Derate 9.0 mW/°C for increase in case temperature above 25°C.

NOTE 1:
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND .250 FROM THE SEATING PLANE. BETWEEN .250 AND END OF LEAD A MAX. OF .021 IS HELD.

ALL DIMENSIONS ARE IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.

TO-18 LEAD SPACING





Equiv. Circuit

electrical characteristics: (25°) (unless otherwise specified)

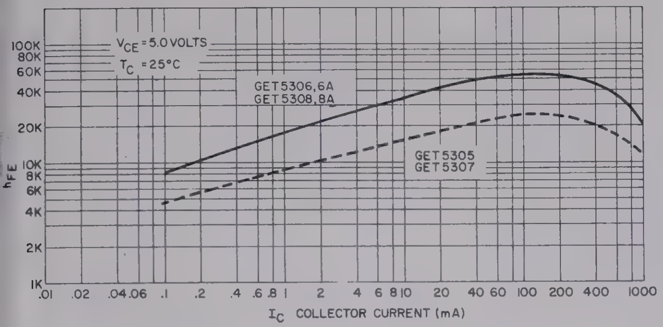
STATIC CHARACTERISTICS		MIN.	MAX.	
Collector to Base Breakdown Voltage (I_C = 0.1 μA, I_C = 0) GET5305, 6, 6A	$V_{(BR)CBO}$	25		Volts
Collector to Emitter Breakdown Voltage (I_C = 10mA, I_B = 0) GET5305, 6, 6A	$V_{(BR)CEO}$	25		Volts
Collector to Base Breakdown Voltage (I_C = 0.1 μA, I_C = 0) GET5307, 8, 8A	$V_{(BR)CBO}$	40		Volts
Collector to Emitter Breakdown Voltage (I_C = 10mA, I_B = 0) GET5307, 8, 8A	$V_{(BR)CEO}$	40		Volts
Emitter to Base Breakdown Voltage (I_E = 0.1 μA, I_E = 0)	$V_{(BR)EBO}$	12		Volts
Forward Current Transfer Ratio				
(V_{CE} = 5V, I_C = 2mA) GET5305, 7	h_{FE}	2000	20000	
(V_{CE} = 5V, I_C = 100mA) GET5305, 7	h_{FE}	6000		
(V_{CE} = 5V, I_C = 2mA) GET5306, 6A, 8, 8A	h_{FE}	7000	70000	
(V_{CE} = 5V, I_C = 100mA) GET5306, 6A, 8, 8A	h_{FE}	20000		
Collector Cutoff Current				
(V_{CB} = 25V, I_E = 0)	I_{CBO}		100	nA
(V_{CB} = 25V, I_E = 0, T_A = 100°C)	I_{CBO}		20	μA
(V_{CB} = 40V, I_E = 0)	I_{CBO}		100	nA
(V_{CB} = 40V, I_E = 0, T_A = 100°C)	I_{CBO}		20	μA
Emitter Cutoff Current (V_{EB} = 12V, I_C = 0)	I_{EBO}		100	nA
Collector Emitter Saturation Voltage (I_C = 200mA, I_B = 0.2mA)	$V_{BE(SAT)}$		1.4	Volts
Base Emitter Saturation Voltage (I_C = 200mA, I_B = 0.2mA)	$V_{CE(SAT)}$		1.6	Volts
Base Emitter Voltage (V_{CE} = 5V, I_C = 200mA)	V_{BE}		1.5	Volts

DYNAMIC CHARACTERISTICS		MIN.	TYP.	MAX.	
Forward Current Transfer Ratio					
(V_{CE} = 5V, I_C = 2mA, f = 1kHz) GET5305, 7	h_{fe}	2000			
(V_{CE} = 5V, I_C = 2mA, f = 1kHz) GET5306, 6A, 8, 8A	h_{fe}	7000			
(V_{CE} = 5V, I_C = 2mA, f = 1kHz)	$\|h_{fe}\|$	15.6			dB
Gain Bandwidth Product (V_{CE} = 5V, I_C = 2mA, f = 10 MHz)	f_T	60			MHz
Input Impedance (V_{CE} = 5V, I_C = 2mA, f = 1 kHz)	h_{ie}		650		kohms
Collector Base Capacitance (V_{CB} = 10V, f = 1 MHz)	C_{cb}		7.6	10	pF
Emitter Capacitance (V_{EB} = 0.5V, f = 1 MHz)	C_{eb}		10.5		pF
GET5306A, 8A only:					
Noise Voltage (I_C = 0.6 mA, V_{CE} = 5V, R_G = 160kΩ f = 10 Hz to 10kHz, B.W. = 15.7 kHz)	e_n		195	230	nV/√Hz

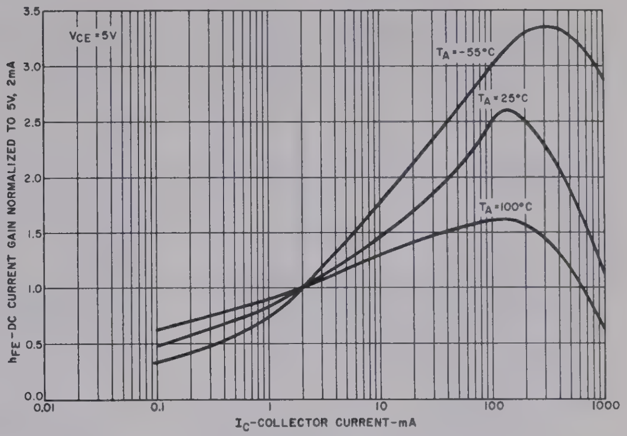
NOTE: As measured on a Quan-Tech Model 2283/2181M test set with 10 Hz filter modified by Quan-Tech to a wideband (f = 10 Hz to 10 kHz, B.W. = 15.7 kHz) filter.

Typical Curves

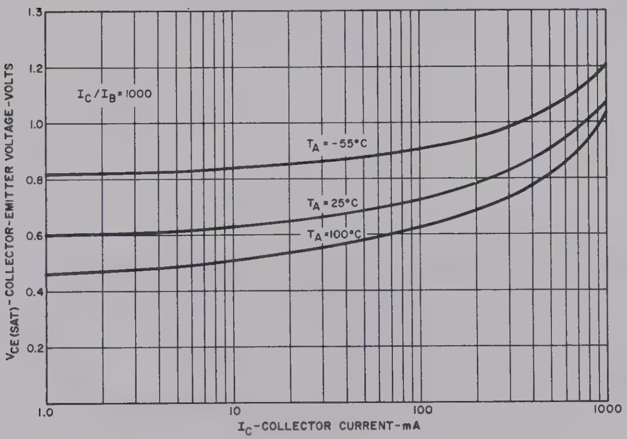
Typical h_{FE} vs. I_C



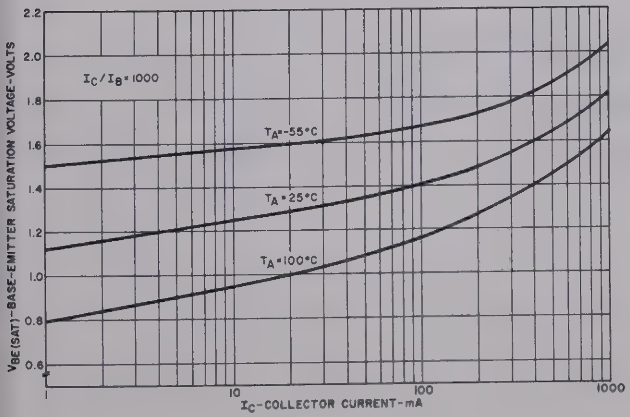
Normalized h_{FE} vs. I_C



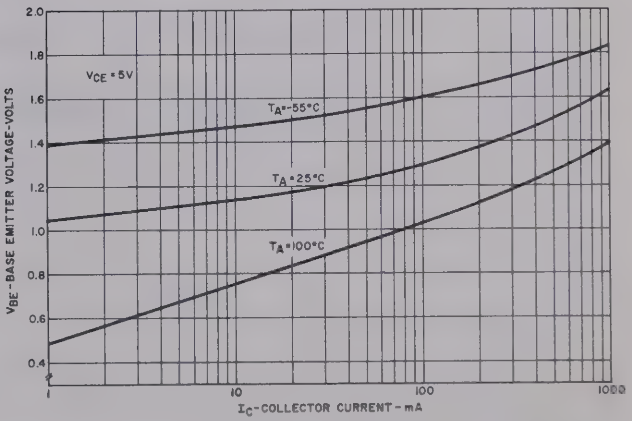
V_{CE} vs. I_C



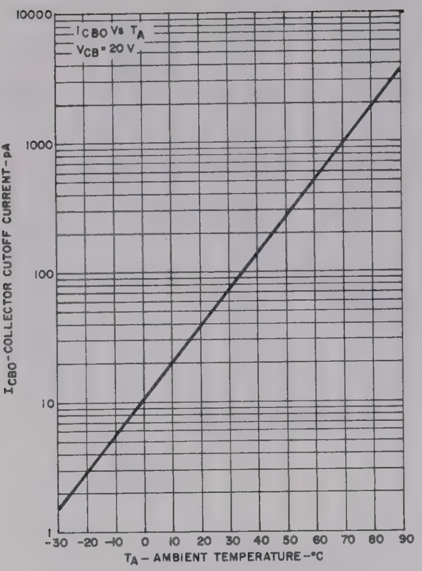
$V_{BE(SAT)}$ vs. I_C



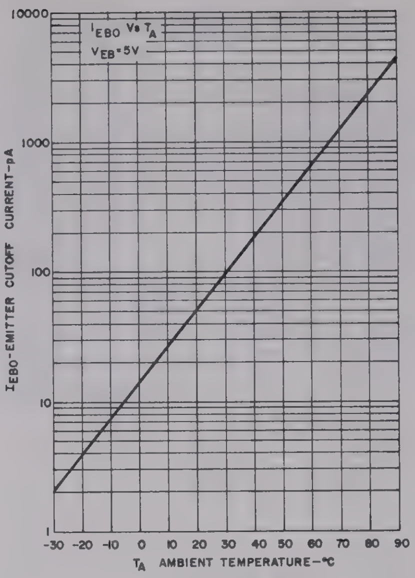
Transconductance Characteristic, V_{BE} vs. I_C



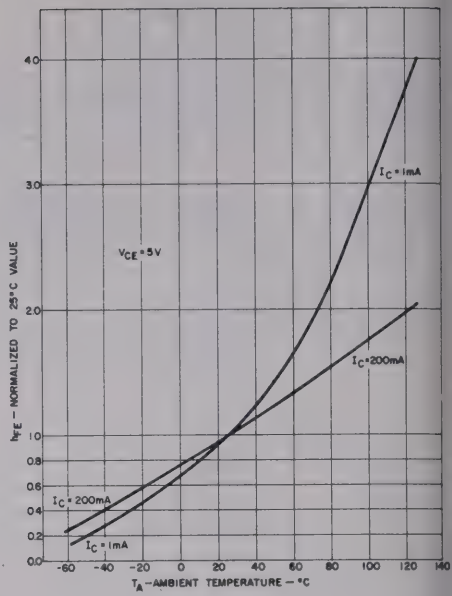
I_{CBO} vs. T_A



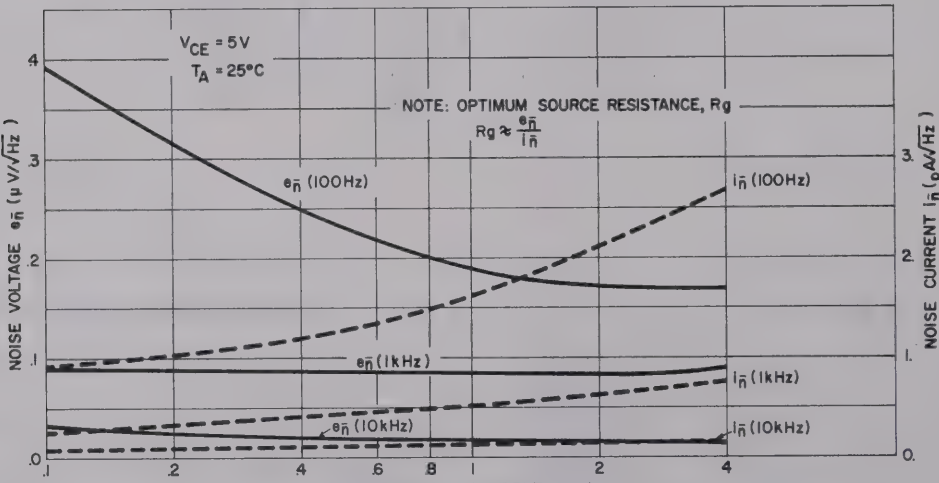
I_{EBO} vs. T_A



h_{FE} vs. T_A

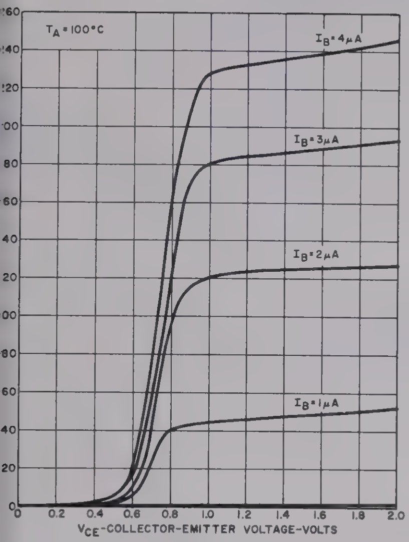


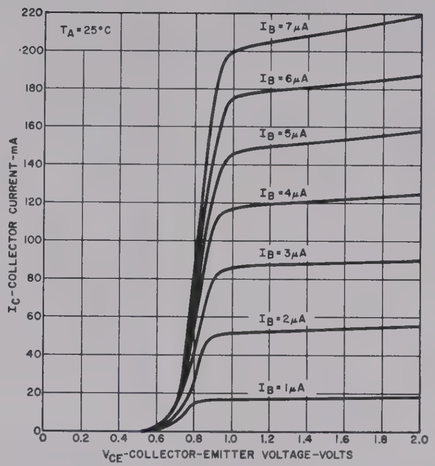
Equivalent Input Noise Voltage and Current vs. Bias Current

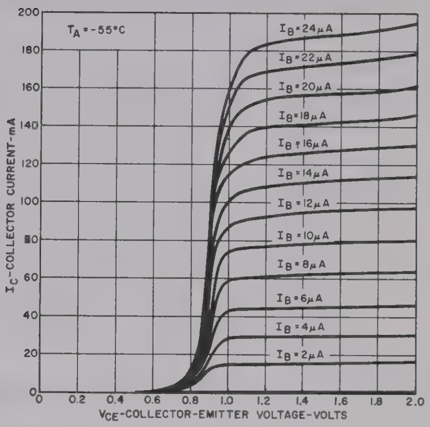


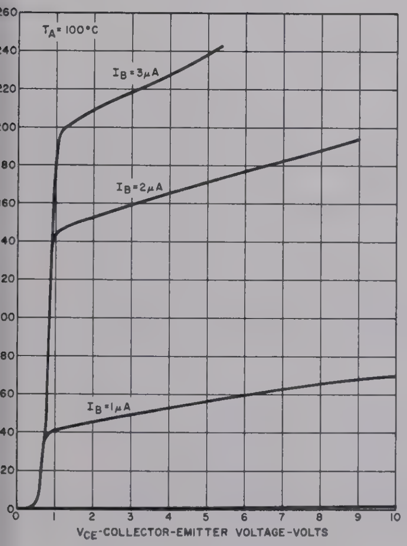
NOTE: Due to the noise characteristics of this device versus frequency, calculation of noise figure (N.F.) from $e_{\bar{n}}$, $I_{\bar{n}}$ values is not accurate [as is the case with field effect transistors (F.E.T.'s)].

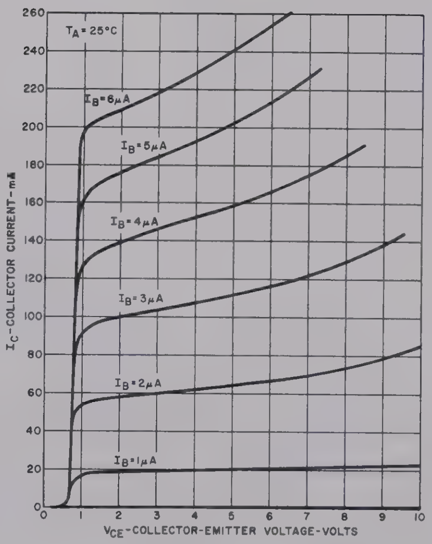
Typical Collector Characteristics

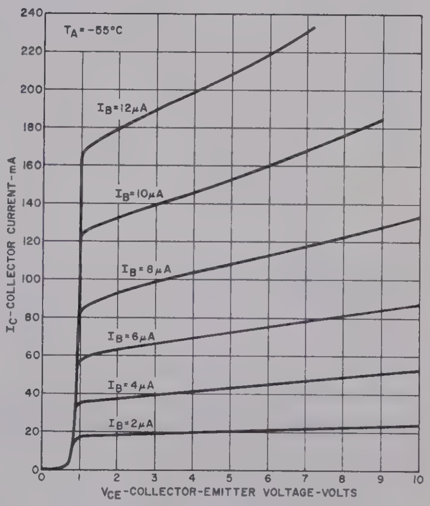






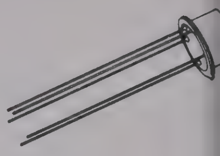






Photon Coupled Isolator H10A1

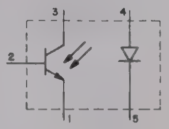
GaAs Solid State Lamp & NPN Silicon Photo-Transistors

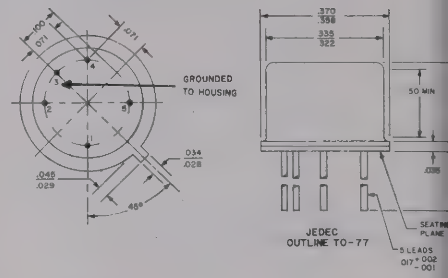


The General Electric H10A1 is a gallium arsenide solid state lamp coupled with a silicon photo transistor in a TO-77 package.

FEATURES:

- Fast switching speeds
- High DC current transfer ratio
- High isolation resistance
- 1000 volts isolation voltage
- I/O compatible with integrated circuits





JEDEC OUTLINE TO-77

absolute maximum ratings: (25°C) (unless otherwise specified)

Storage Temperature -55 to 150°C. Operating Temperature -55 to 100°C. Lead Soldering Time (at 260°C) 10 seconds

SOLID STATE LAMP		
Power Dissipation	*75	milliwatts
Forward Current (Continuous)	50	milliamps
Forward Current (Peak 100 μsec 1% duty cycle)	1	ampere
Reverse Voltage	3	volts

* Derate 1 mW/° C above 25°C ambient

PHOTO-TRANSISTOR		
Power Dissipation	**300	milliwatts
V_{CEO}	40	volts
V_{CBO}	40	volts
V_{ECO}	5	volts
Collector Current (Continuous)	50	milliamps

** Derate 4.0mW/° C above 25° C ambient

individual electrical characteristics (25°C)

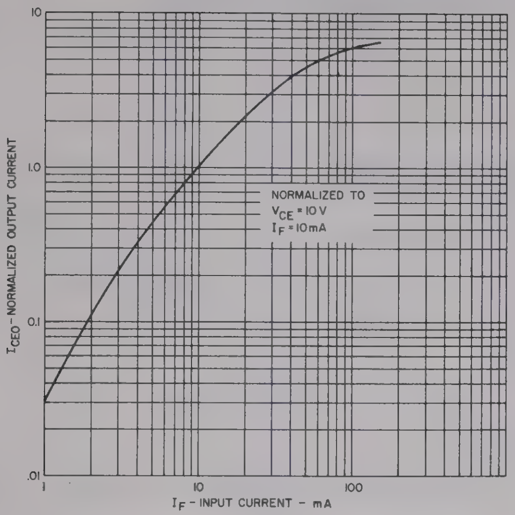
SOLID STATE LAMP	TYP.	MAX.	UNITS
Forward Voltage (I_F = 10 mA)	1.2	1.6	volts
Reverse Current (V_R = 2V)	—	10	microamps
Capacitance (V = O, f = 1MHz)	500	—	picofarads

PHOTO-TRANSISTOR	MIN.	TYP.	MAX.	UNITS
Breakdown Voltage—$V_{(BR)CEO}$ (I_C = 10 mA, I_F = O)	40	—	—	volts
Breakdown Voltage—$V_{(BR)CBO}$ (I_C = 100 μA, I_F = O)	40	—	—	volts
Breakdown Voltage—$V_{(BR)ECO}$ (I_E = 100 μA, I_F = O)	5	—	—	volts
Collector Dark Current —I_{CEO} (V_{CE} = 10V, I_F = O)	—	5	100	nanoam
Capacitance (V_{CE} = 10V, f = 1MHz)	—	3.5	—	picofara

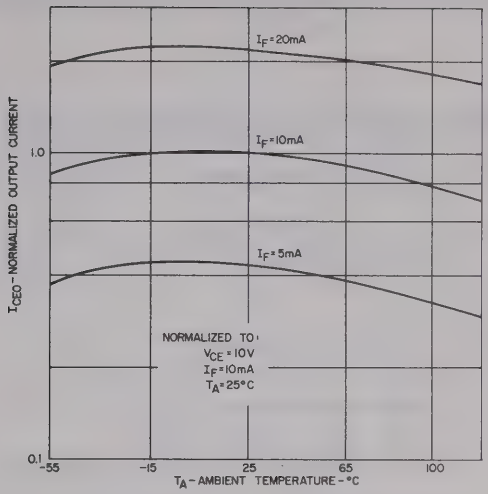
coupled electrical characteristics (25°C)

	MIN.	TYP.	MAX.	UNITS
DC Current Transfer Ratio (I_F = 10mA, V_{CE} = 10V)	20	60	—	%
Saturation Voltage — Collector — Emitter (I_F = 10 mA, I_C = 1 mA)	—	0.2	0.4	volts
Resistance — SSL to Phototransistor (@ 500 volts)	—	100	—	gigaohms
Capacitance — SSL to Phototransistor	—	2	—	picofarads
Surge Voltage (Input to Output Isolation)	1000	—	—	volts
Switching Speeds: (V_{CE} = 10V, I_{CE} = 2mA, R_L = 100Ω)				
On Time	—	3	—	microsecond
Off Time	—	3	—	microsecond
Switching Speeds: (V_{CB} = 10V, I_{CB} = 50μA, R_L = 100Ω)				
On Time	—	300	—	nanoseconds
Off Time	—	300	—	nanoseconds

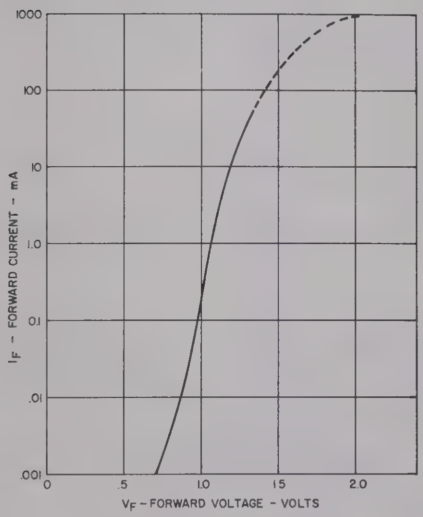
TYPICAL CHARACTERISTICS



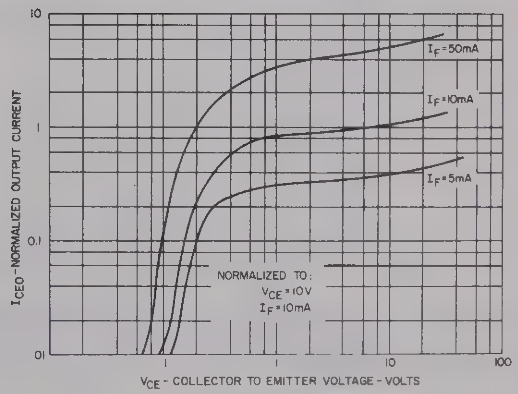
OUTPUT CURRENT VS INPUT CURRENT



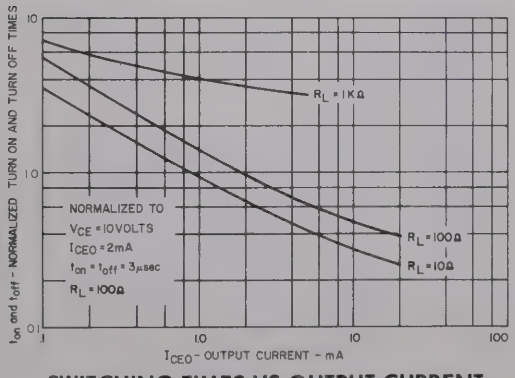
OUTPUT CURRENT VS TEMPERATURE



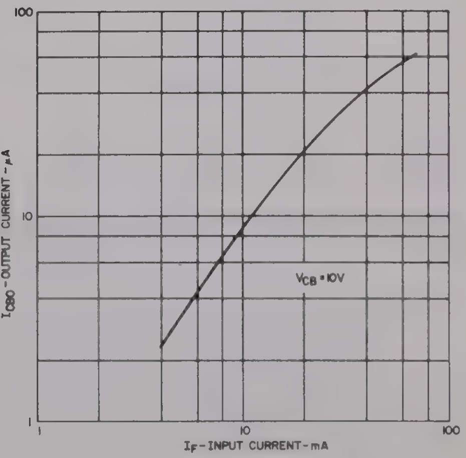
INPUT CHARACTERISTICS



OUTPUT CHARACTERISTICS



SWITCHING TIMES VS OUTPUT CURRENT



OUTPUT CURRENT (I_{CBO}) VS INPUT CURRENT

SOLID STATE

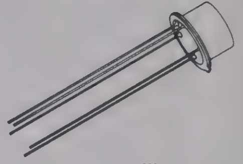
GENERAL ELECTRIC

OPTOELECTRONICS

Photon Coupled Isolator H10B1

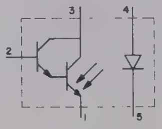
Ga As Solid State Lamp & NPN Silicon Photo-Darlington Amplifier

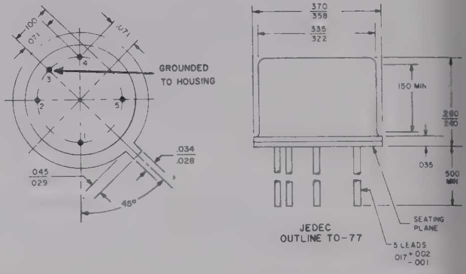
The General Electric H10B1 is a gallium arsenide solid state lamp coupled with a silicon photo-darlington amplifier in a TO-77 package.



FEATURES:

- Fast switching speeds
- High DC current transfer ratio
- High isolation resistance
- 1000 volts isolation voltage
- I/O compatible with integrated circuits





absolute maximum ratings: (25°C) (unless otherwise specified)

Storage Temperature -55 to 150°C. Operating Temperature -55 to 100°C. Lead Soldering Time (at 260°C) 10 seconds.

SOLID STATE LAMP		
Power Dissipation	*75	milliwatts
Forward Current (Continuous)	50	milliamps
Forward Current (Peak 100 μsec 1% duty cycle)	1	ampere
Reverse Voltage	3	volts

* Derate 1 mW/°C above 25°C ambient

PHOTO-DARLINGTON		
Power Dissipation	**300	milliwatts
V_{CEO}	25	volts
V_{CBO}	25	volts
V_{ECO}	8	volts
Collector Current (Continuous)	200	milliamps

** Derate 4.0mW/° C above 25° C ambient

individual electrical characteristics (25°C)

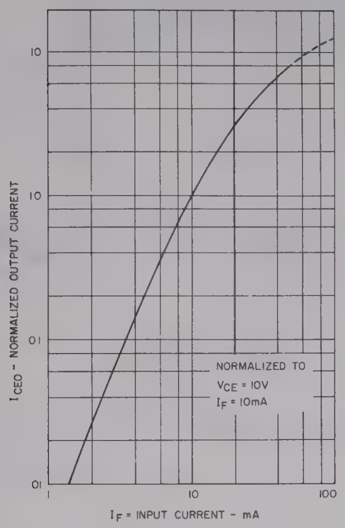
SOLID STATE LAMP	TYP.	MAX.	UNITS
Forward Voltage (I_F = 10 mA)	1.2	1.6	volts
Reverse Current (V_R = 2V)	—	10	microamps
Capacitance V = O, f = 1 MHz)	50	—	picofarads

PHOTO-DARLINGTON	MIN.	TYP.	MAX.	UNITS
Breakdown Voltage—$V_{(BR)CEO}$ (I_C = 10mA, I_F = O)	25	—	—	volts
Breakdown Voltage—$V_{(BR)CBO}$ (I_C = 100μA, I_F = O)	25	—	—	volts
Breakdown Voltage—$V_{(BR)ECO}$ (I_E = 100μA, I_F = O)	8	—	—	volts
Collector Dark Current—I_{CEO} (V_{CE} = 10V, I_F = O)	—	5	100	nanoamps
Capacitance Collector-Emitter - C_{CEO} (V_{CE} = 10V, f = 1MHz)	—	6	—	picofarads

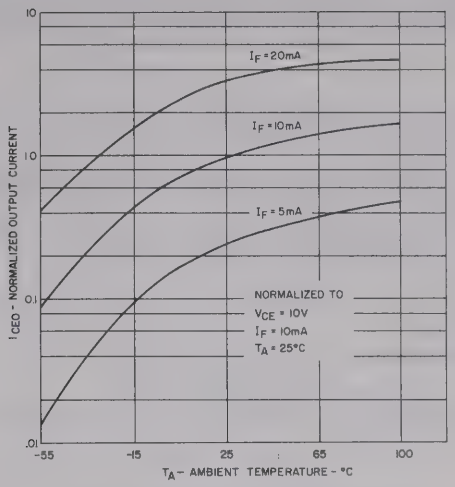
coupled electrical characteristics (25°C)

	MIN.	TYP.	MAX.	UNITS
DC Current Transfer Ratio (I_F = 10mA, V_{CE} = 10V)	200	500	—	%
Saturation Voltage—Collector—Emitter (I_F = 10mA, I_C = 10mA)	—	0.8	1.2	volts
Resistance—SSL to Photo-Darlington (@ 500 volts)	—	100	—	gigaohms
Capacitance—SSL to Photo-Darlington	—	2	—	picofards
Surge Voltage (Input to Output Isolation)	1000	—	—	volts
Switching Speeds: (V_{CE} = 10V, I_C, = 10 mA, R_L = 100 Ω)				
On Time	—	125	—	microseconds
Off Time	—	100	—	microseconds

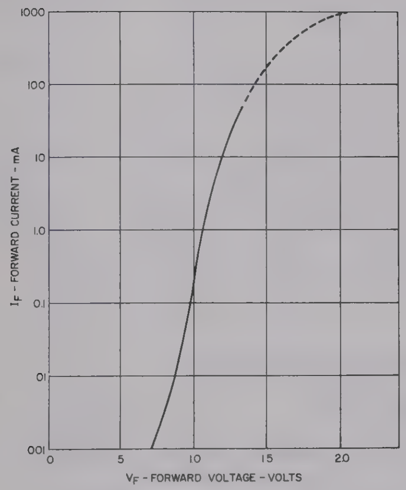
TYPICAL CHARACTERISTICS



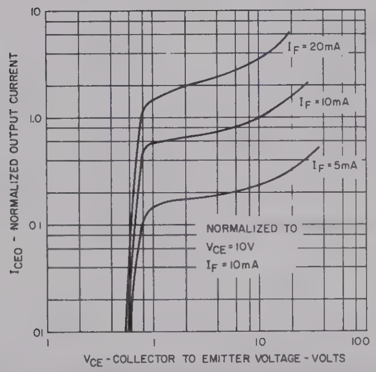
OUTPUT CURRENT VS INPUT CURRENT



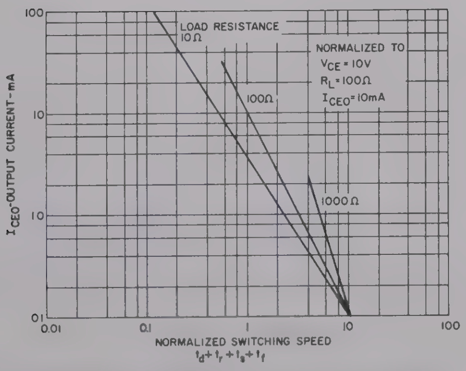
OUTPUT CURRENT VS TEMPERATURE



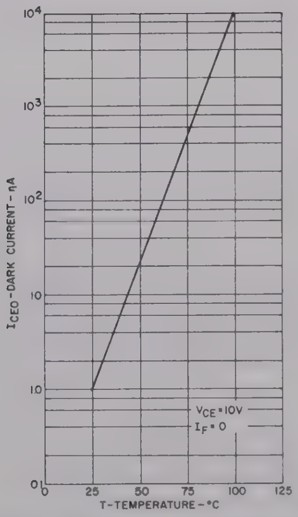
INPUT CHARACTERISTICS



OUTPUT CHARACTERISTICS



SWITCHING SPEED VS OUTPUT CURRENT

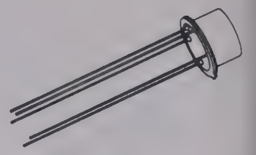


DARK CURRENT VS TEMPERATURE

55.63 9/71

Photon Coupled Isolator HI0CI

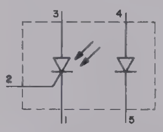
Ga As Solid State Lamp & Light Activated SCR

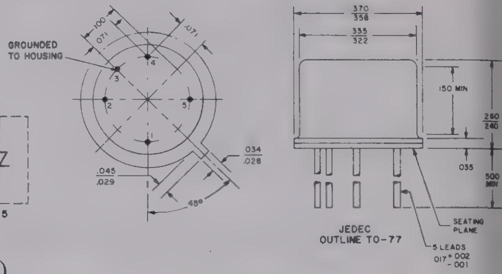


The General Electric H10CI is a gallium arsenide solid state lamp coupled with a light activated silicon controlled rectifier in a TO-77 package.

FEATURES:

- High current carrying capability
- High speed switching
- High isolation resistance
- 1000 volts isolation voltage





absolute maximum ratings: (25°C) (unless otherwise specified)

Storage Temperature -55 to 150°C. Operating Temperature -55 to 100°C. Lead Soldering Time (at 260°C) 10 seconds.

SOLID STATE LAMP		
Power Dissipation	*75	milliwatts
Forward Current (Continuous)	50	milliamps
Forward Current (Peak, 100usec 1% duty cycle)	1	ampere
Reverse Voltage	3	volts

*Derate 1.OmW/°C above 25°C ambient

PHOTO - SCR		
Peak Forward Voltage	200	volts
RMS Forward Current	1	ampere
Forward Current (Peak, 100μsec 1% duty cycle)	25	amperes
Surge Current (One cycle)	10	amperes
Power Dissipation (25°C Ambient)	** 400	milliwatts
Power Dissipation (25°C Case)	***1000	milliwatts

** Derate 5.3 mW/°C above 25°C ambient
*** Derate 13.3 mW/°C above 25°C case

individual electrical characteristics (25°C) (unless otherwise specified)

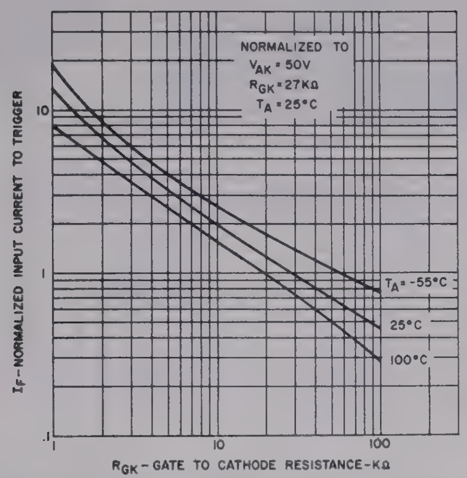
SOLID STATE LAMP	TYP.	MAX.	UNITS
Forward Voltage (I_F = 20mA)	1.2	1.6	volts
Reverse Current (V_R = 2V)	—	10	microamps
Capacitance (V = O,f = 1MHz)	500	—	picofarads

PHOTO - SCR	MIN.	TYP.	MAX.	UNITS
Peak Off-State Voltage-V_{DM} (R_{GK} = 27KΩ,100°C)	200	—	—	volts
Peak Reverse Voltage-V_{RM} (R_{GK} = 27KΩ, 100°C)	200	—	—	volts
On-State Voltage-V_{TM} (I_{TM}= 1 amp)	—	1.2	1.5	volts
Off-State Current-I_{DM} (V_{TM} = 50 volts)	—	—	10	microamps
Reverse Current-I_{RM} (V_{RM}= 50 volts)	—	—	10	microamps
Thermal Impedance-Θ_{J-C} (Junction to Case)	—	—	60	°C/watt

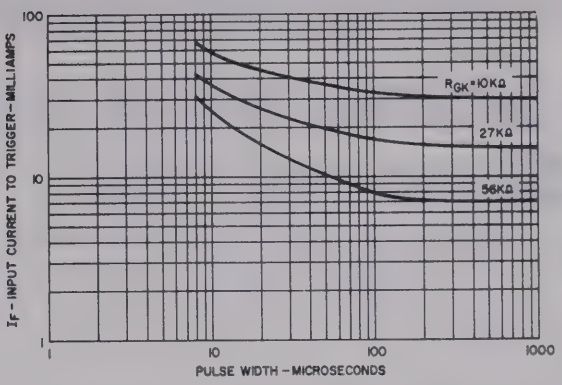
coupled electrical characteristics (25°C)

	MIN.	TYP.	MAX.	UNITS
Input Current To Trigger (V_{AK} = 50V, R_{GK}= 27KΩ)	—	15	50	milliamps
Turn On Time (V_{AK} = 50V, R_{GK}=27KΩ)	—	1.0	—	microseconds
Surge Voltage (Input to Output Isolation)	1000	—	—	volts
Resistance — SSL to Photo-SCR	—	100	—	gigaohms
Capacitance — SSL to Photo-SCR	—	2	—	picofarads
Thermal Impedance (Case to Ambient)	—	—	125	°C/watt

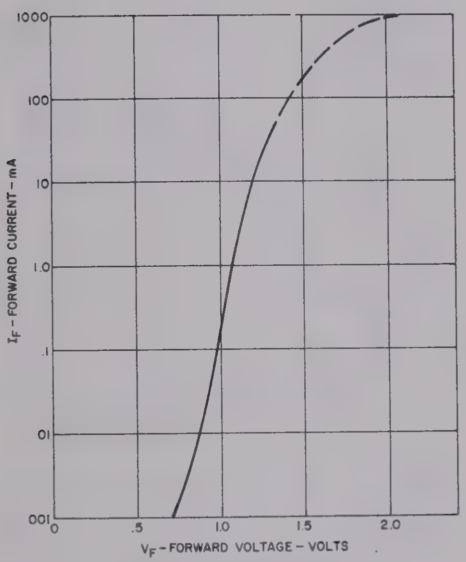
TYPICAL CHARACTERISTICS



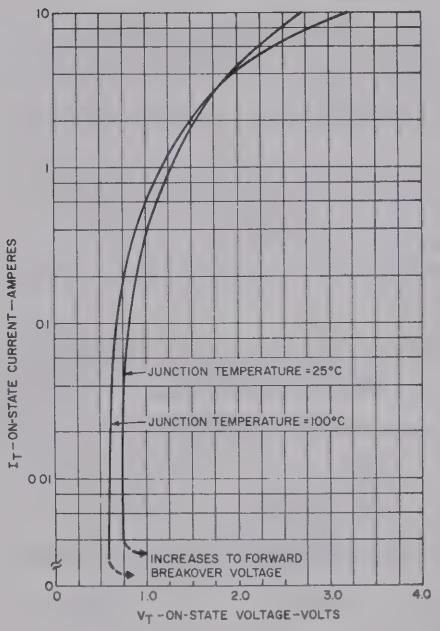
GATE RESISTANCE VS INPUT CURRENT TO TRIGGER



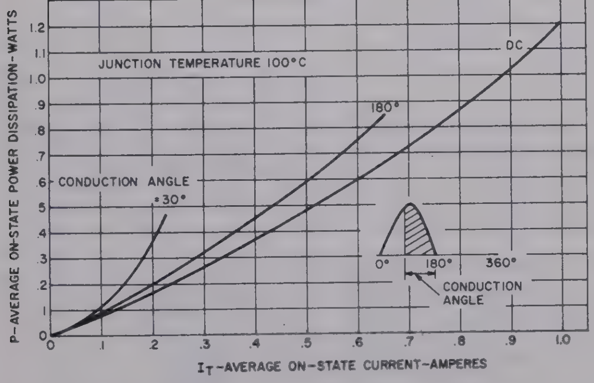
PULSE WIDTH VS INPUT CURRENT TO TRIGGER



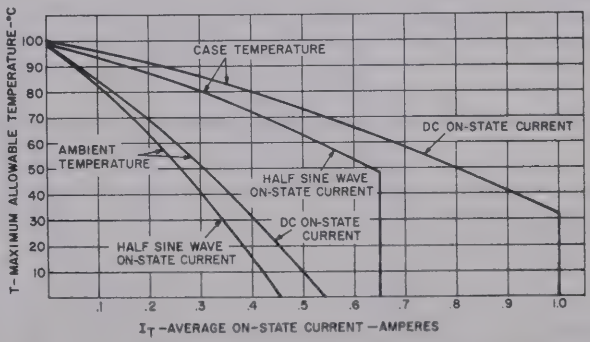
INPUT CHARACTERISTICS



ON-STATE CHARACTERISTICS



POWER DISSIPATION VS ON-STATE CURRENT

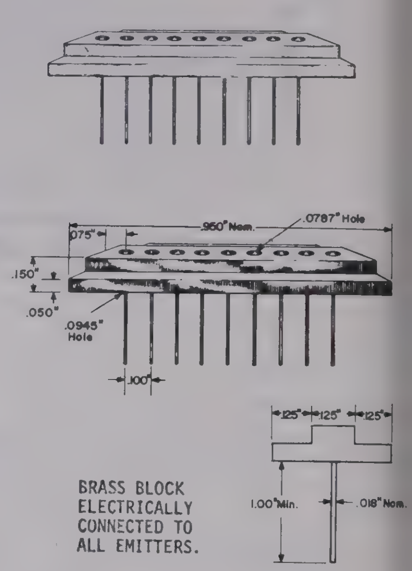


MAXIMUM ALLOWABLE TEMPERATURE VS ON-STATE CURRENT

Light Detector ARRAY OF PLANAR SILICON PHOTOTRANSISTORS

NPN J300/J300A

The General Electric J300 Light Detector Array consists of nine (9) L15E planar silicon phototransistors on 0.100" centers. These devices are connected with the emitter common and separate collectors. This array is ideally suited for tape reading applications.


.075"
.950" Nom.
.0787" Hole
.150"
.050"
.0945" Hole
.100"
.125"
.125"
.125"
1.00" Min.
.018" Nom.
BRASS BLOCK ELECTRICALLY CONNECTED TO ALL EMITTERS.

FEATURES:

- **High Sensitivity**
- **High Speed**
- **Hermetic L15E Devices**

absolute maximum ratings: (per element)

Collector to Emitter Voltage	V_{CEO}	40	Volts
Emitter to Collector Voltage	V_{ECO}	5	Volts
Light Current	I_L	100	mA
Power Dissipation (Free Air 25°C) Derate 2mW/°C above 25°C Ambient	P_T	200	mW
Power Dissipation (Case Temp. = 25°C) Derate 4 mW/°C above 25°C Case	P_T	400	mW
Junction Temperature	T_J	−65 to 125	°C
Storage Temperature	T_{STG}	−65 to 150	°C

electrical characteristics: (25°C)

		Min.	Typ.	Max.	Units
Light Current (V_{CE} = 5V, H* = 10mW/cm²)	I_L	1.5	4		mA
Matching Factor*** J300		50%			
J300A		75%			
Dark Current (V_{CE} = 30V, H ≈ 0)	I_D			100	ηA
Collector-Emitter Breakdown Voltage, (I_C = 10mA)	$V_{(BR)CEO}$	40			Volts
Saturation Voltage (I_L = 500μA, H* = 20mW/cm²)	$V_{CE(SAT)}$			0.4	Volts
Switching Speeds (V_{CC} = 30V, I_L = 10mA, R_L = 100Ω)**					
On Time	t_{on}		3		μsec
Off Time	t_{off}		3		μsec

* H = Radiation Flux Density. Radiation source is an unfiltered tungsten filament bulb at 2870°K color temp.

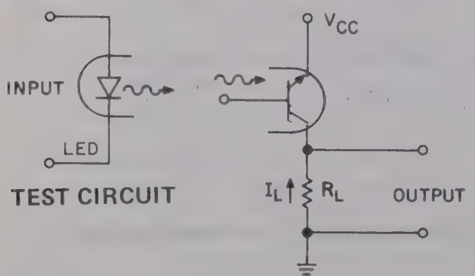
** Radiant source is a gallium arsenide light emitting diode.

***Matching Factor is the ratio of the light currents of any two elements in a given array.

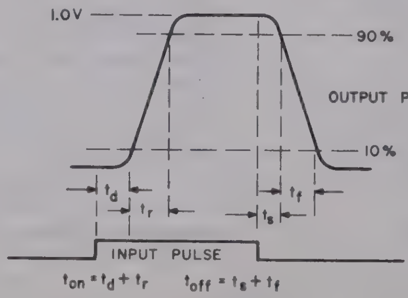
I_L (min) / I_L (max) at H = 10mW / cm²

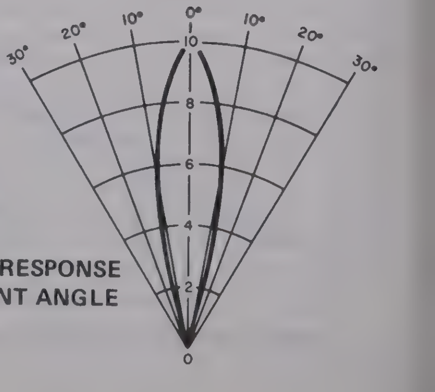
NOTE:

A GaAs source of 3.0 mW/cm² is approximately equivalent to 10 mW/cm² from the tungsten source at 2870°K.


INPUT
LED
V_{CC}
I_L
R_L
OUTPUT

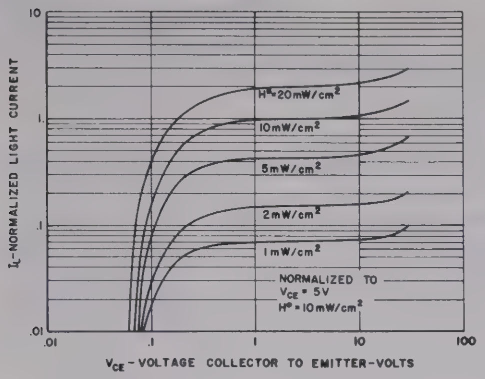
TEST CIRCUIT


1.0V
90%
OUTPUT PULSE
10%
t_d
t_r
t_s
t_f
INPUT PULSE
$t_{on} = t_d + t_r$
$t_{off} = t_s + t_f$

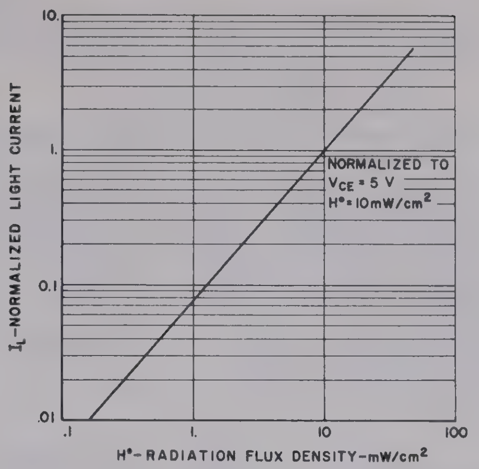


RELATIVE RESPONSE VS. INCIDENT ANGLE

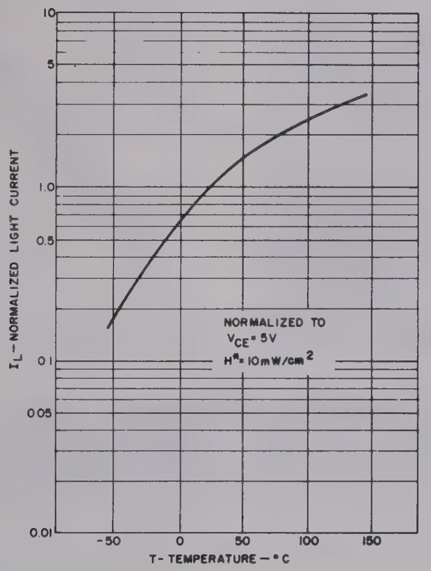
TYPICAL ELECTRICAL CHARACTERISTICS (PER ELEMENT)



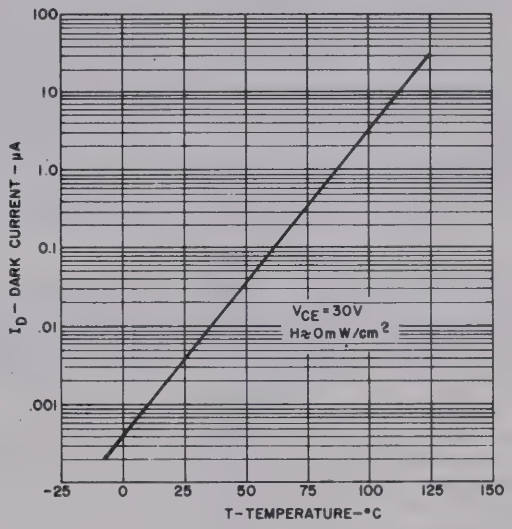
1. NORMALIZED LIGHT CURRENT VS. COLLECTOR TO EMITTER VOLTAGE



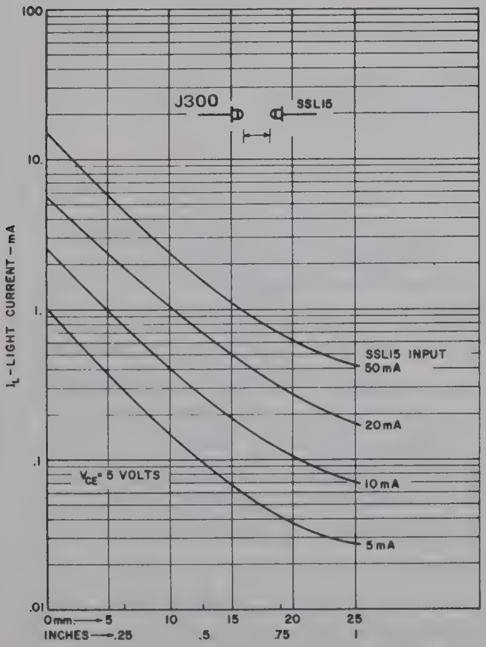
2. NORMALIZED LIGHT CURRENT VS. RADIATION



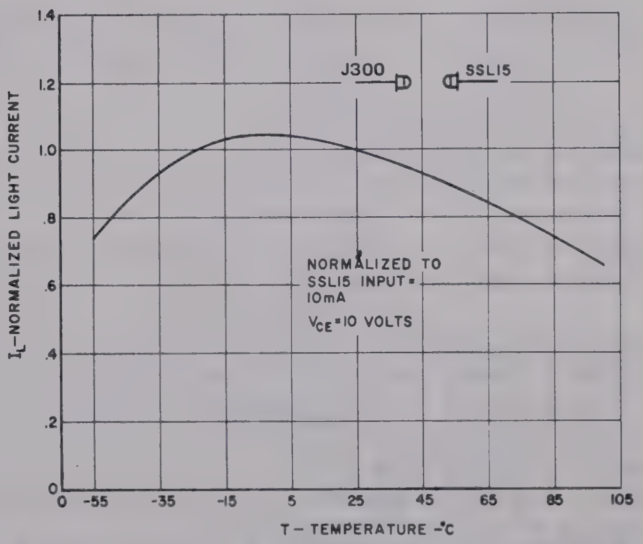
3. NORMALIZED LIGHT CURRENT VS. TEMPERATURE



4. DARK CURRENT VS. TEMPERATURE



5. LIGHT CURRENT VS. DISTANCE



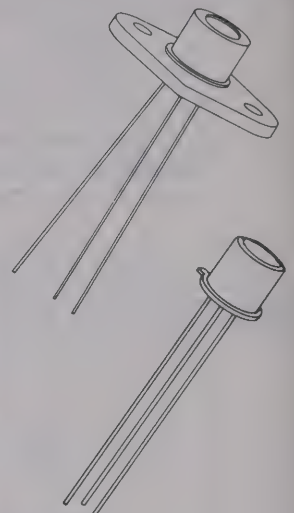
6. NORMALIZED LIGHT CURRENT VS. TEMPERATURE

SCR

L8,9 L811,L911 (Diamond Base*)

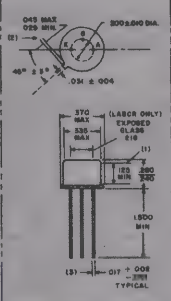
The L8, L9 Light Activated SCR's are basically Silicon Controlled Rectifiers with incident light taking the place of (or adding to) an electrical gate current. Thus it is a photo-operated device that is truly a switch. It features optional gate triggering inputs; i.e., from either an isolated light source or direct electrical supply. The former trigger technique offers a range of light trigger intensity with varying gate bias. The L8, L9 is expected to be particularly useful in such applications as:

- **Optical logic control**
- **Counting**
- **Sorting**
- **Precision Indexing**
- **Explosion proff isolated switches**
- **Static Relays**
- **Meter Relays**

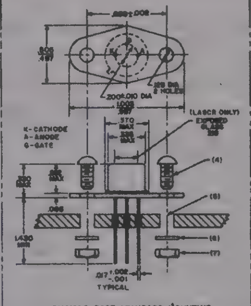


OUTLINE DRAWING

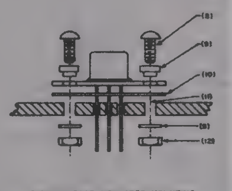
(1) This zone is controlled for automatic handling. The variation in actual diameter within this zone shall not exceed .010.
(2) Measured from max. diameter of the actual device.
(3) The specified lead diameter applies in the zone between .050 and .250 from the base seat. Between .250 and 1.5 maximum of .021 diameter is held. Outside of these the lead diameter is not controlled. Leads may be inserted, without damage in .031 holes while device enters .371 hole concentric with lead hole circle.
(4) #4-40 screw, st'n steel ¹/₁₆" long
(5) .120 hole (#31 drill)
(6) Int tooth lockwasher, st'n steel
(7) #4-40 nut, st'n steel
(8) #2-56 screw, st'n steel ⅜" long
(9) Shoulder washer, teflon
(10) Mica insulator, .003 thick
(11) .0935 hole (#42 drill)
(12) #2-56 nut, st'n steel
All dimensions in inches



CONFORMS TO JEDEC TO-5 OUTLINE



DIAMOND BASE STANDARD MOUNTING



DIAMOND BASE INSULATED MOUNTING

Types†	Peak Forward Blocking Voltage, V_{FXM}. $T_J = -65°C$ to $+100°C$ $R_{GK} = 56{,}000$ Ohms Maximum	Working and Repetitive Peak Reverse Voltage, $V_{ROM\ (wkg)}$ and $V_{ROM}{}^{(rep)}$. $T_J = -65°C$ to $+100°C$	Non-Repetitive Peak Reverse Voltage, $V_{ROM\ (non\text{-}rep)}$ (< 5 Millisec.) $T_J = -65°C$ to $+100°C$
L8U, L9U	25 Volts	25 Volts	40 Volts
L8F, L9F	50 Volts	50 Volts	75 Volts
L8A, L9A	100 Volts	100 Volts	150 Volts
L8G, L9G	150 Volts	150 Volts	225 Volts
L8B, L9B	200 Volts	200 Volts	300 Volts

†When ordering the Diamond Base versions, be sure to include the proper voltage letter symbol. For example: The 25 volt, Diamond Base version of the L8U is type number L811U.

Peak Forward Voltage, PFV	300	Volts
RMS Forward Current, On-state	1.6	Amperes
Average Forward Current, On-state	Depends on conduction angle (see charts 11, 12, 15, & 16)	
Peak One Cycle Surge Forward Current (Non-repetitive), I_{FM} (surge)	15	Amperes
I^2t (for fusing)	0.5	Ampere² seconds (for times < 1.5 milliseconds)
Peak Forward Gate Power Dissipation, P_{GM}	0.1	Watt
Average Forward Gate Power Dissipation, P_{G} (AV)	0.01	Watt
Peak Gate Voltage, Forward & Reverse, V_{GFM} & V_{GRM}	6	Volts
Storage Temperature, T_{stg}	−65°C to +150°C	
Operating Temperature	−65°C to +100°C	
Peak Non-recurrent Surge Forward Current During Turn-on Time Interval (Current Rise Time < 5 Microseconds)	40	Amperes

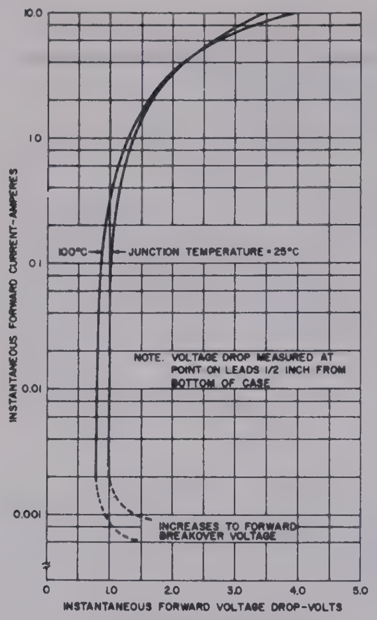
*The L811 and L911 series are identical to the L8 and L9 respectively except that they are soldered to a diamond base heat sink. See charts 14, 15, & 16 for Transient Thermal Resistance and Current Curves, and Page 4 for Outline Drawings.

L8,9 L811,L911(Diamond Base*)

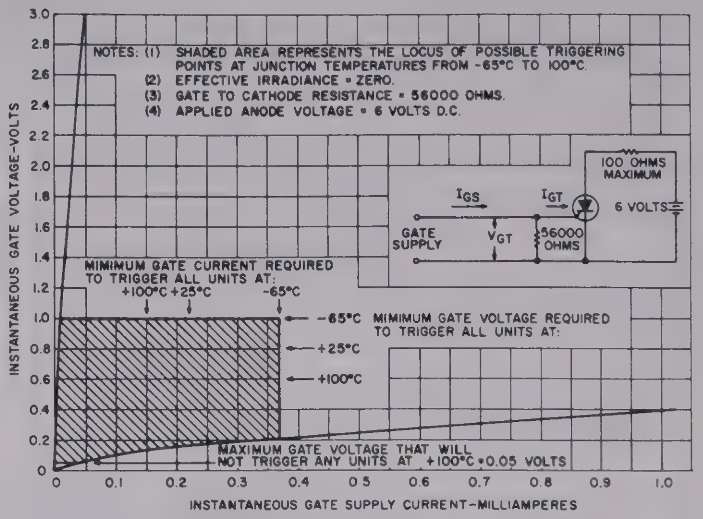
CHARACTERISTICS

Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Forward Breakover Voltage	$V_{(BR)FX}$				Volts	T_J = −65°C to +100°C R_{GK} = 56,000 Ohms Sinusoidal Waveform, 60 CPS. H_e <0.02 MW/CM^2 for L9 types H_e <0.08 MW/CM^2 for L8 types
L8U, L9U		25	—	—		
L8F, L9F		50	—	—		
L8A, L9A		100	—	—		
L8G, L9G		150	—	—		
L8B, L9B		200	—	—		
Forward Blocking Current	I_{FX}	—	2.0	10	μamperes	V_{FX} = Rated V_{FXM}, R_{GK} = 56,000 Ohms T_J = +25°C, H_e <0.02 or 0.08 MW/CM^2
		—	40	100	μamperes	V_{FX} = Rated V_{FXM}, R_{GK} = 56,000 Ohms T_J = +100°C, H_e <0.02 or 0.08 MW/CM^2
Reverse Blocking Current	I_{RX}	—	2.0	10	μamperes	V_{RX} = Rated $V_{ROM(rep)}$, R_{GK} = 56,000 Ohms T_J = +25°C, H_e <0.02 or 0.08 MW/CM^2
		—	40	100	μamperes	V_{RX} = Rated $V_{ROM(rep)}$, R_{GK} = 56,000 Ohms T_J = +100°C, H_e <0.02 or 0.08 MW/CM^2
Gate Supply Trigger Current	I_{GS}	—	20	220	μamperes	V_{FX} = 6 Vdc, R_{GK} = 56,000 Ohms, R_L = 100 Ohms, T_J = +25°C, H_e = 0
		—	10	150	μamperes	V_{FX} = 6 Vdc, R_{GK} = 56,000 Ohms, R_L = 100 Ohms, T_J = +100°C, H_e = 0
		—	30	370	μamperes	V_{FX} = 6 Vdc, R_{GK} = 56,000 Ohms, R_L = 100 Ohms, T_J = −65°C, H_e = 0
Gate Trigger Voltage	V_{GT}	0.3	0.5	0.8	Vdc	V_{FX} = 6 Vdc, R_{GK} = 56,000 Ohms, R_L = 100 Ohms, T_J = +25°C, H_e = 0
		—	0.2	0.6	Vdc	V_{FX} = 6 Vdc, R_{GK} = 56,000 Ohms, R_L = 100 Ohms, T_J = +100°C, H_e = 0
		—	0.7	1.0	Vdc	V_{FX} = 6 Vdc, R_{GK} = 56,000 Ohms, R_L = 100 Ohms, T_J = −65°C, H_e = 0
		0.05	0.15	—	Vdc	V_{FX} = Rated V_{FXM}, R_{GK} = 56,000 Ohms, R_L = 100 Ohms, T_J = +100°C, H_e = 0
Peak On-Voltage	V_{FM}	—	1.2	1.4	Volts	T_J = +25°C, I_{FM} = 1 ampere Single half sine wave pulse, 2.0 milliseconds wide.
Holding Current	I_{HX}	20	75	560	μamperes	T_J = +25°C, V_{FX} = 5 Vdc, H_e = 0 R_{GK} = 56,000 Ohms
		10	40	450	μamperes	T_J = +100°C, V_{FX} = 5 Vdc, H_e = 0 R_{GK} = 56,000 Ohms
		30	180	750	μamperes	T_J = −65°C, V_{FX} = 5 Vdc, H_e = 0 R_{GK} = 56,000 Ohms
Effective Irradiance to Trigger	H_{ET}				Milliwatts/CM^2	V_{FX} = 6 Vdc, R_L = 100 Ohms R_{GK} = 56,000 Ohms. Light Source Perpendicular to Plane of Header.
L8 L9		0.68 0.68	5.0 2.0	10.0 4.2		T_J = +25°C
L8 L9		0.15 0.15	2.0 0.7	6.0 2.5		T_J = +100°C
L8 L9		0.9 0.9	15.0 4.0	50.0 20.0		T_J = −65°C
L8 L9		0.02 0.02	— —	— —		T_J = +100°C, R_{GK} = 56,000 Ohms, V_{FX} = Rated V_{FXM}, R_L = 500 Ohms, Light Source Perpendicular to Plane of Header.
Rate of Rise of Applied Forward Voltage	dv/dt				Volts/μsec	T_J = +100°C, R_{GK} = 56,000 Ohms
L8U, L9U		0.01	0.02	—		V_{FXM} = 25 Volts
L8F, L9F		0.02	0.04	—		V_{FXM} = 50 Volts
L8A, L9A		0.05	0.07	—		V_{FXM} = 100 Volts
L8G, L9G		0.07	0.10	—		V_{FXM} = 150 Volts
L8B, L9B		0.09	0.12	—		V_{FXM} = 200 Volts
Delay Time	t_d	—	1 to 100	—	μsec	See Application Note 200.34
Rise Time	t_r	—	0.6	—	μsec	T_J = +25°C, I_F = 1.0 Ampere, V_{FX} = Rated V_{FXM}
Circuit-Commutated Turn-off Time	t_{off}	—	40	—	μsec	T_J = +100°C, I_{FM} = 1.0 Ampere, I_R (recovery) = 1.0 Ampere, Reapplied V_{FXM}=Rated V_{FXM}, Rate of Rise of Reapplied. V_{FXM} = 20 Volts Per μsec, R_{GK} = 100 Ohms, H_e = 0

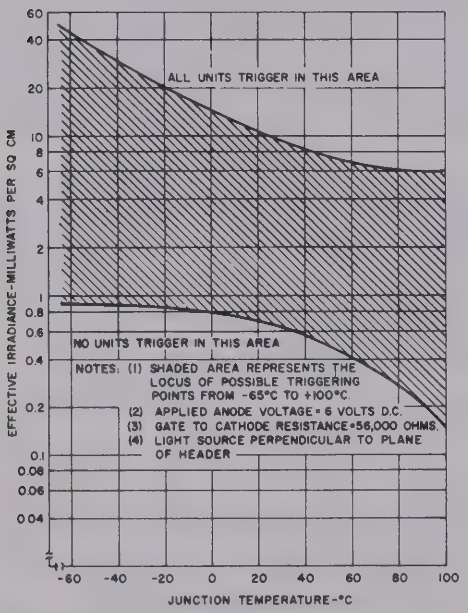
L8,9 L811, L911(Diamond Base*)



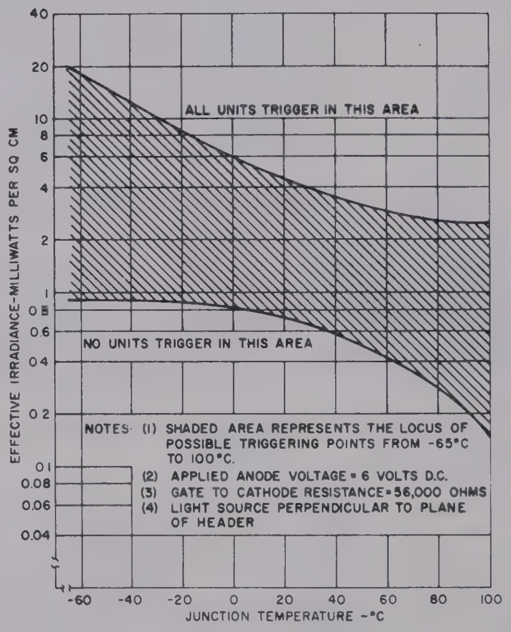
1. MAXIMUM FORWARD CHARACTERISTICS, ON-STATE



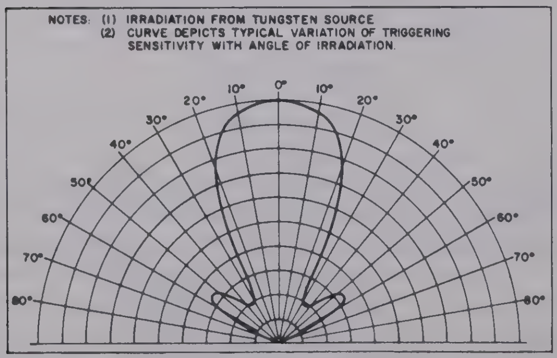
2. ELECTRICAL GATE TRIGGERING CHARACTERISTICS



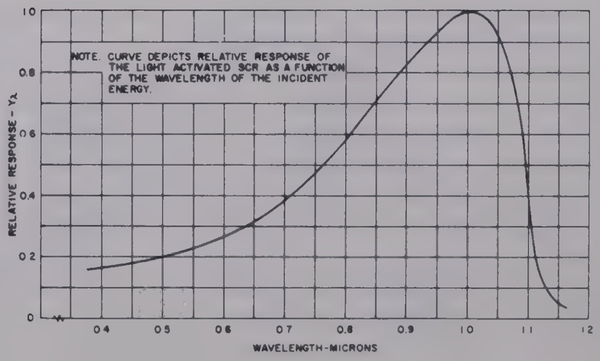
3. L8 LIGHT TRIGGERING CHARACTERISTICS



4. L9 LIGHT TRIGGERING CHARACTERISTICS

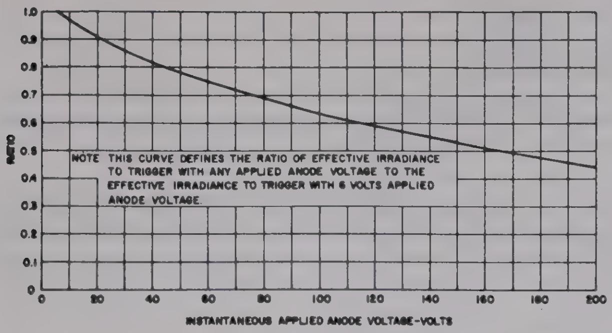


5. TYPICAL ANGULAR RESPONSE

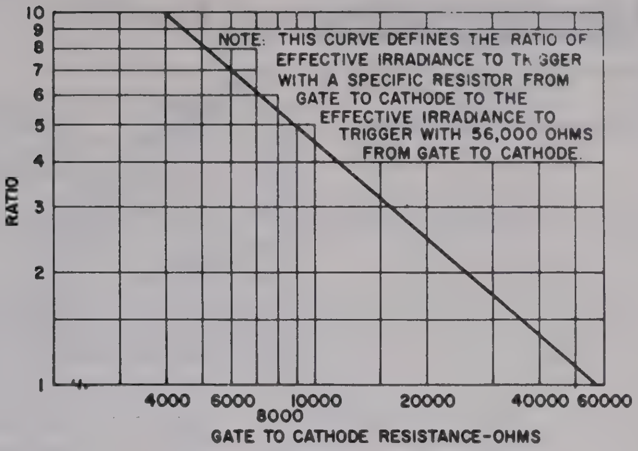


6. TYPICAL SPECTRAL RESPONSE

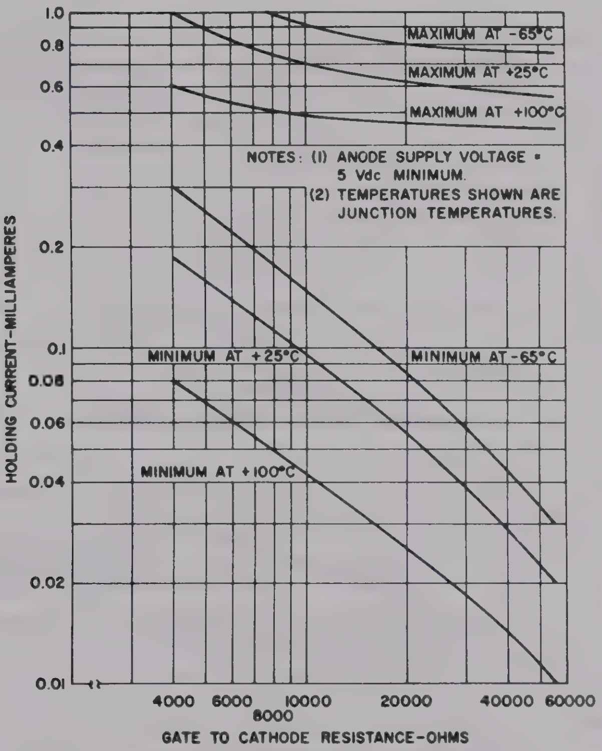
L8,9 L811,L911(Diamond Base*)



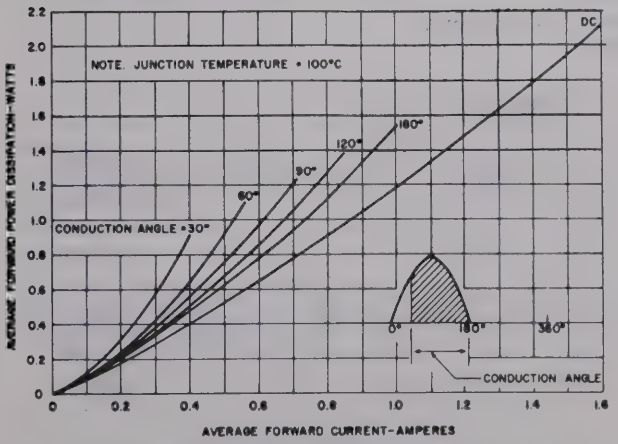
7. TYPICAL VARIATION OF LIGHT SENSITIVITY WITH ANODE VOLTAGE



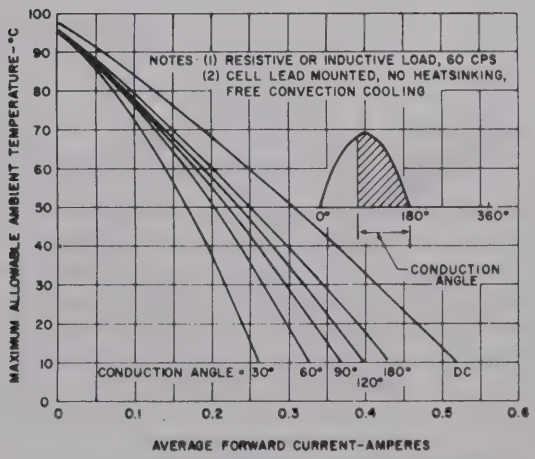
8. TYPICAL VARIATION OF LIGHT SENSITIVITY WITH GATE TO CATHODE RESISTANCE



9. VARIATION OF HOLDING CURRENT WITH GATE TO CATHODE RESISTANCE

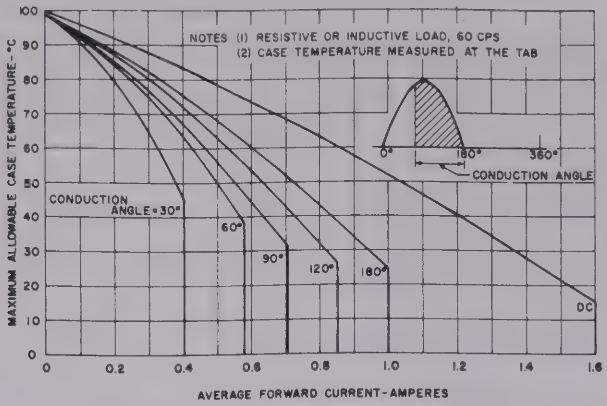


10. FORWARD POWER DISSIPATION FOR HALF WAVE RECTIFIED SINE WAVE

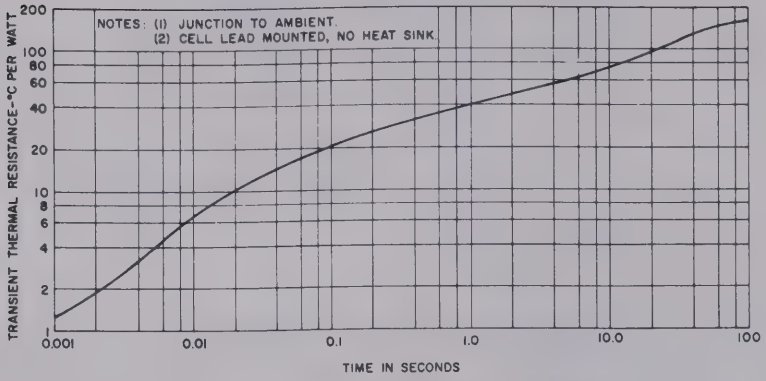


11. MAXIMUM AMBIENT TEMPERATURE FOR HALF WAVE RECTIFIED SINE WAVE

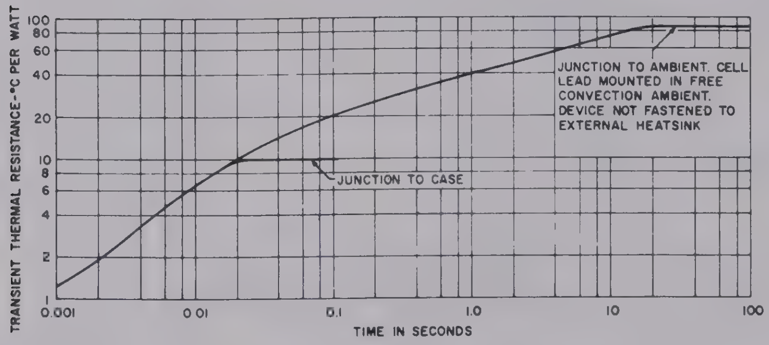
L8,9 L811,L911(Diamond Base*)



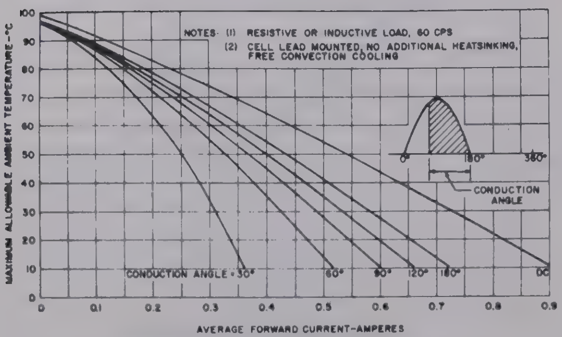
12. MAXIMUM CASE TEMPERATURE FOR HALF WAVE RECTIFIED SINE WAVE



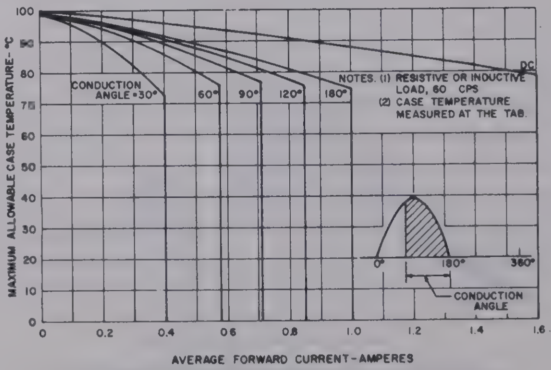
13. MAXIMUM TRANSIENT THERMAL RESISTANCE



14. MAXIMUM TRANSIENT THERMAL RESISTANCE
(Diamond Base)



15. MAXIMUM AMBIENT TEMPERATURE FOR HALF WAVE RECTIFIED SINE WAVE (Diamond Base)



16. MAXIMUM CASE TEMPERATURE FOR HALF WAVE RECTIFIED SINE WAVE (Diamond Base)

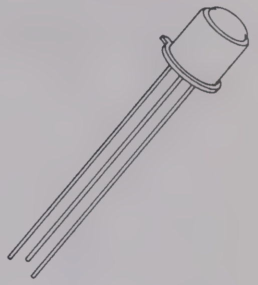
Light Detector

NPN

L14A502

PLANAR SILICON
PHOTOTRANSISTOR

The General Electric L14A502 Light Detector is a NPN Planar Silicon Phototransistor. For most applications two leads are used (collector and emitter leads), however, a third lead is provided (base lead) which controls sensitivity and the gain of the device. The L14A502 is packaged in a hermetically sealed can. A focusing lens is at the top of the can.

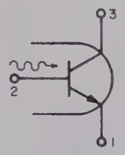


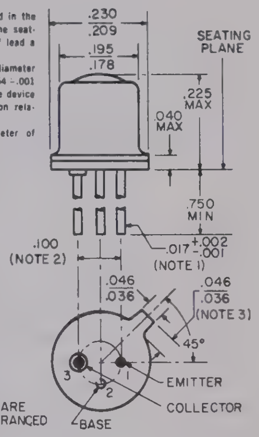
absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages — Dark Characteristics			
Collector to Emitter Voltage	V_{CEO}	45	volts
Collector to Base Voltage	V_{CBO}	45	volts
Emitter to Collector Voltage	V_{ECO}	5	volts
Emitter to Base Voltage	V_{EBO}	5	volts
Currents			
Light Current	I_L	50	mA
Dissipations			
Power Dissipation ($T_A = 25°C$)*	P_T	300	mW
Power Dissipation ($T_C = 25°C$)**	P_T	600	mW
Temperatures			
Juncture Temperatures	T_J	200	°C
Storage Temperature	T_{STG}	−65 to 200	°C

*Derate1.71mW/°C above 25°C ambient
**Derate 3.43mW/°C above 25°C case

NOTE 1: Lead diameter is controlled in the zone between .050 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.
NOTE 2: Leads having maximum diameter (.019) measured in gaging plane .054 +.001 −.000 below the seating plane of the device shall be within .007 of true position relative to a maximum width tab.
NOTE 3: Measured from max. diameter of the actual device.





ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

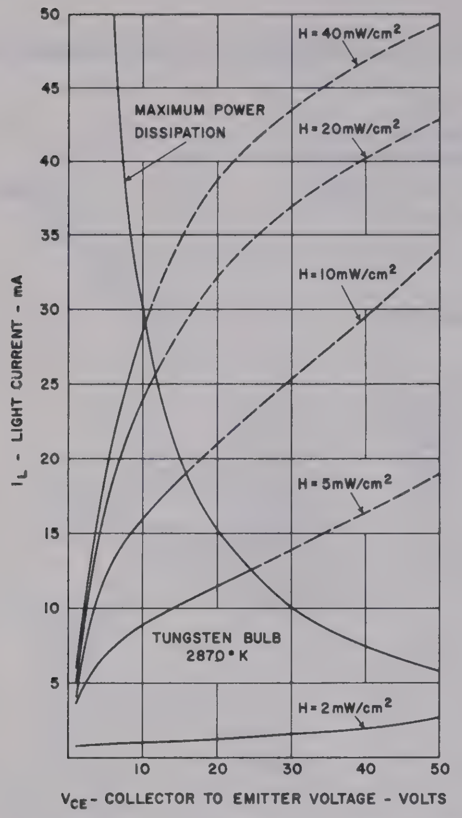
electrical characteristics: (25°C) (unless otherwise specified)

STATIC CHARACTERISTICS		Min.	Typ.	Max.	Units
Light Current ($V_{CE} = 5V$, H† $= 10mW/cm^2$)	I_L	3	7		mA
Dark Current ($V_{CE} = 30V$, $I_B = 0$)	I_D			10	nA
Emitter-Base Breakdown Voltage ($I_C = 100\ \mu A$)	BV_{EBO}	5			V
Collector-Base Breakdown Voltage ($I_C = 100\ \mu A$)	BV_{CBO}	45			V
Collector-Emitter Breakdown Voltage ($I_C = 10$ mA)	BV_{CEO}	45			V
SWITCHING CHARACTERISTICS (see Switching Circuit)					
Switching Speeds ($V_{CE} = 30V$, $I_L = 800\ \mu A$, $R_L = 1k\Omega$)††					
Delay time	t_d		2.0		μsec
Rise time	t_r		5.0		μsec
Storage time	t_s		0.5		μsec
Fall time	t_f		5.0		μsec
Junction capacity ($V_{CE} = 10V$, $I_L = 0$, $f = 1$ MHz)	C_J		1.9		pF

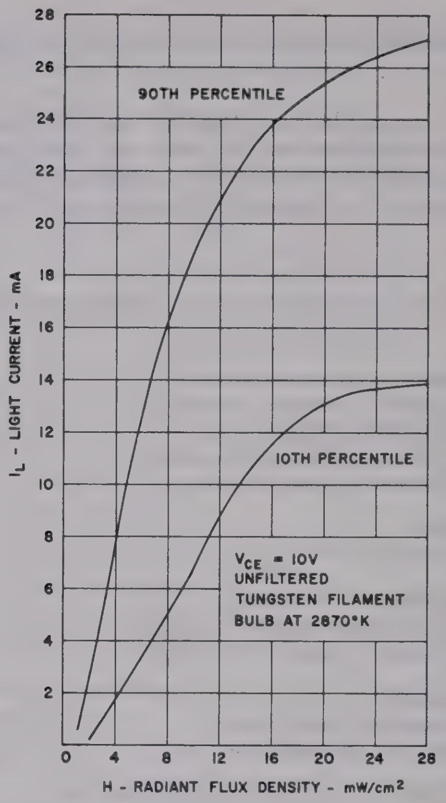
†H = Radiation Flux Density. Radiation source is an unfiltered tungsten. filament bulb at 2870°K color temperature.
††Radiant Source is a GaAs Light Emitting Diode (LED10).

TYPICAL ELECTRICAL CHARACTERISTICS

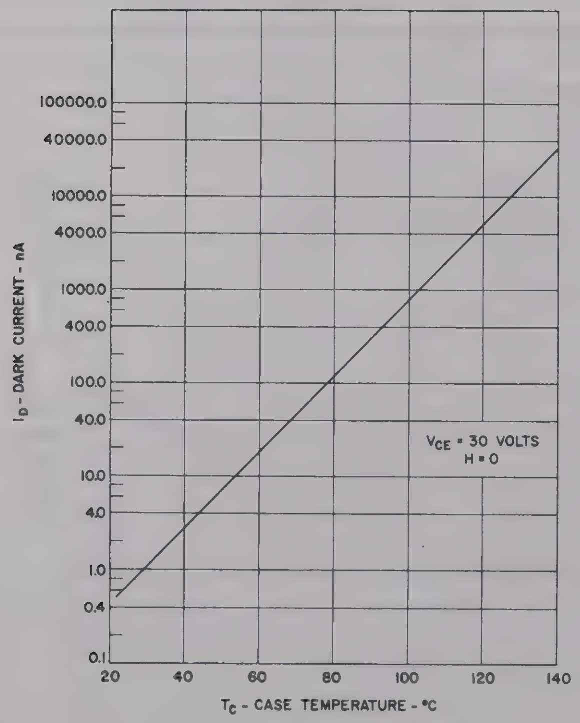
VI CURVES vs. LIGHT INTENSITY



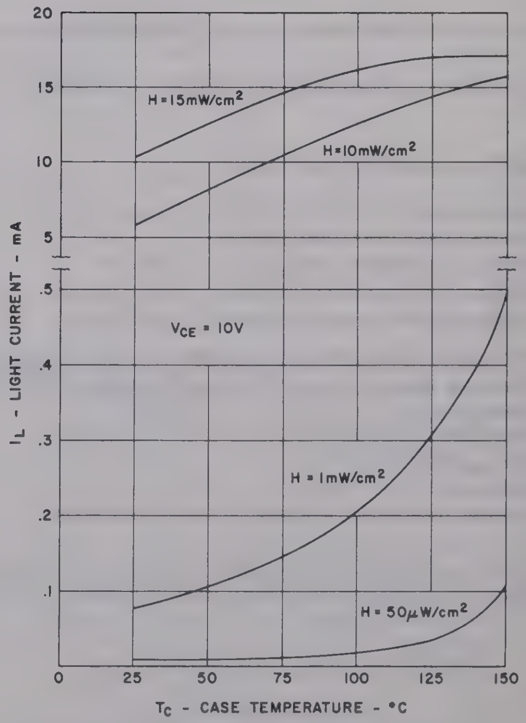
IRRADIANCE vs. LIGHT CURRENT



DARK CURRENT vs. TEMPERATURE

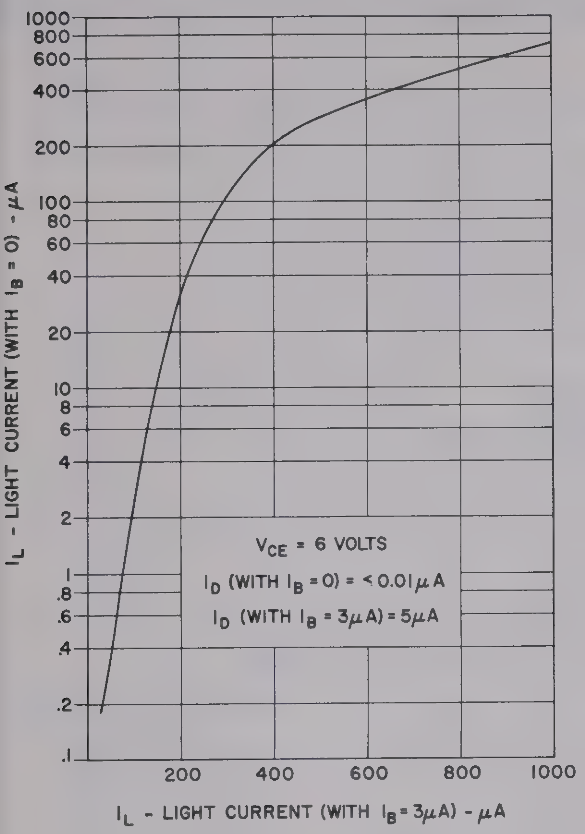


LIGHT CURRENT vs. TEMPERATURE

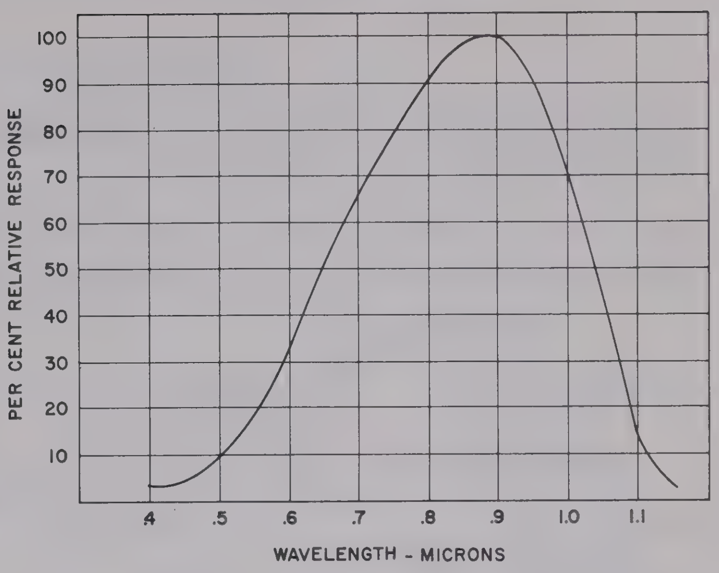


TYPICAL ELECTRICAL CHARACTERISTICS

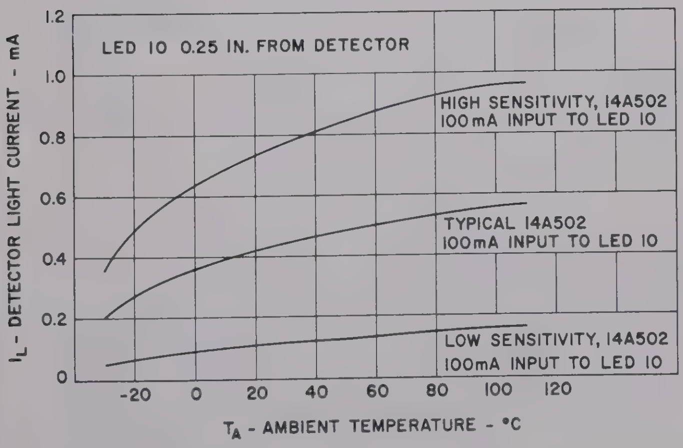
BASE DRIVE EFFECTS ON DETECTOR SENSITIVITY



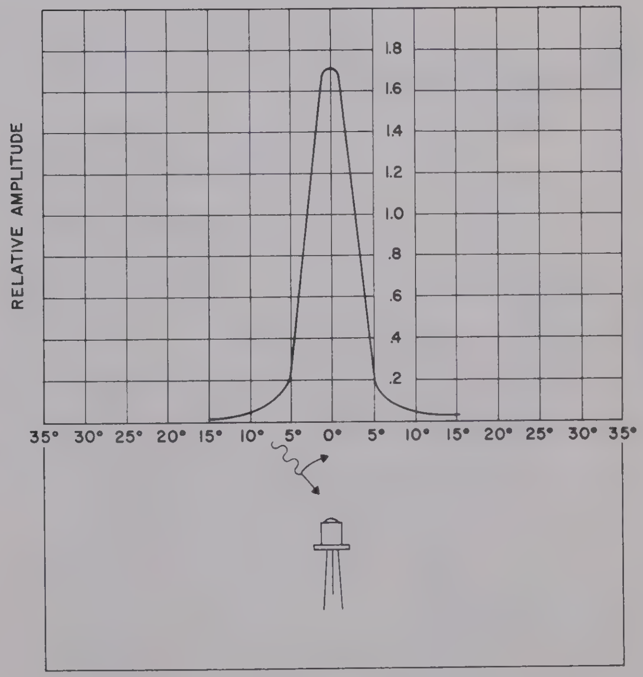
SPECTRAL RESPONSE



TEMPERATURE TRACKING FOR LED 10 AND LIGHT DETECTOR

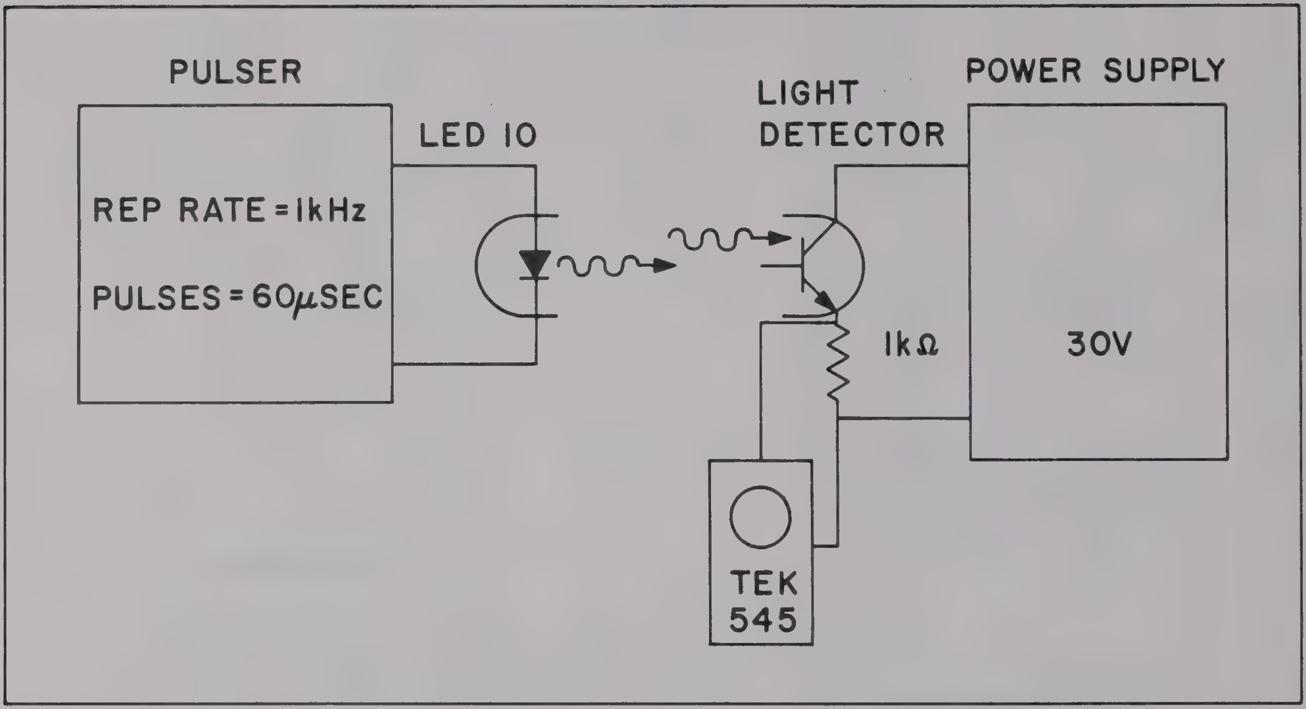


ANGLE vs. AMPLITUDE



TEST CIRCUIT

SWITCHING CIRCUIT

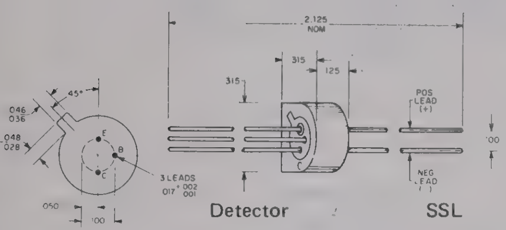

PULSER
REP RATE = 1kHz
PULSES = 60μSEC
LED 10
LIGHT DETECTOR
POWER SUPPLY
30V
1kΩ
TEK 545

PHOTON COUPLER TYPE—PC 4-73
APPLICATION—ELECTRICAL ISOLATION, HIGH SPEED SWITCHING

DESCRIPTION – The General Electric PC4-73 is a photon coupler consisting of a gallium arsenide solid state lamp and an NPN planar silicon photo-darlington amplifier. The optical coupling of the pair is accomplished through the use of clear epoxy as a light pipe, and the pair is permanently enclosed in a black epoxy holder for the best possible dark resistance.

This totally solid state device has the inherent reliability of a transistor, and can be used in severe shock and vibration environments.

For many applications, only the collector and emitter leads of the photo-darlington amplifier are used; however, the base lead is provided to control the sensitivity and gain of the device.



Leads: .016 — .019 in. diameter 1.0 in. nom. length

MECHANICAL SPECIFICATIONS

USES

ELECTRICAL ISOLATION	HIGH SPEED SWITCHING
Attenuators	Channel switching
Circuit/line voltage isolators	Data transmission
Logic to relay circuit couplers	Multiplexing
Circulating ground current elimination	Coding
Noise isolation	Computer-peripheral equipment coupling
	Process control equipment

ABSOLUTE MAXIMUM RATINGS: ($T_A = 25°$ C unless otherwise shown)

SOLID STATE LAMP

Power Dissipation	*150 milliwatts (10^{-3} watts)
Forward Current (Continuous)	100 milliamps (10^{-3} amperes)
Forward Current (Peak)	1 ampere
Reverse Voltage @ 10μA	2 volts
Junction Temperature	-65°C to 100°C

* Derate 2.0mW/°C above 25°C ambient

PHOTO - DARLINGTON AMPLIFIER

Power Dissipation	**200 milliwatts (10^{-3} watts)
BV_{CEO}	25 volts
BV_{ECO}	8 volts
Light Current (I_L)	250 milliamps (10^{-3} amperes)
Junction Temperature	-65°C to 100°C

** Derate 2.67mW/°C above 25°C ambient

ELECTRICAL CHARACTERISTICS: ($T_A = 25°$ C unless otherwise shown)

SOLID STATE LAMP

	MIN.	TYP.	MAX.	UNITS
Forward Voltage (I_F = 10mA)	0.8	1.0	1.3	volts
Reverse Current (V_R = 2V)	—	—	10	microamps (10^{-6} amperes)
Capacitance (V = O)	—	500	—	picofarads

PHOTO - DARLINGTON AMPLIFIER

	MIN.	TYP.	MAX.	UNITS
Collector – Emitter Breakdown Voltage – BV_{CEO} (I_C = 10mA, I_F = O)	25	—	—	volts
Emitter – Collector Breakdown Voltage – BV_{ECO} (I_E = 100μA, I_F = O)	8	—	—	volts
Collector Dark Current – I_D (V_{CE} = 10V, I_F = O)	—	—	100	nanoamps (10^{-9} amperes)
Capacitance Collector – Emitter – C_{CEO} (V_{CE} = 10V, f = 1MHz)	—	3.4	—	picofarads

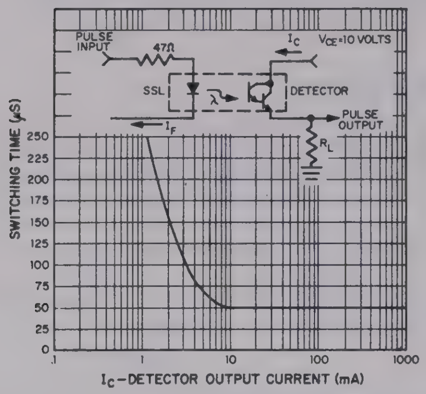
COUPLED: ($T_A = 25°$C unless otherwise shown)

	MIN.	TYP.	MAX.	UNITS
DC Current Transfer Ratio – (I_F = 10mA, V_{CE} = 10V)	100	200	—	%
Bandwidth – (I_C = 10mA)	—	20	—	kHz
Saturation Voltage – Collector – Emitter (I_F = 10mA, I_C = 10mA)	—	0.75	—	volts
Resistance – SSL to Photo - Darlington (@ 500 volts)	—	100	—	gigaohms (10^9 ohms)
Capacitance – SSL to Photo - Darlington	—	2	—	picofarads
Surge Voltage	—	—	2500	volts
Switching Speeds: (V_{CE} = 10V, I_C = 10mA, R_L = 100Ω)				
Rise Time	—	50	—	microseconds
Fall Time	—	30	—	microseconds

TYPICAL CHARACTERISTICS

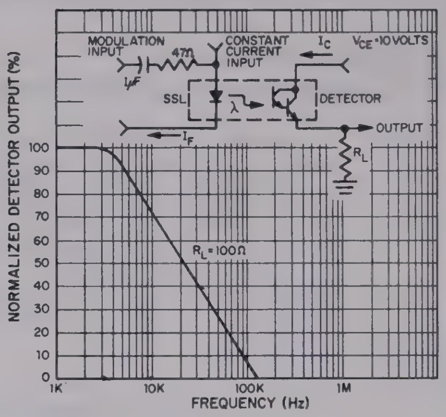
PC4-73

SWITCHING TIME vs DETECTOR CURRENT



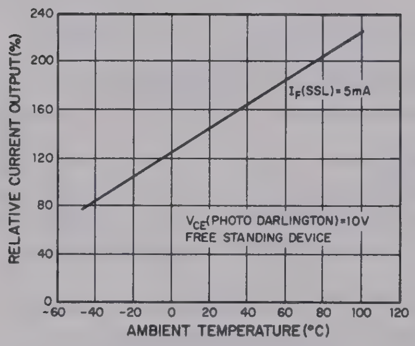
PC4-73

FREQUENCY vs DETECTOR OUTPUT



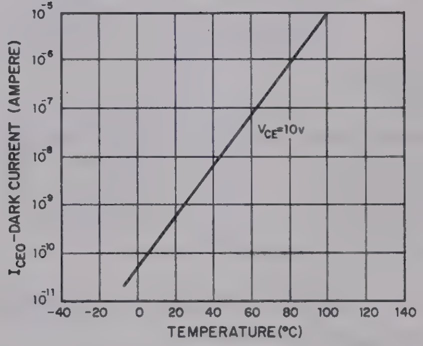
PC4-73

CURRENT OUTPUT
vs
TEMPERATURE



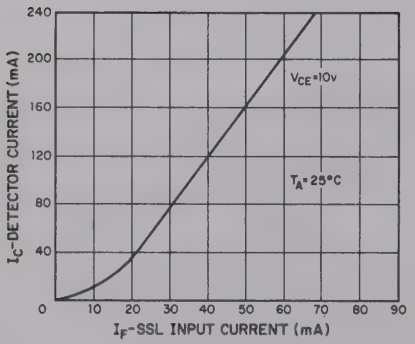
PC4-73

DARK CURRENT
vs
TEMPERATURE



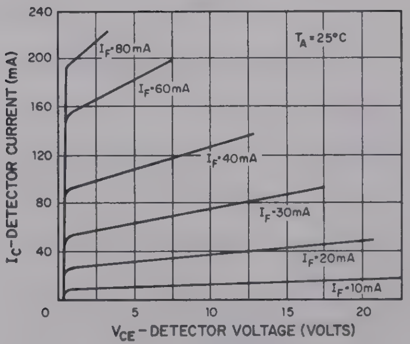
PC4-73

INPUT CURRENT
vs
OUTPUT CURRENT



PC4-73

DETECTOR OUTPUT
CHARACTERISTICS



LID STATE

GENERAL ELECTRIC

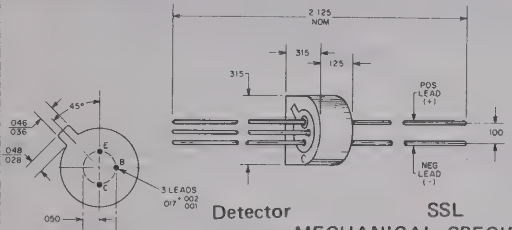
PTOELECTRONICS

PHOTON COUPLER TYPE—PC 15-26
APPLICATION—ELECTRICAL ISOLATION, HIGH SPEED SWITCHING

DESCRIPTION — The General Electric PC15-26 is a photon coupler consisting of a gallium arsenide solid state lamp and an NPN planar silicon phototransistor. The optical coupling of the pair is accomplished through the use of clear epoxy as a light pipe, and the pair is permanently enclosed in a black epoxy holder for the best possible dark resistance.

This totally solid state device has the inherent reliability of a transistor, and can be used in severe shock and vibration environments.

For many applications, only the collector and emitter leads of the phototransistor are used; however, the base lead is provided to control the sensitivity and gain of the device.



Leads:
.016 — .019 in. diameter
1.0 in. nom. length

MECHANICAL SPECIFICATIONS

USES

ELECTRICAL ISOLATION

- Video pulse transformers
- Attenuators
- Circuit/ line voltage isolators
- Logic to relay circuit couplers
- Circulating ground current elimination
- rf signal coupler
- Noise isolation

HIGH SPEED SWITCHING

- Channel switching
- Data transmission
- Multiplexing
- Coding
- Computer-peripheral equipment coupling
- Process control equipment

ABSOLUTE MAXIMUM RATINGS: (T_A = 25°C unless otherwise shown)

SOLID STATE LAMP

Power Dissipation	*150 milliwatts (10^{-3} watts)
Forward Current (Continuous)	60 milliamps (10^{-3} amperes)
Forward Current (Peak)	3 amperes
Reverse Voltage @10μA	3 volts
Junction Temperature	-65°C to 100°C

* Derate 2.0mW/°C above 25°C ambient

PHOTOTRANSISTOR

Power Dissipation	**300 milliwatts (10^{-3} watts)
BV_{CEO}	45 volts
BV_{ECO}	5 volts
Light Current (I_L)	50 milliamps (10^{-3} amperes)
Junction Temperature	-65°C to 100°C

** Derate 4.0mW/°C above 25°C ambient

ELECTRICAL CHARACTERISTICS: (T_A = 25°C unless otherwise shown)

SOLID STATE LAMP

	MIN.	TYP.	MAX.	UNITS
Forward Voltage (I_F = 20mA)	1.1	1.3	1.8	volts
Reverse Current (V_R = 2V)	—	—	10	microamps (10^{-6} amperes)
Capacitance (V = O)	—	50	—	picofarads

PHOTOTRANSISTOR

	MIN.	TYP.	MAX.	UNITS
Collector — Emitter Breakdown Voltage — BV_{CEO} (I_C = 10mA, I_F = O)	45	—	—	volts
Emitter — Collector Breakdown Voltage — BV_{ECO} (I_E = 100μA, I_F = O)	5	—	—	volts
Collector Dark Current — I_D (V_{CE} = 10V, I_F = O)	—	2	25	nanoamps (10^{-9} amperes)
Capacitance Collector — Emitter — C_{CEO} (V_{CE} = 10V, f = 1MHz)	—	2	—	picofarads

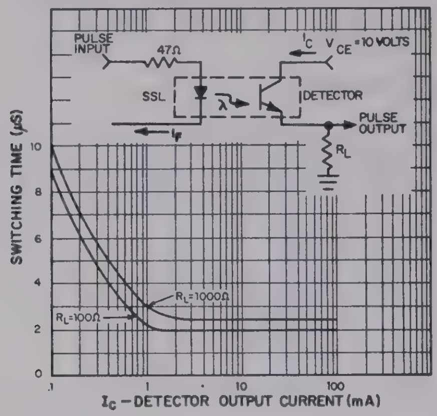
COUPLED: (T_A = 25°C unless otherwise shown)

	MIN.	TYP.	MAX.	UNITS
DC Current Transfer Ratio (I_F = 10mA, V_{CE} = 10V)	30	50	—	%
Bandwidth — (I_C = 2mA)	—	350	—	kHz
Saturation Voltage — Collector — Emitter (I_F = 50mA, I_C = 2mA)	—	0.1	0.5	volts
Resistance — SSL to Phototransistor (@ 500 volts)	—	100	—	gigaohms (10^9 ohms)
Capacitance — SSL to Phototransistor	—	2	—	picofarads
Surge Voltage	—	—	2500	volts
Switching Speeds: (V_{CE} = 10V, I_C = 2mA, R_L = 100Ω)				
Rise Time	—	2	—	microseconds
Fall Time	—	2	—	microseconds

TYPICAL CHARACTERISTICS

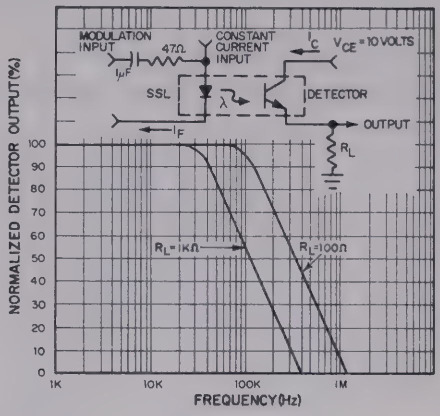
PC15-26

SWITCHING TIME VS DETECTOR CURRENT



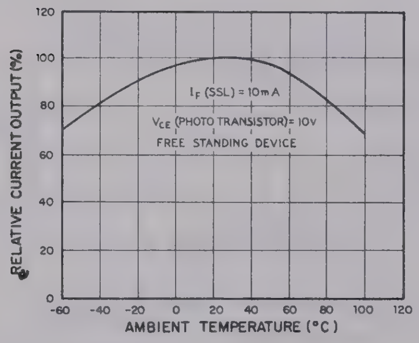
PC15-26

FREQUENCY VS DETECTOR OUTPUT



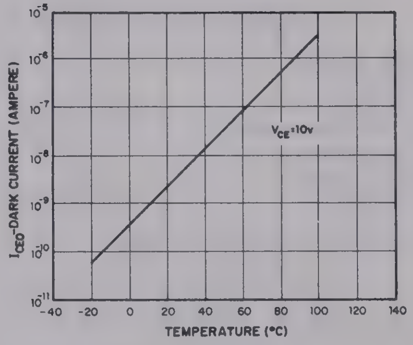
PC15-26

CURRENT OUTPUT
VS
TEMPERATURE



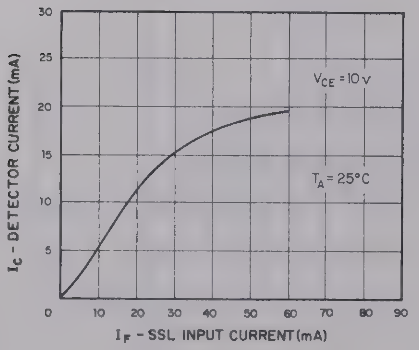
PC15-26

DARK CURRENT vs TEMPERATURE



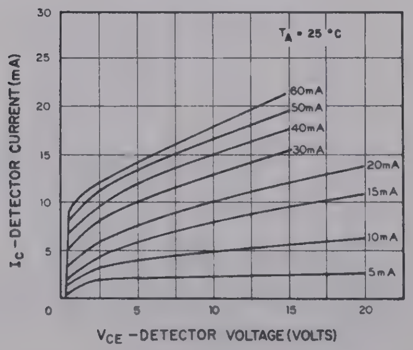
PC15-26

INPUT CURRENT
VS
OUTPUT CURRENT



PC15-26

DETECTOR OUTPUT
CHARACTERISTICS



Light Detector

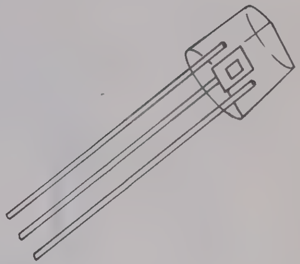
L14E1-4

PLANAR SILICON PHOTOTRANSISTOR

The General Electric L14E Light Detector is an NPN Silicon Phototransistor in a clear epoxy T092 package.

FEATURES:

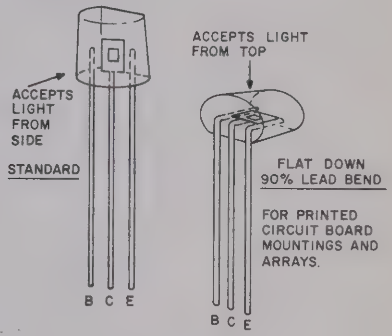
- Low Cost.
- Base Lead for sensitivity control.
- Maximum sensitivity compatible with GaAs LED output.
- Multiple parts allow choice of *speed* and sensitivity.
- Right Angle Lead option offers alternate orientation.
- Fast Switching Speeds.

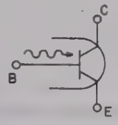


absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages—Dark Characteristics			
Collector to Emitter	V_{CEO}	50	Volts
Collector to Base	V_{CBO}	50	Volts
Emitter to Base	V_{EBO}	5	Volts
Current			
Light Current	I_L	100	mA
Dissipation			
Power Dissipation*	P_T	200	mW
Temperature			
Junction Temperature	T_J	100	°C
Storage Temperature	T_{stg}	−65 to 100	°C

*Derate 2.67mW/°C above 25°C ambient



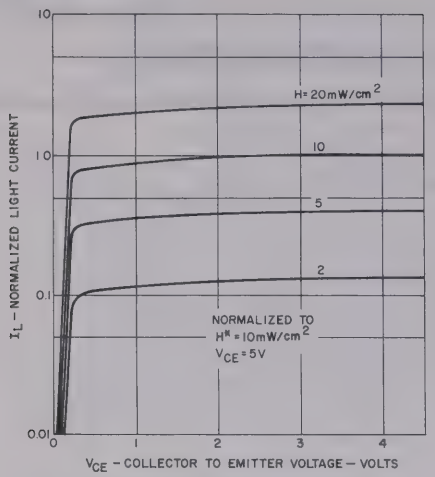


electrical characteristics: (25°C) (unless otherwise specified)

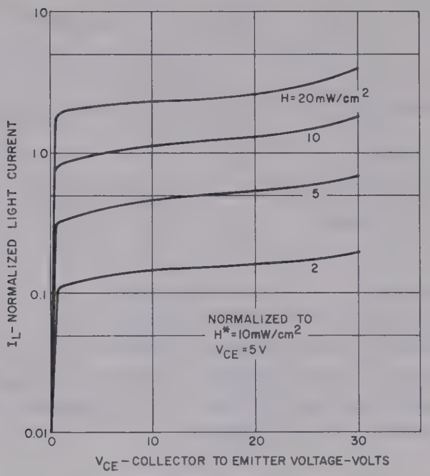
		L14E1		L14E2		L14E3		L14E4		
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Units
Light Current ($V_{CE} = 5V$, $H^* = 10mW/cm^2$)	I_L	50	300	100	700	400	1000	50		μA
Dark Current ($V_{CE} = 30V$, $H \approx 0$, $I_B = 0$)	I_D		100		100		100		100	nA
Emitter-Base Breakdown Voltage ($I_E = 100\ \mu A$)	BV_{EBO}	5		5		5		5		Volts
Collector-Base Breakdown Voltage ($I_C = 100\ \mu A$)	BV_{CBO}	50		50		50		50		Volts
Collector-Emitter Breakdown Voltage ($I_C = 10$ mA)	BV_{CEO}	50		50		50		50		Volts
Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)	$V_{CE(SAT)}$		0.2		0.2		0.2		0.2	Volts
Switching Speeds ($V_{CE} = 30V$, $I_L = 800\ \mu A$, $R_L = 1k\Omega$) **										
On Time ($t_d + t_r$)	t_{on}		6		15		20			μsec
Off Time ($t_s + t_f$)	t_{off}		6		10		15			μsec

*H = Radiation Flux Density. Radiation source is an unfiltered tungsten filament bulb at 2870°K color temperature.
**Radiant source is a gallium arsenide light emitting diode.

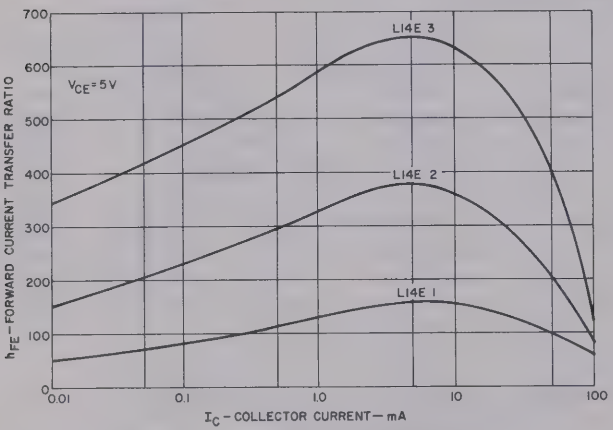
TYPICAL ELECTRICAL CHARACTERISTICS



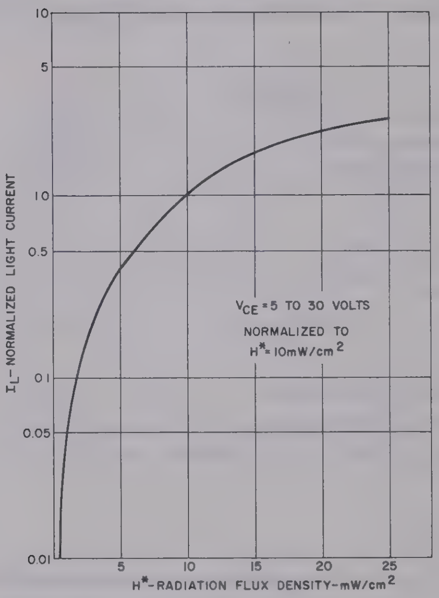
1. NORMALIZED LIGHT CURRENT VS. COLLECTOR TO EMITTER VOLTAGE



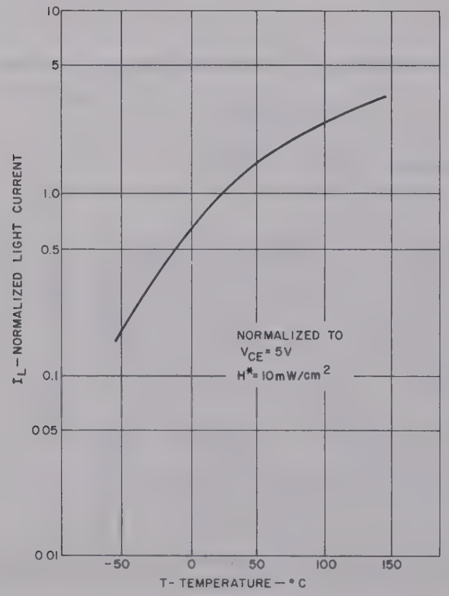
2. NORMALIZED LIGHT CURRENT VS. COLLECTOR TO EMITTER VOLTAGE



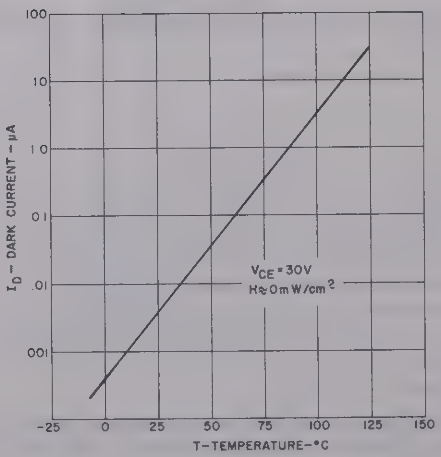
3. FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT



4. NORMALIZED LIGHT CURRENT VS. RADIATION

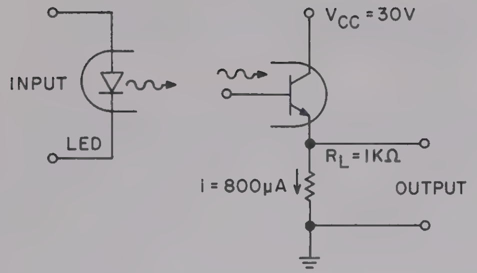


5. NORMALIZED LIGHT CURRENT VS. TEMPERATURE

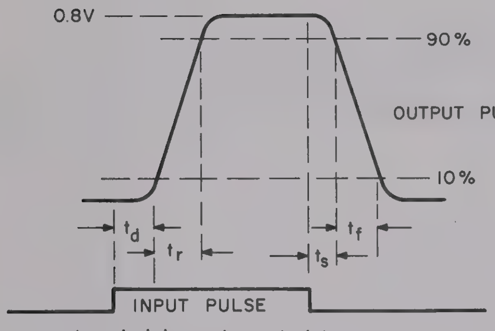


6. DARK CURRENT VS. TEMPERATURE

TYPICAL ELECTRICAL CHARACTERISTICS

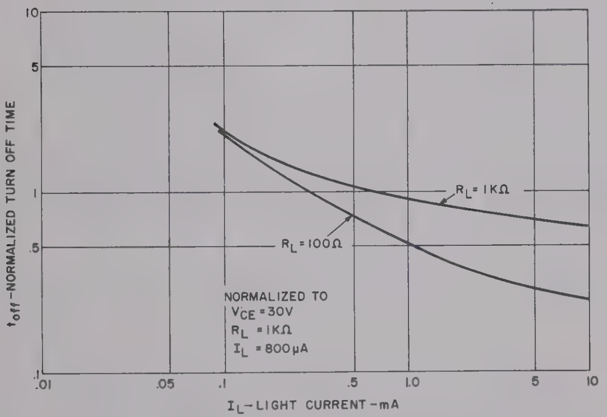

INPUT
LED
V_{CC} = 30V
R_L = 1KΩ
i = 800μA
OUTPUT

TEST CIRCUIT

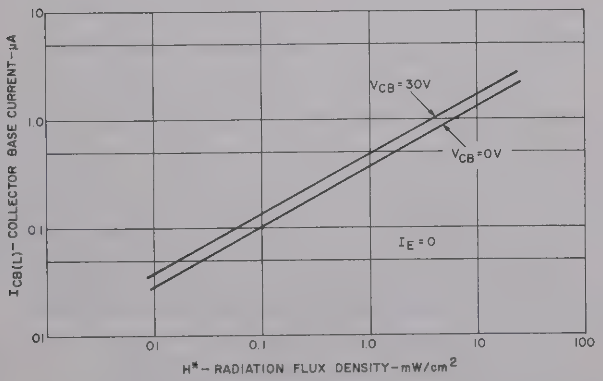

0.8V
90%
OUTPUT PULSE
10%
t_d
t_r
t_s
t_f
INPUT PULSE

$t_{on} = t_d + t_r$ $t_{off} = t_s + t_f$

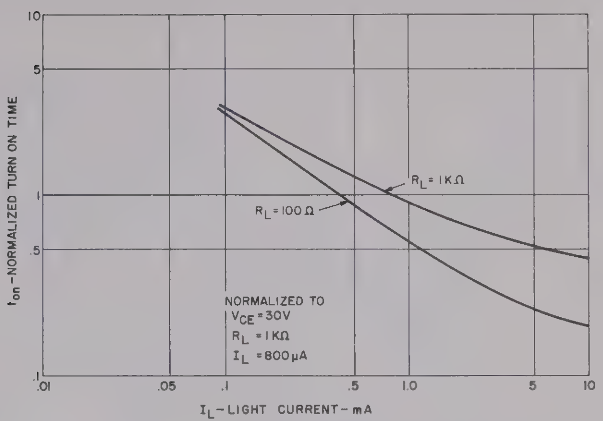
WAVE FORMS



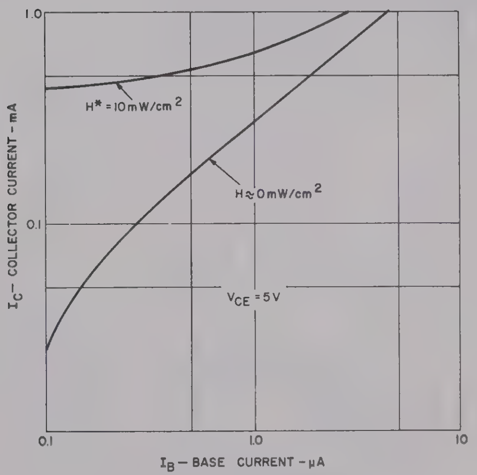
8. NORMALIZED TURN OFF TIME VS. LIGHT CURRENT



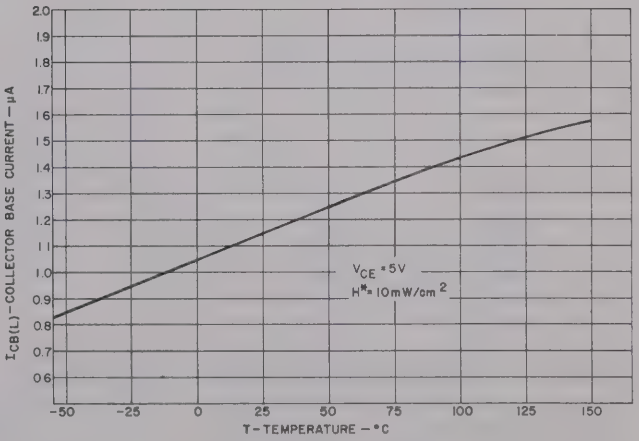
10. COLLECTOR-BASE CURRENT VS. RADIATION



7. NORMALIZED TURN ON TIME VS. LIGHT CURRENT

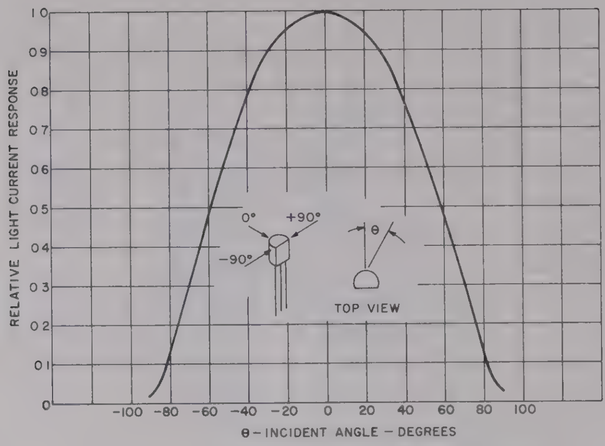


9. COLLECTOR CURRENT VS. BASE CURRENT

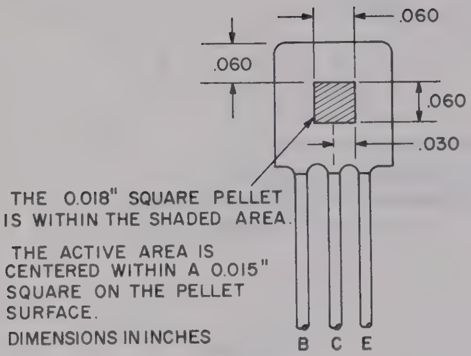


11. COLLECTOR BASE CURRENT VS. TEMPERATURE

TYPICAL ELECTRICAL CHARACTERISTICS



12. RELATIVE RESPONSE VS. INCIDENT ANGLE

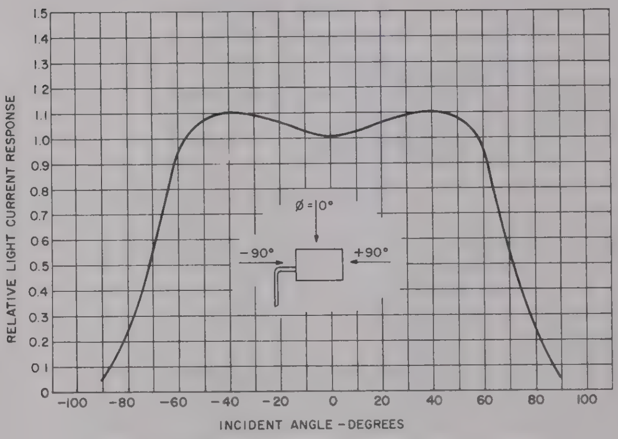

.060
.060
.060
.030
B
C
E

THE 0.018" SQUARE PELLET IS WITHIN THE SHADED AREA.

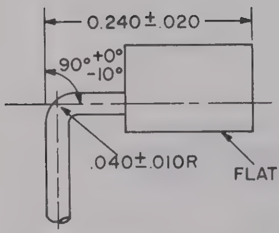
THE ACTIVE AREA IS CENTERED WITHIN A 0.015" SQUARE ON THE PELLET SURFACE.

DIMENSIONS IN INCHES

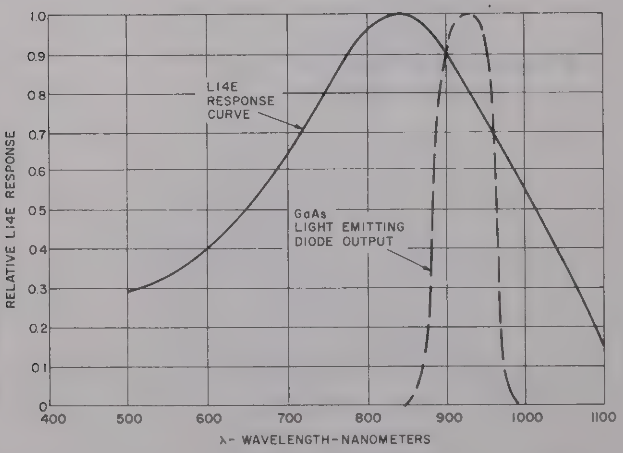
PELLET LOCATION



13. RELATIVE RESPONSE VS. INCIDENT ANGLE


0.240 ± .020
90° +0° -10°
.040 ± .010R
FLAT

RIGHT ANGLE LEAD OPTION



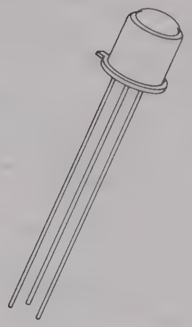
14. SPECTRAL CURVES

Silicon Transistors

NPN

L14F

The General Electric L14F light detector is a supersensitive NPN Planar Silicon Photodarlington Amplifier. For many applications, only the collector and emitter leads are used; however, a base lead is provided to control sensitivity and the gain of the device. The L14F is a TO-18 Style hermetically sealed package with lens cap and is designed to be used in optoelectronic sensing applications requiring very high sensitivity.

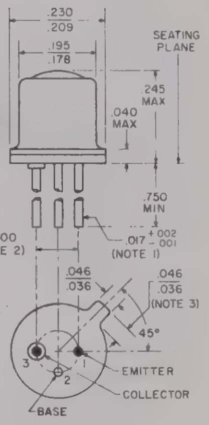


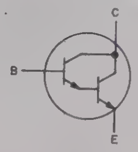
absolute maximum ratings: (25°C unless otherwise specified)

Voltages — Dark Characteristics			
Collector to Emitter Voltage	V_{CEO}	25	volts
Collector to Base Voltage	V_{CBO}	25	volts
Emitter to Base Voltage	V_{EBO}	12	volts
Currents			
Light Current	I_L	250	mA
Dissipations			
Power Dissipation (T_A = 25°C)*	P_T	300	mW
Power Dissipation (T_C = 25°C)**	P_T	600	mW
Temperatures			
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	— 65 to 200	°C

*Derate 1.71 mW/°C above 25°C ambient
**Derate 3.43 mW/°C above 25°C case

NOTE 1: Lead diameter is controlled in the zone between .050 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.
NOTE 2: Leads having maximum diameter (.019) measured in gaging plane .054 + .001 — .000 below the seating plane of the device shall be within .007 of true position relative to a maximum width tab.
NOTE 3: Measured from max. diameter of the actual device





ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.

electrical characteristics: (25°C unless otherwise specified)

STATIC CHARACTERISTICS		MIN.	TYP.	MAX.	
Light Current (V_{CE} = 5V, H† = 0.2mW/cm²)	I_L	3	30		mA
Dark Current (V_{CE} = 12V, I_B = 0)	I_D			100	nA
Emitter-Base Breakdown Voltage (I_E = 100nA)	$V_{(BR)EBO}$	12			V
Collector-Base Breakdown Voltage (I_C = 100nA)	$V_{(BR)CBO}$	25			V
Collector-Emitter Breakdown Voltage (I_C = 10mA)	$V_{(BR)CEO}$	25			V

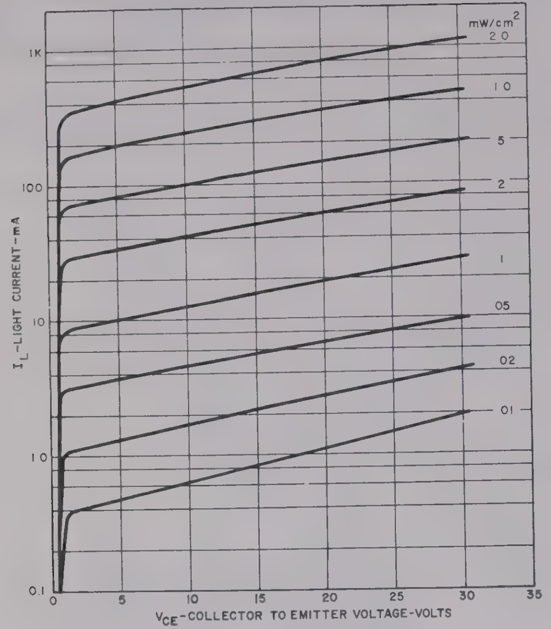
SWITCHING CHARACTERISTICS (see Switching Circuit)

Switching Speeds (V_{CC} = 10V, I_L = 10mA, R_L = 100 Ω)					
Delay time	t_d		12	50	μsec
Rise time	t_r		100	300	μsec
Storage time	t_s		5	10	μsec
Fall time	t_f		100	250	μsec
Junction capacity (V_{CE} = 10V, I_L = 0, f = 1 MHz)	C_{CE}		3.4		pF

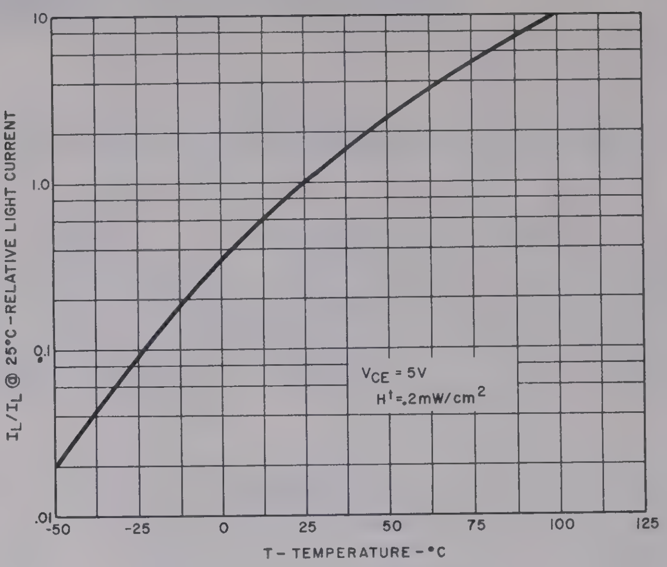
†H = Radiation Flux Density. Radiation source is an unfiltered tungsten filament bulb at 2870°K color temperature.

NOTE: The 2870°K radiation is 30% effective on the photodarlington, i.e. a GaAs source of 0.06 mW/cm² is equivalent to this 0.2 mW/cm² tungsten source.

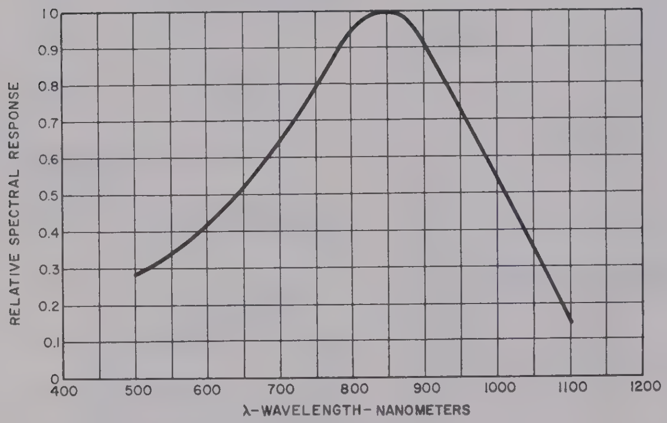
TYPICAL ELECTRICAL CHARACTERISTICS



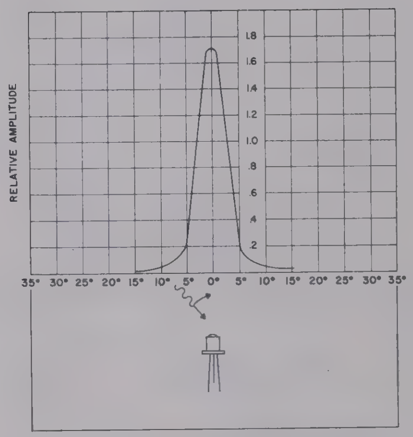
1. LIGHT CURRENT VS. COLLECTOR TO EMITTER VOLTAGE



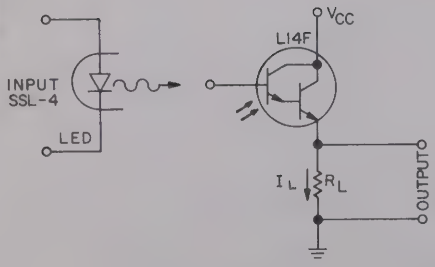
2. RELATIVE LIGHT CURRENT VS. AMBIENT TEMPERATURE



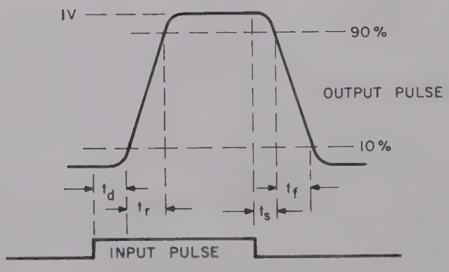
3. SPECTRAL RESPONSE CURVE



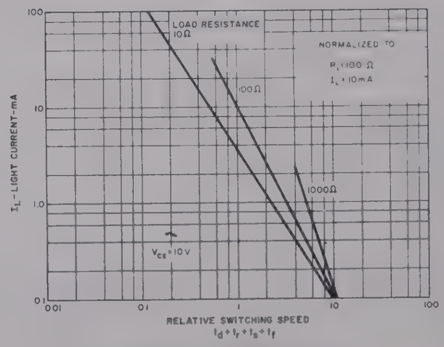
4. ANGULAR RESPONSE


INPUT
SSL-4
LED
V_{CC}
L14F
I_L
R_L
OUTPUT

5. TEST CIRCUIT


IV
90 %
OUTPUT PULSE
10 %
t_d
t_r
t_s
t_f
INPUT PULSE

6. WAVE FORMS



7. LIGHT CURRENT VS. RELATIVE SWITCHING SPEED

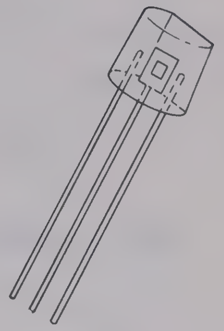
OLID STATE

GENERAL ELECTRIC

OPTOELECTRONICS

Planar Silicon Photo-Switch

PNPN L14T1-L14T5 (L14T Series)



The General Electric L14T Series is a PNPN Silicon Photo-Switch in a clear epoxy TO-92 package. These devices are very similar to a complementary SCR with the device activated by light incident on the gate junction. Adjustment of the trigger point may be accomplished by varying the size of the anode to gate resistor.

FEATURES:
- Right angle lead option offers alternate orientation
- Bistable switching characteristics
- Multiple parts allow choice of triggering values

absolute maximum ratings: (25°C) (unless otherwise specified)

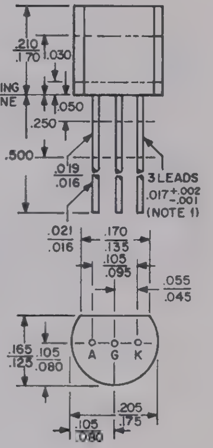
VOLTAGE

Gate - Cathode Forward Voltage		40	Volts
Gate - Cathode Reverse Voltage		5	Volts
Gate - Anode Reverse Voltage		40	Volts
Anode - Cathode Voltage		±40	Volts
CURRENT			
DC Anode Current		100	mA
Gate Current		±20	mA
POWER			
Total Average Power		200	mW
TEMPERATURE			
Operating Junction	-55 to	100	°C
Storage Temperature	-55 to	100	°C

DIMENSIONS WITHIN JEDEC OUTLINE TO-92.

NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.



electrical characteristics: (25°C)

		FIG. NO.	L14T1 MIN	L14T1 MAX	L14T2 MIN	L14T2 MAX	L14T3 MIN	L14T3 MAX	L14T4 MIN	L14T4 MAX	L14T5 MIN	L14T5 MAX	UNITS
Anode Gate-Anode Leakage Current (V_S = 40V, H ≈ 0)	I_{GAO}	2		50		50		50		50		50	nA
Gate to Cathode Leakage Current (V_S = 40V, H ≈ 0)	I_{GKS}	3		100		100		100		100		100	nA
Forward Voltage (I_T =50mA)	V_T	1		1.6		1.6		1.6		1.6		1.6	V
Irradiance to Trigger (V_S = 10V, R_G= 400k)	H_T	4			0.1		0.1		0.1		0.1		mW/cm²
Irradiance to Trigger (V_S = 10V, R_G= 100k)	H_T	4	0.1										mW/cm²
Minimum Gate Resistor to Trigger (V_S = 10V, H* = 2 mW/cm²)	R_{GT}	4	10	100	75	150	125	250	200	400		400	K ohms

* H = Radiation Flux Density. Radiation source is an unfiltered tungsten filament bulb at 2870°K color temperature.

NOTE: The 2870°K radiation is 30% effective on the photo-switch; i.e., a GaAs source of 0.60 mW/cm² is equivalent to this 2.0 mW/cm² tungsten source.

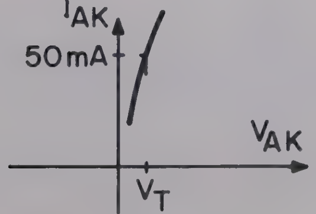


FIGURE 1

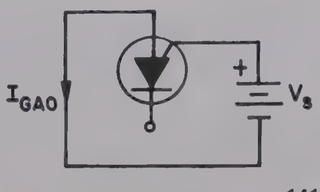


FIGURE 2

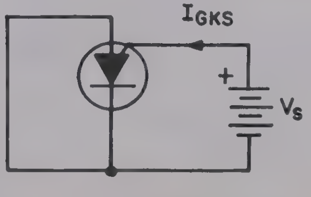


FIGURE 3

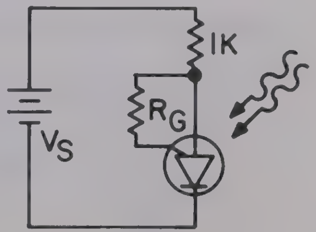
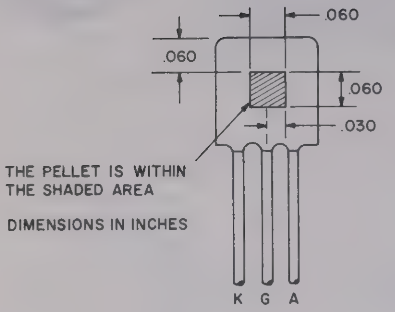
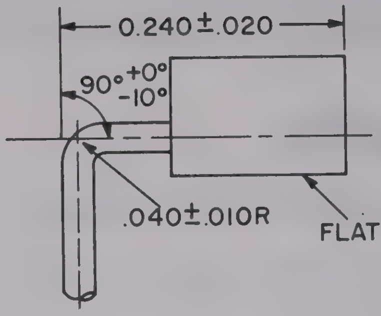


FIGURE 4

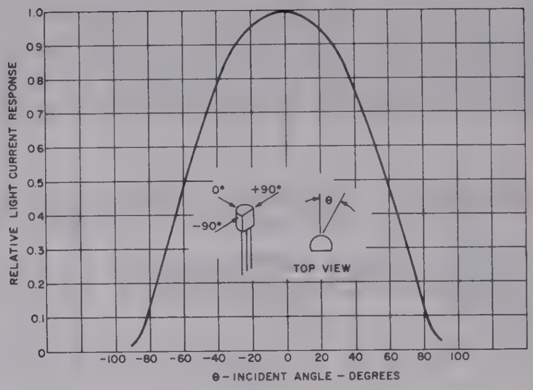
TYPICAL CHARACTERISTICS


.060
.060
.060
.030
THE PELLET IS WITHIN THE SHADED AREA
DIMENSIONS IN INCHES
K
G
A

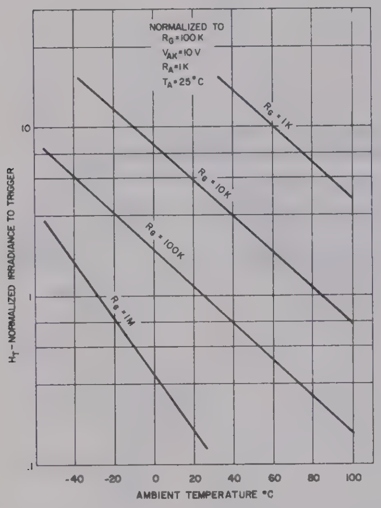
PELLET LOCATION


0.240±.020
90° +0° −10°
.040±.010R
FLAT

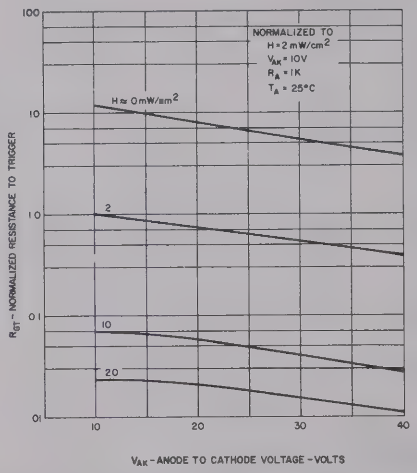
RIGHT ANGLE LEAD OPTION



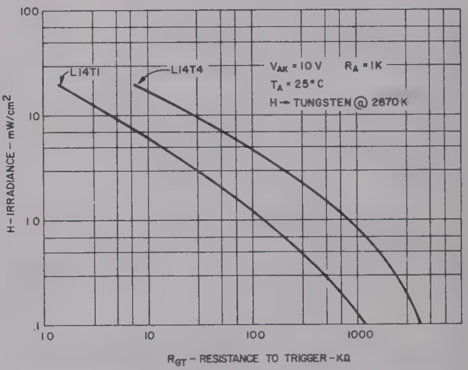
RELATIVE RESPONSE VS. INCIDENT ANGLE



H_T VS. T_A

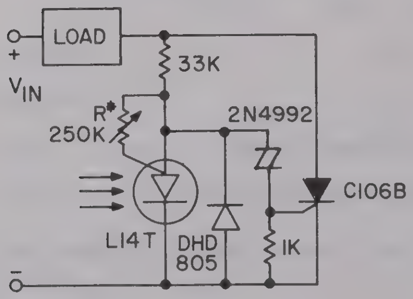


V_{AK} VS. R_{GT} (Normalized)



H VS. R_{GT}
Typical L14T1 and L14T4

LIGHT ACTIVATED NORMALLY CLOSED LINE SWITCH


LOAD
+
V_{IN}
−
33K
R*
250K
2N4992
C106B
L14T
DHD 805
1K

V_{IN}	V_{LOAD}
120V AC	HALF WAVE RECTIFIED
120V FWR	120V FWR

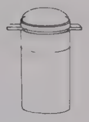
* R is adjusted to provide the desired sensitivity.

OPERATION: When Light input is insufficient to trigger the L14T at V_{AK} = 8V, the 2N4992 (SBS) will trigger in the first 5° of the A.C. Waveform, turning on the C106 B and supplying load power. If light input triggers the L14T, the anode of the SBS is clamped to ground and no load power is supplied.

NOTE: The circuit above will not phase control.

Light Detector Planar Silicon Phototransistor

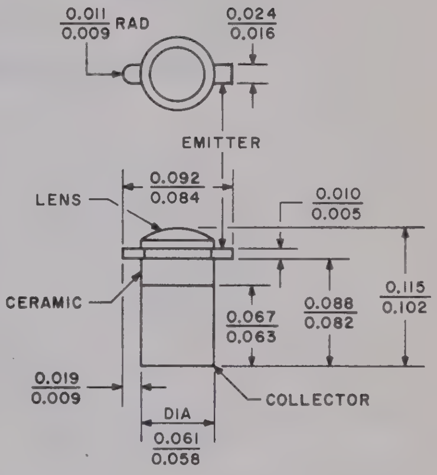
NPN L15A600



The General Electric L15A600 Light Detector is an NPN Silicon Photo-transistor in a hermetically sealed D0-31 style package.

FEATURES:

- .060" diameter package allows assembly of high density linear and matrix arrays.
- High sensitivity - High speed
- Low saturation voltage


0.011 / 0.009 RAD
0.024 / 0.016
EMITTER
LENS
0.092 / 0.084
0.010 / 0.005
CERAMIC
0.115 / 0.102
0.067 / 0.063
0.088 / 0.082
0.019 / 0.009
COLLECTOR
DIA
0.061 / 0.058

ALL DIMENSIONS ARE IN INCHES

absolute maximum ratings:

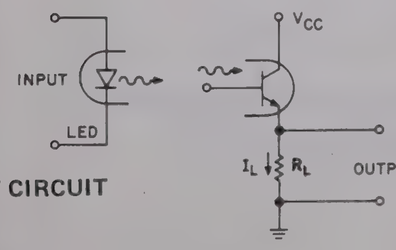
Voltages			
Collector to Emitter Voltage	V_{CEO}	40	Volts
Emitter to Collector Voltage	V_{ECO}	5	Volts
Currents			
Light Current	I_L	50	mA
Dissipations			
Power Dissipation (Free Air 25°C) Derate 0.5 mW/°C Ambient	P_T	50	mW
Power Dissipation (Case Temp. = 25°C) Derate 1.0 mW/°C above 25°C Case	P_T	100	mW
Temperatures			
Junction Temperature	T_J	–65° to 125	°C
Storage Temperature	T_{STG}	–65° to 150	°C

electrical characteristics: (25°C)

STATIC CHARACTERISTICS		MIN.	TYP.	MAX.	UNITS
Light Current (V_{CE} = 5V, H* = 10 mW/cm²)	I_L	0.5	3		mA
Dark Current (V_{CE} = 30V, H ≈ 0)	I_D			100	nA
Collector-Emitter Breakdown Voltage (I_C = 10 mA)	$V_{(BR)CEO}$	40			Volts
Saturation Voltage (I_L = 500 μA, H* = 20 mW/cm²)	$V_{CE(SAT)}$			0.4	Volts
SWITCHING CHARACTERISTICS (See Test Circuit)					
Switching Speeds (V_{CC} = 30V, I_L = 10 mA, R_L = 100 Ω)					
Turn On Time	t_{on}		3		μsec
Turn Off Time	t_{off}		3		μsec

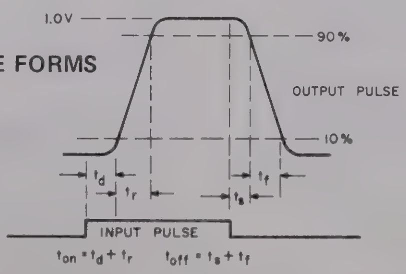
* H = Radiation Flux Density. Radiation source is on unfiltered tungsten filament bulb at 2870°K color temperature.

NOTE: A GaAs source of 3.0 mW/cm² is approximately equivalent to a tungsten source, at 2870°K, of 10 mW/cm².

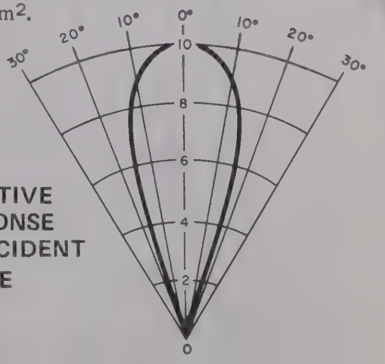

INPUT
LED
V_{CC}
I_L
R_L
OUTPUT

EST CIRCUIT

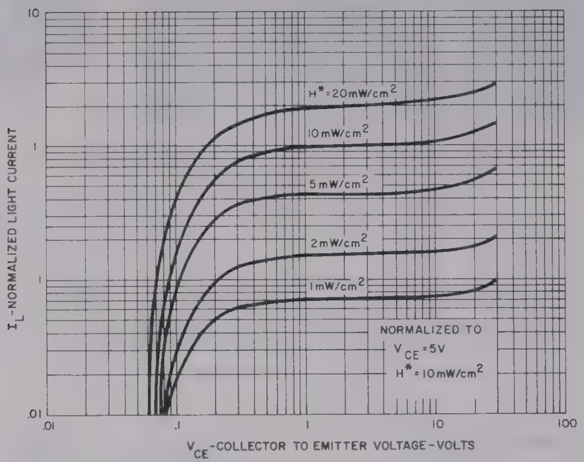
WAVE FORMS


1.0V
90%
OUTPUT PULSE
10%
t_d
t_r
t_s
t_f
INPUT PULSE
$t_{on} = t_d + t_r$
$t_{off} = t_s + t_f$

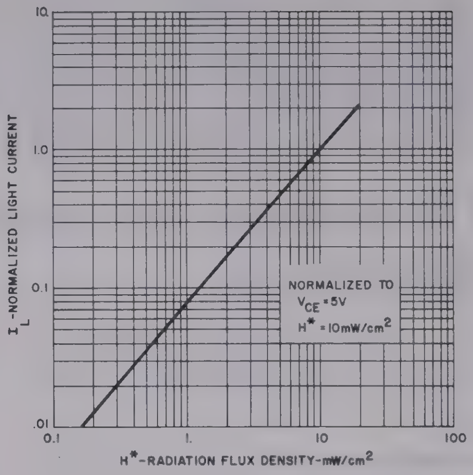
RELATIVE RESPONSE VS INCIDENT ANGLE



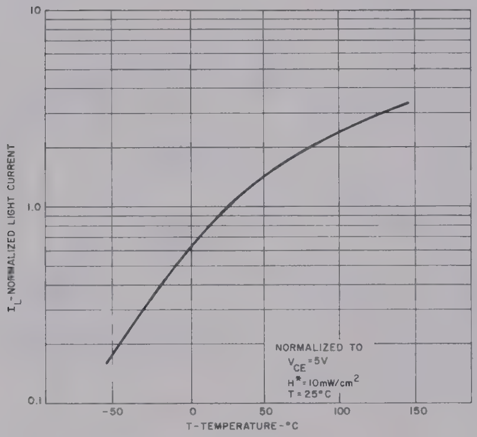
TYPICAL ELECTRICAL CHARACTERISTICS



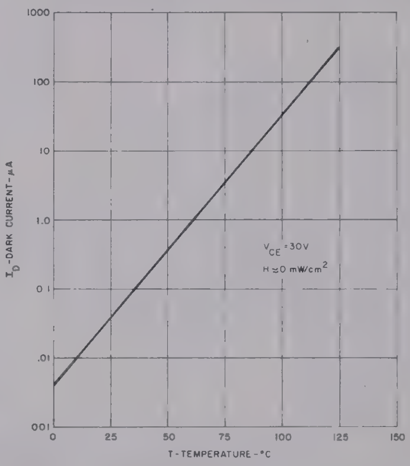
Light Current vs Collector to Emitter Voltage



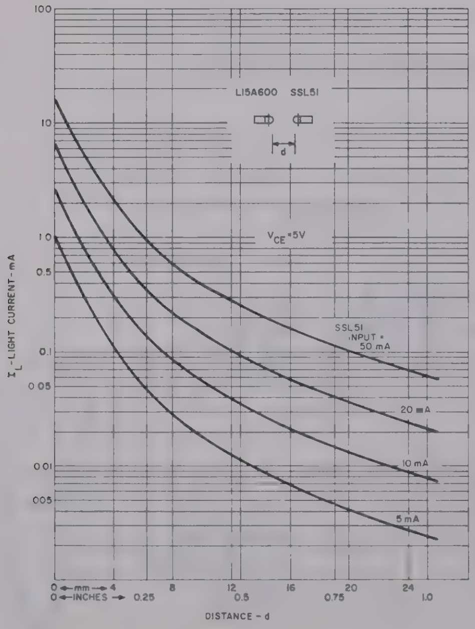
Normalized light Current vs Radiation



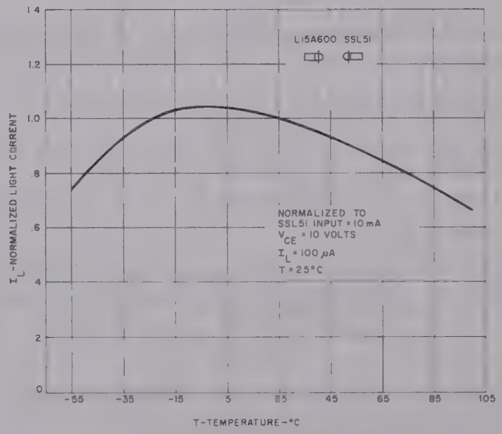
Normalized Light Current vs Temperature



Dark Current vs Temperature



Light Current vs Distance



Normalized Light Current vs Temperature
Both Emitter (SSL51) and Detector L15A600 at Same Temperature

SOLID STATE

GENERAL ELECTRIC

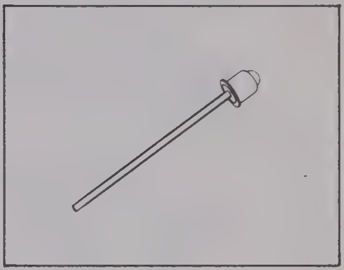
OPTOELECTRONICS

Light Detector PLANAR SILICON PHOTOTRANSISTOR

NPN L15E

55.56 6/71

The General Electric L15E Light Detector is an NPN Silicon Phototransistor in a hermetically sealed package. This device is ideally suited for card and tape reader applications and other applications where a small diameter package is required.



FEATURES:

- **Compliments the GE SSL-15 Infrared Solid State Lamp.**
- **.095″ diameter package allows mounting on .100″ centers.**
- **High sensitivity — High speed.**

absolute maximum ratings:

Collector to Emitter Voltage	V_{CEO}	40	Volts
Emitter to Collector Voltage	V_{ECO}	5	Volts
Light Current	I_L	100	mA
Power Dissipation (Free Air 25°C) Derate 2mW/°C above 25°C Ambient	P_T	200	mW
Power Dissipation (Case Temp. = 25°C) Derate 4 mW/°C above 25°C Case	P_T	400	mW
Junction Temperature	T_J	−65 to 125	°C
Storage Temperature	T_{STG}	−65 to 150	°C

electrical characteristics: (25°C)

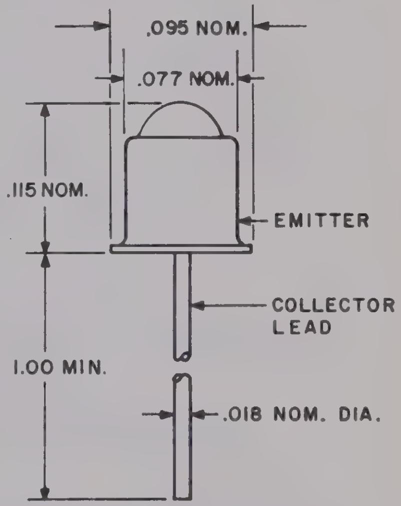
		Min.	Typ.	Max.	Units
Light Current (V_{CE} = 5V, H* = 10mW/cm^2)	I_L	1.5	4		mA
Dark Current (V_{CE} = 30V, H $\approx$ 0)	I_D			100	ηA
Collector-Emitter Breakdown Voltage, (I_C = 10mA)	$V_{(BR)CEO}$	40			Volts
Saturation Voltage (I_L = 500μA, H* = 20mW/cm^2)	$V_{CE(SAT)}$			0.4	Volts
Switching Speeds (V_{CC} = 30V, I_L = 10mA, R_L = 100Ω)**					
On Time	t_{on}		3		μsec
Off Time	t_{off}		3		μsec

* H = Radiation Flux Density. Radiation source is an unfiltered tungsten filament bulb at 2870°K color temp.

** Radiant source is a gallium arsenide light emitting diode.

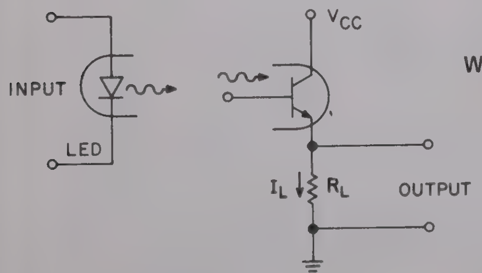
NOTE:

A GaAs source of 3.0 mW/cm^2 is approximately equivalent to 10 mW/cm^2 from the tungsten source at 2870°K.



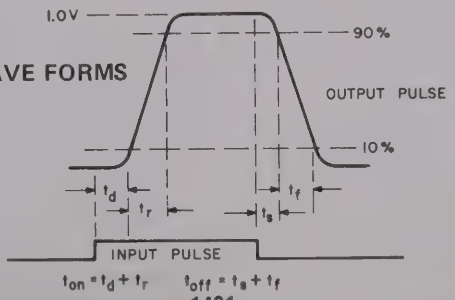
MECHANICAL SPECIFICATIONS

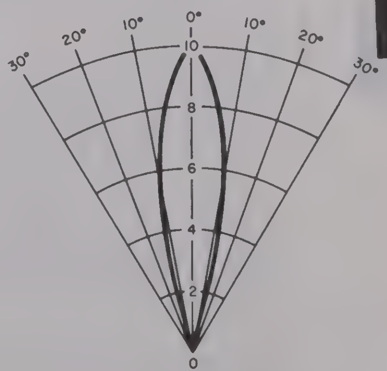
Max. Overall Length — .125 in.
(excluding leads)
Max. Diam.: Header — .097 in.
Case — .080 in.
Lead: .017 — .020 in. diam.
1 in. length minimum



TEST CIRCUIT

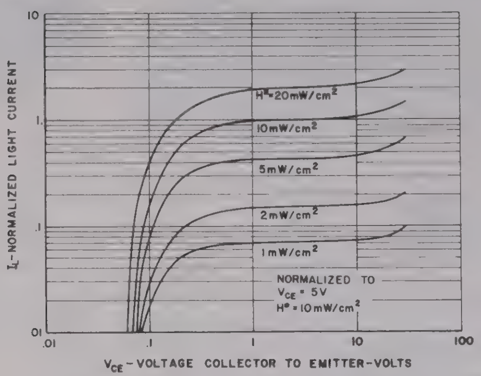
WAVE FORMS



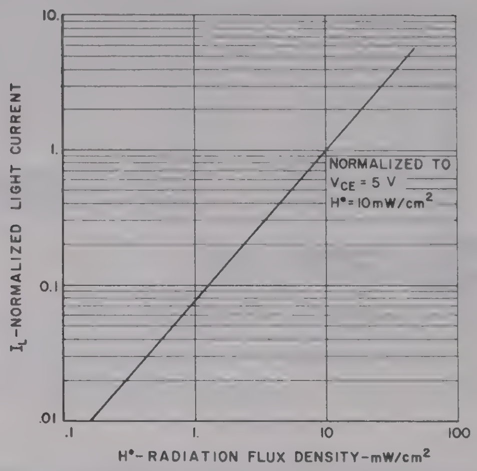


RELATIVE RESPONSE VS. INCIDENT ANGLE

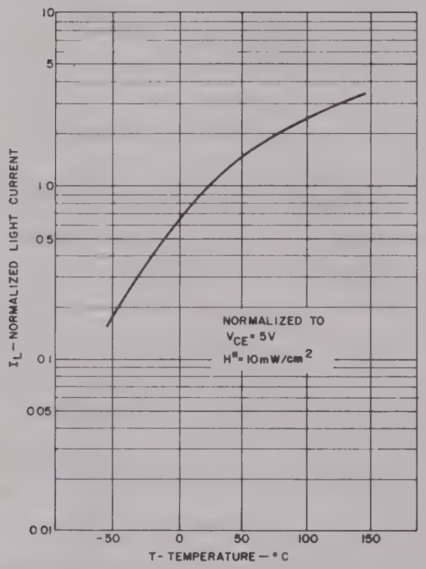
TYPICAL ELECTRICAL CHARACTERISTICS



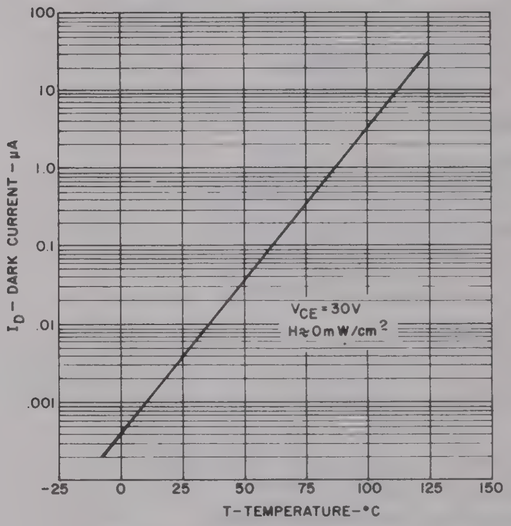
1. NORMALIZED LIGHT CURRENT VS. COLLECTOR TO EMITTER VOLTAGE



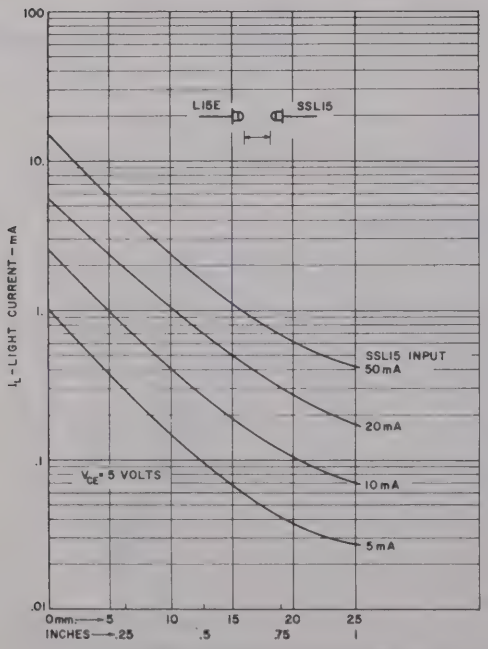
2. NORMALIZED LIGHT CURRENT VS. RADIATION



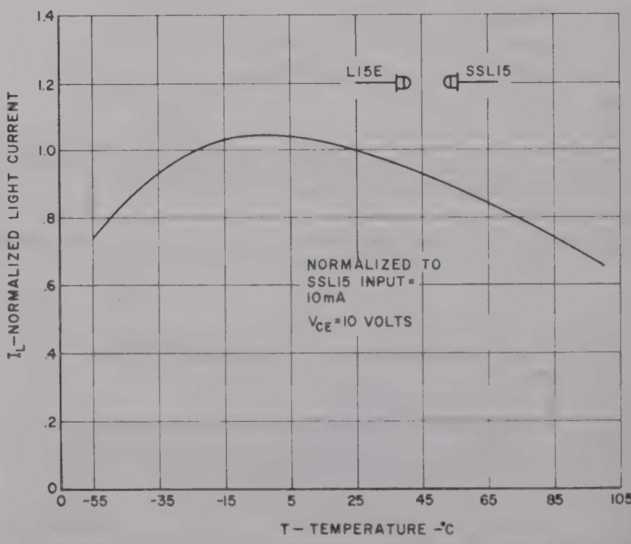
3. NORMALIZED LIGHT CURRENT VS. TEMPERATURE



4. DARK CURRENT VS. TEMPERATURE



5. LIGHT CURRENT VS. DISTANCE



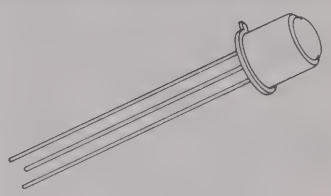
6. NORMALIZED LIGHT CURRENT VS. TEMPERATURE

Silicon Transistors

PNPN

LASCS

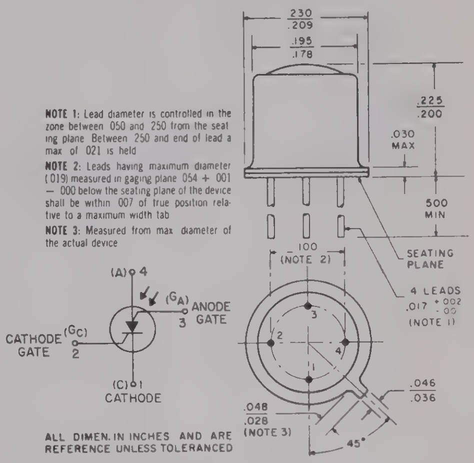
The General Electric LASCS is a PNPN Light Activated Switch. The regenerative action of the PNPN structure gives the device bistable properties and allows a low light level to switch up to 175 mA of current. For a maximum of circuit flexibility, leads have been connected to all four regions of the device. This device is thoroughly characterized at temperature extremes to permit worse case circuit designs.



absolute maximum ratings: (25°C unless otherwise specified)

Voltages	
Anode to Cathode forward and reverse	40 volts
Anode to Anode gate	40 volts
Cathode to Cathode Gate	5 volts
Currents	
Anode (steady state)*	175 mA
Peak recurrent Anode ($T_A = 100°C$, 100 μsec 1% Duty Cycle)	.5 amps
Peak non recurrent Anode (10 μsec)	2.0 amps
Anode gate (steady state)*	100 mA
Peak recurrent Anode gate ($T_A = 100°C$, 100 μsec 1% Duty Cycle)	200 mA
Cathode gate (steady state)	10 mA
Peak recurrent cathode gate ($T_A = 100°C$, 100 μsec 1% Duty Cycle)	100 mA
Dissipation	
Total power*	400 mW
Temperature	
Storage	−65 to +200°C
Operating Junction	−55 to +125°C

*Derate 3.2 mW/°C increase in ambient above 25°C.


.230
.209
.195
.178
.225
.200
.030
MAX
500
MIN
SEATING
PLANE
100
(NOTE 2)
4 LEADS
.017 +.002 -.00
(NOTE 1)
.046
.036
.048
.028
(NOTE 3)
45°
(A) 4
(GA) ANODE GATE 3
CATHODE GATE (GC) 2
(C) 1
CATHODE
1
2
3
4

NOTE 1: Lead diameter is controlled in the zone between 050 and 250 from the seating plane Between 250 and end of lead a max of 021 is held

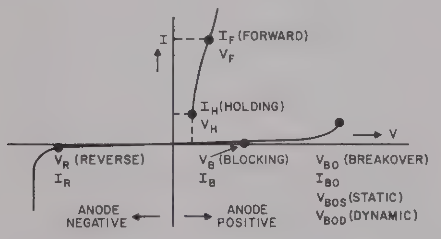
NOTE 2: Leads having maximum diameter (019) measured in gaging plane 054 + 001 − 000 below the seating plane of the device shall be within 007 of true position relative to a maximum width tab

NOTE 3: Measured from max diameter of the actual device

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

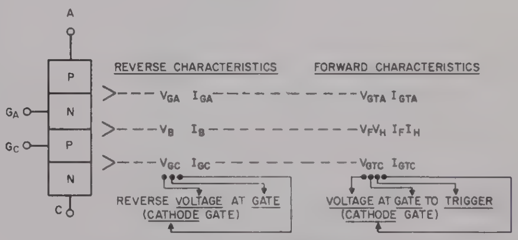
definition of terms used in scs specifications

PNPN devices available at present do not have a common nomenclature. In part, this is due to their different construction and varied applications. SCS nomenclature permits the reverse characteristics of all three junctions to be specified. The anode forward characteristic and gate triggering characteristics can also be specified fully. The principles used in assigning symbols are illustrated below and with cutline drawing above.

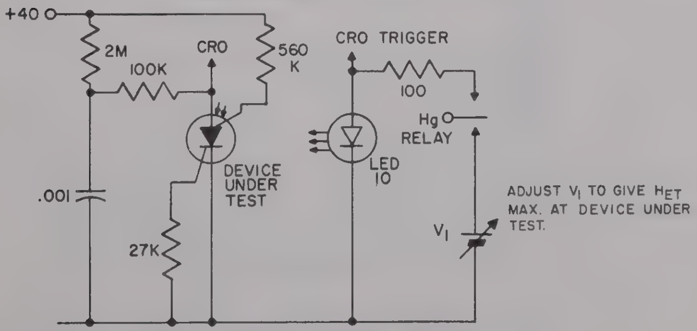


ANODE TO CATHODE CHARACTERISTICS

NOTE — ABSENCE OF G INDENTIFIES ANODE TO CATHODE SYMBOLS. DOT IDENTIFIES OPERATING POINT. BRACKETS INDICATE MEANING OF SUBSCRIPT LETTER.

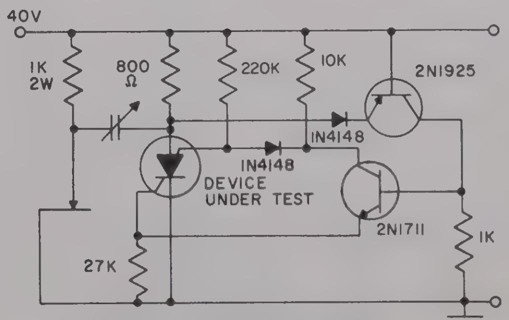

A
P
N
P
N
G_A
G_C
C
REVERSE CHARACTERISTICS
FORWARD CHARACTERISTICS
V_{GA} I_{GA}
V_{GTA} I_{GTA}
V_B I_B
$V_F V_H$ $I_F I_H$
V_{GC} I_{GC}
V_{GTC} I_{GTC}
REVERSE VOLTAGE AT GATE (CATHODE GATE)
VOLTAGE AT GATE TO TRIGGER (CATHODE GATE)

NOTE: G IDENTIFIES GATE SYMBOLS. LAST LETTER (A OR C) MAY BE DROPPED IF NO AMBIGUITY RESULTS IN SPECIFIC CHARACTERIZATION. F MEANS "FORWARD" AND T MEANS "TRIGGER"


+40
2M
100K
CRO
560 K
CRO TRIGGER
100
Hg
RELAY
LED
10
.001
DEVICE UNDER TEST
27K
V_I

ADJUST V_I TO GIVE H_{ET} MAX. AT DEVICE UNDER TEST.

1. Turn on Time Test

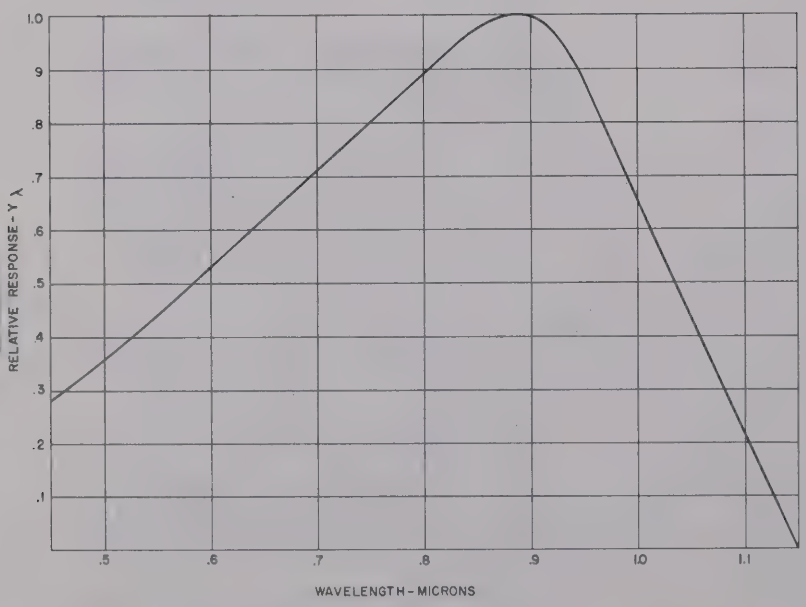

40V
1K
2W
800 Ω
220K
10K
2N1925
1N4148
1N4148
DEVICE UNDER TEST
2N1711
27K
1K

2. Recovery Test Set

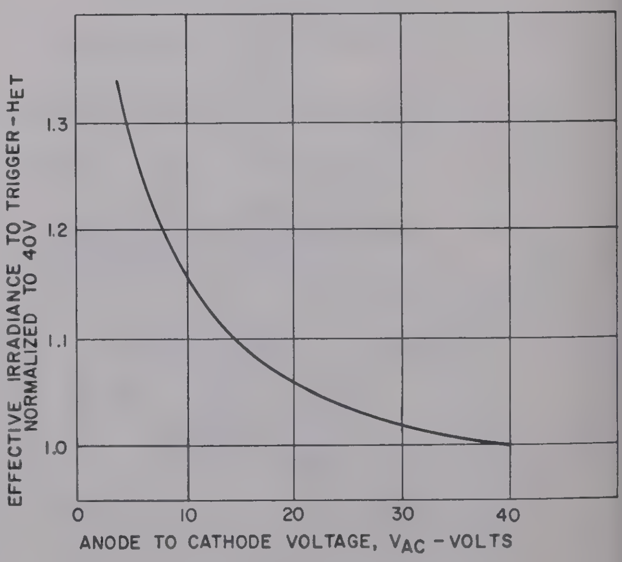
electrical characteristics: (25°C unless otherwise specified)

	Symbol	Min.	Max.		Typical Curves See Fig. #
Cutoff Characteristics (dark)					
Forward Blocking Current					
($R_{GC} = 27\ K\Omega$, $V_{AC} = 40V$)	I_B		1	μA	
($R_{GC} = 27\ K\Omega$, $V_{AC} = 40V$, $T_A = 100°C$)	I_B		20	μA	
Reverse Blocking Current					
($R_{GC} = 27\ K\Omega$, $V_{AC} = 40V$)	I_R		1	μA	
($R_{GC} = 27\ K\Omega$, $V_{AC} = 40V$, $T_A = 100°C$)	I_R		20	μA	
Cathode Gate Reverse Cutoff Current					
($V_{GC} = 5V$)	I_{GC}		20	μA	
Anode Gate Reverse Cutoff Current					
($V_{GA} = 40V$)	I_{GA}		1	μA	
Conducting Characteristics					
Forward Voltage					
($I_A = 175$ mA, $R_{GC} = 27\ K\Omega$)	V_F		2.0	volts	10, 11
($I_A = 175$ mA, $R_{GC} = 27\ K\Omega$, $T_A = -55°C$)	V_F		2.5	volts	
Holding Current					
($R_{GC} = 27\ K\Omega$)	I_H		2	mA	8, 9
($R_{GC} = 27\ K\Omega$, $T_A = -55°C$)	I_H		10	mA	
Triggering Characteristics					
Effective Irradiance to trigger**					
($V_{AC} = 40V$, $R_A = 800\ \Omega$, $R_{GC} = 27\ K\Omega$)	H_{ET}	1.0	10	mW/cm²	3-7, 14
($V_{AC} = 40V$, $R_A = 800\ \Omega$, $R_{GC} = 27\ K\Omega$, $T_A = -55°C$)	H_{ET}		50	mW/cm²	
($V_{AC} = 40V$, $R_A = 800\ \Omega$, $R_{GC} = 27\ K\Omega$, $T_A = 100°C$)	H_{ET}	.3		mW/cm²	
Cathode Gate Current to Trigger					
($R_{GC} = 1\ meg\Omega$, $V_{AC} = 40V$, $R_A = 800\Omega$)	I_{GTC}		10	μA	
($R_{GC} = 1\ meg\Omega$, $V_{AC} = 40V$, $R_A = 800\Omega$, $T_A = -55°C$)	I_{GTC}		100	μA	
Cathode Gate Voltage to Trigger					
($R_{GC} = 27\ K\Omega$, $V_{AC} = 40V$, $R_A = 800\ \Omega$)	V_{GTC}	.4	.65	volts	
($R_{GC} = 27\ K\Omega$, $V_{AC} = 40V$, $R_A = 800\ \Omega$, $T_A = -55°C$)	V_{GTC}		1.0	volts	
($R_{GC} = 27\ K\Omega$, $V_{AC} = 40V$, $R_A = 800\ \Omega$, $T_A = 100°C$)	V_{GTC}	.2		volts	
Transient Characteristics					
Turn on time (Fig. 1)	t_{on}		15	μs	
Recovery time (Fig. 2)	t_{rec}		25	μs	12, 13

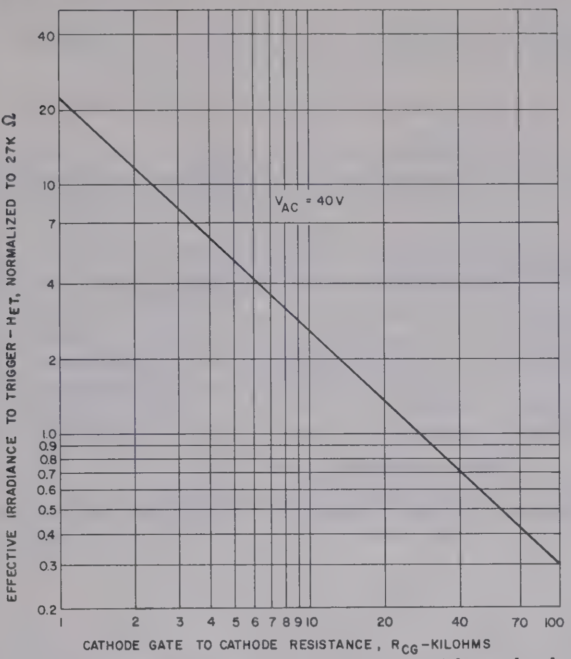
**The effective irradiance (H_E) is the product of the spectral distribution of the light energy (Y_λ) and the spectral distribution of the device sensitivity (H_λ) integrated with respect to wavelength. ($H_E = \int H_\lambda Y_\lambda d\lambda$). Effective irradiance to trigger (H_{ET}) is the effective irradiance necessary to just trigger the device. See Application Note 200.34 for a discussion of these parameters.



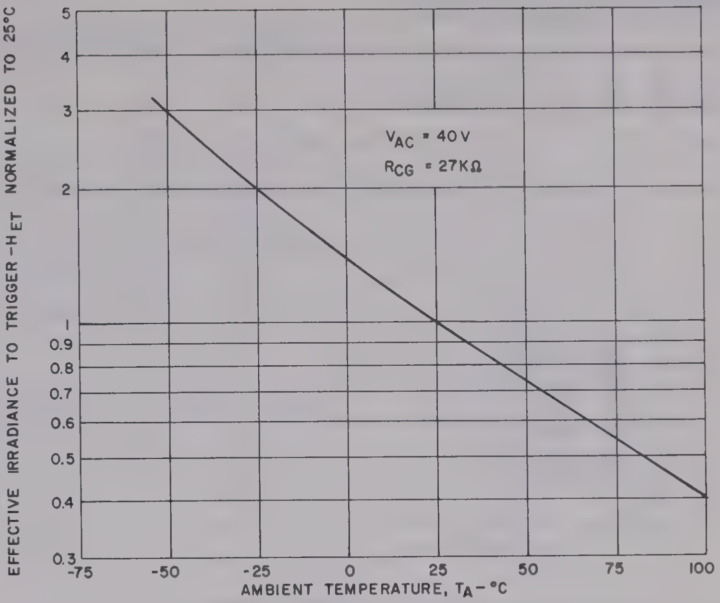
3. Spectral Response



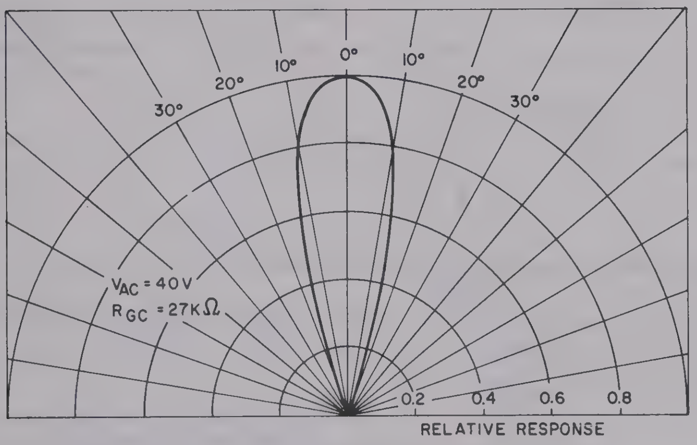
4. Variation in Light Sensitivity with Anode Voltage



5. Variation in Light Sensitivity with Cathode Gate to Cathode Resistance



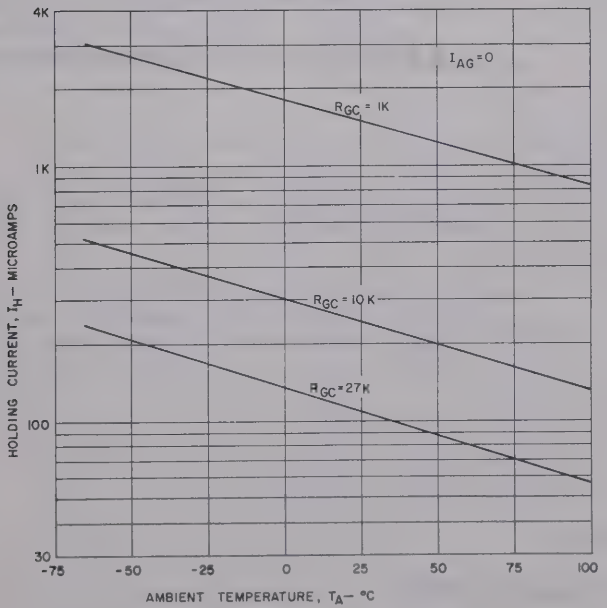
6. Variation in Light Sensitivity with Temperature



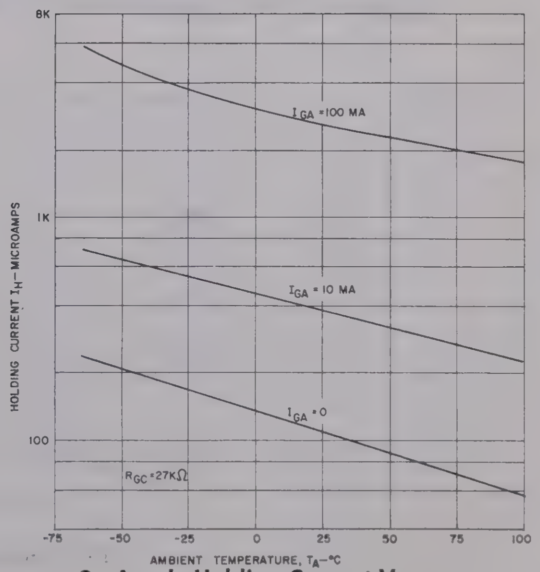
7. Angular Response

Note:

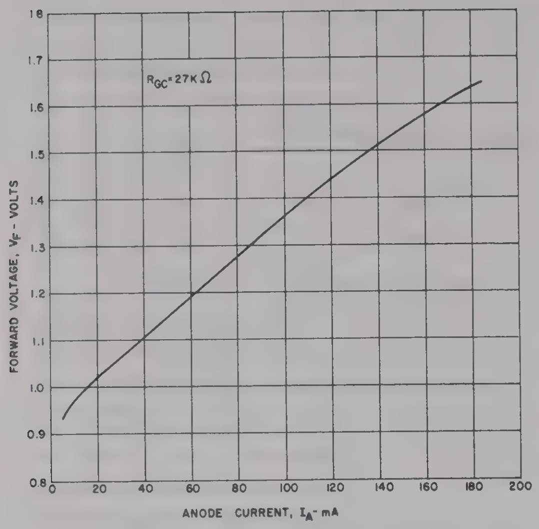
The variation in relative response is due to variations in the angle of incident light. This angle is between the direction of incident light and a line through the center of, and perpendicular to, the top of the LASCS.



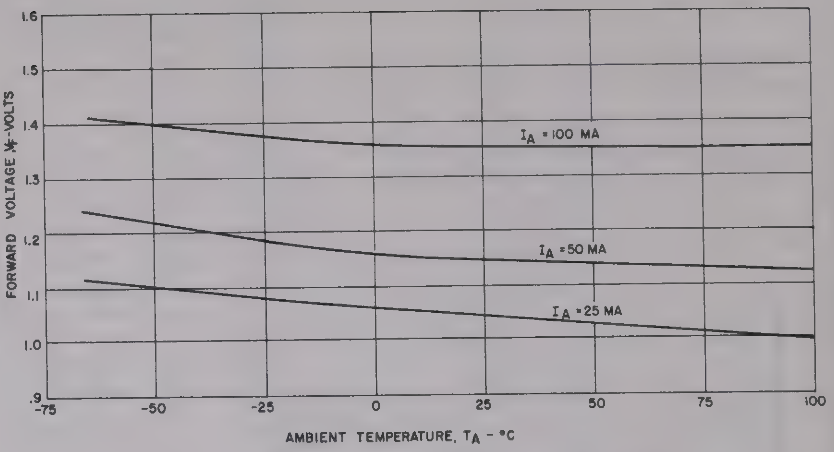
8. Anode Holding Current Versus Ambient Temperature



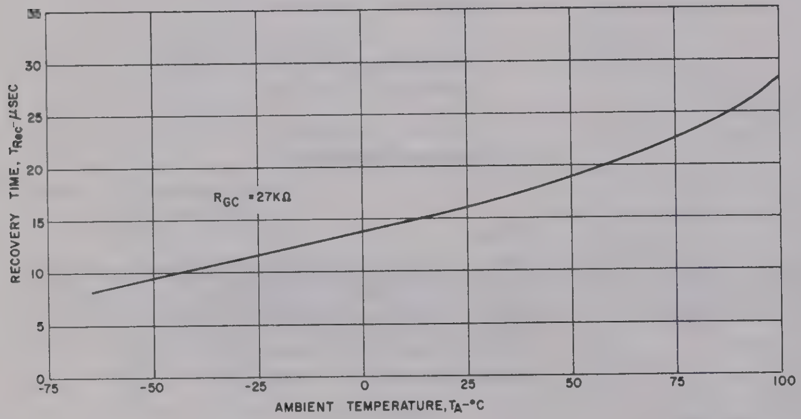
9. Anode Holding Current Versus Ambient Temperature



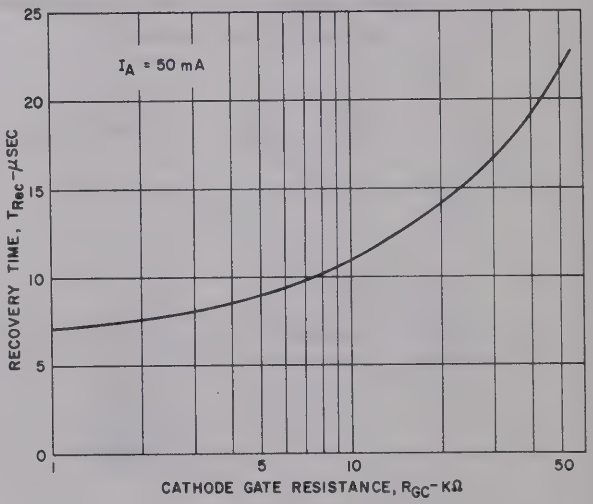
10. Forward Voltage Versus Anode Current



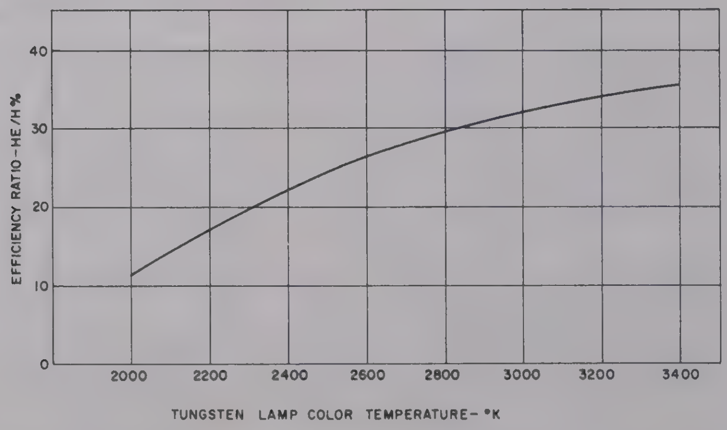
11. Forward Voltage Versus Ambient Temperature



12. Recovery Time Versus Ambient Temperature



13. Recovery Time Versus Cathode Gate Resistance



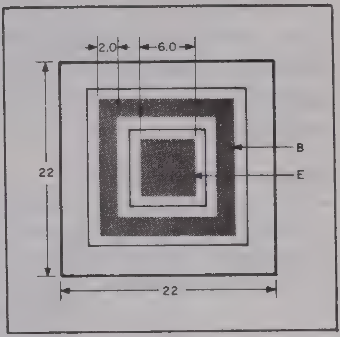
14. Tungsten Lamp Color Temperature Effect

Silicon
Transistor Chips

NPN

M22P2, 3, 4

The General Electric M22P2, 3 & 4 are NPN silicon planar passivated transistor chips designed primarily for general low signal level applications.



General specifications:

- Gold collector contact backing, minimum thickness—3000Å
- Aluminum base and emitter contact metalization
- Maximum conditions for mounting chips—425°C for 5 minutes (Max.) in an inert atmosphere
- Shipping containers: Glass vials sealed with a nitrogen back-fill
  Maximum of 10k chips per vial
  Egg crate containers available at extra cost
- Chip drawing dimensions are in mils
- Chip thickness = 5.4 ±0.9 mils

absolute maximum ratings: ($T_A = 25°C$)

	Symbol	M22P2, 3, 4	
Voltages			
Collector to Base	V_{CBO}	25	V
Collector to Emitter	V_{CEO}	18	V
Emitter to Base	V_{EBO}	5	V
Current			
Collector	I_C	100	mA
Temperature			
Storage	T_{STG}	−65°C to +200°C	
Operating	T_J	−65°C to +200°C	

electrical characteristics: 100% Probe ($T_A = 25°C$)

Tested at outgoing acceptance to a 10% LTPD with a maximum accept number of 3.

	Symbol	M22P2	M22P3	M22P4	
Collector Base Breakdown Voltage ($I_C = .05\ \mu A$)	BV_{CBO}	25	25	25	V
Collector Emitter Breakdown Voltage ($I_C = 10$ mA)	BV_{CEO}	18	18	18	V
Emitter Base Breakdown Voltage ($I_E = 0.5\ \mu A$)	BV_{EBO}	5	5	5	V
Forward Current Transfer Ratio (same as 35.87)	h_{FE}	70-110	110-150	150-200	

specifications: ($T_A = 25°C$)

Product yield is at least 93% to each of the following parameters:

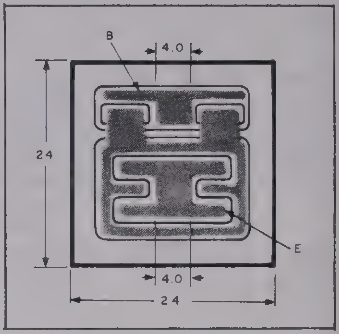
	Symbol	Min.	Max.	
Collector Saturation Voltage ($I_C = 50$ mA, $I_B = 3$ mA)	$V_{CE(SAT)}$	—	1.6	V
Base Saturation Voltage ($I_C = 50$ mA, $I_B = 3$ mA)	$V_{BE(SAT)}$	—	0.9	V
Gain Bandwidth Product ($I_C = 4$ mA, $V_{CB} = 5V$)	f_t	120	200	MHz
Collector Base Capacitance ($V_{cb} = 10V$, $f = 1$ MHz)	C_{cb}	4.5	10	pF

Silicon
Darlington Chips

NPN

M73P1

The General Electric M73P1 is an NPN silicon planar epitaxial passivated monolithic Darlington chip especially suited for preamplifier input stages requiring input impedances of several megohms, or extremely low level, high gain, low noise amplifier applications. This chip can also be used in medium-speed switching control circuits.



General specifications:
- Gold collector contact backing, minimum thickness—3000Å
- Aluminum base and emitter contact metalization
- Maximum conditions for mounting chips—425°C for 5 minutes (Max.) in an inert atmosphere
- Shipping containers: Glass vials sealed with a nitrogen back-fill
  Maximum of 10k chips per vial
  Egg crate containers available at extra cost
- Chip drawing dimensions are in mils
- Chip thickness = $5.4 \, {}^{+0.8}_{-0.9}$ mils

absolute maximum ratings: ($T_A = 25°C$)

	Symbol	M73P1	
Voltages			
Collector to Base	V_{CBO}	18	V
Collector to Emitter	V_{CEO}	12	V
Emitter to Base	V_{EBO}	12	V
Current			
Collector (steady state)	I_C	200	mA
Collector (pulsed)*	I_C	500	mA
Base (steady state)	I_B	50	mA
Temperature			
Storage	T_{STG}	−65°C to +200°C	
Operating	T_J	−65°C to +200°C	

*Pulse conditions: pulse width $\leq 300\ \mu sec$, duty cycle $\leq 2\%$.

electrical characteristics: 100% Probe ($T_A = 25°C$)

Tested at outgoing acceptance to a 10% LTPD with a maximum accept number of 3.

	Symbol	Min.	Max.	
Collector Emitter Breakdown Voltage ($I_C = 10$ mA)	BV_{CEO}	12	—	V
Emitter Cutoff Current ($V_{EB} = 13V$)	I_{EBO}	—	100	nA
Collector Cutoff Current ($V_{CB} = 20V$)	I_{CBO}	—	100	nA
Forward Current Transfer Ratio ($I_C = 2$ mA, $V_{CE} = 5V$)	h_{FE}	3K	—	

specifications: ($T_A = 25°C$)

Product yield is at least 93% to each of the following parameters:

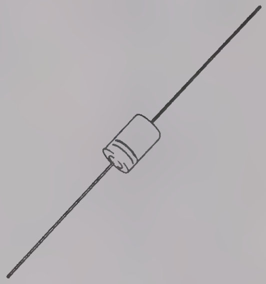
	Symbol	Min.	Max.	
Forward Current Transfer Ratio ($I_C = 100$ mA, $V_{CE} = 5V$)	h_{FE}	6K	—	
Collector Saturation Voltage ($I_C = 200$ mA, $I_B = 0.2$ mA)	$V_{CE(SAT)}$	—	1.4	V
Base Saturation Voltage ($I_C = 200$ mA, $I_B = 0.2$ mA)	$V_{BE(SAT)}$	—	1.6	V
Forward Current Transfer Ratio ($I_C = 2$ mA, $V_{CE} = 5V$, f = 10 MHz)	$\lvert h_{fe} \rvert$	15.6	—	dB
Gain Bandwidth Product ($I_C = 2$ mA, $V_{CE} = 5V$, f = 10 MHz)	f_t	60	—	MHz
Input Impedance ($I_C = 2$ mA, $V_{CE} = 5V$, f = 1 KHz)	h_{ie}	40K	—	Ohms
Collector Base Capacitance $V_{CB} = 10V$, f = 1 MHz)	C_{cb}	—	10	pF

Silicon Diodes

MA1701,2,3,4

This family of General Electric Milli-Heatsink Diodes are very high speed switching diodes for computer circuits and general purpose applications. These diodes incorporate an oxide passivated epitaxial pellet with a raised solid silicon anode contact.

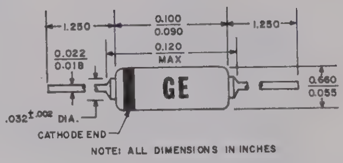
These MA-series diodes *exceed* the electrical and mechanical requirements of the following JEDEC devices:



MA1701		MA1702	MA1703
1N914	1N4153	1N4151	1N4152
1N914A	1N4154	1N4152	1N4154
1N916	1N4446	1N4153	1N4727
1N916A	1N4447	1N4154	
1N4148	1N4448	1N4454	
1N4149	1N4454	1N4727	
1N4151	1N4727		
1N4152			

Standard Cathode Band and Body Marking Colors:

MA1701 — Violet
MA1702 — Yellow
MA1703 — Green
MA1704 — Black
Body marking will consist *only* of the GE symbol



NOTE: ALL DIMENSIONS IN INCHES

absolute maximum ratings: (25°C)

		MA1701	MA1702	MA1703	MA1704	
Voltage						
Reverse	V_R	100	75	40	25	Volts
Current						
Average Rectified	I_o	← 200 →				mA
Recurrent Peak Forward	I_{FRM}	← 600 →				mA
Forward Steady State D-C	I_F	← 150 →				mA
Peak Forward Surge (1μsec)	I_{FSM}	← 4 →				Amps
Derate above 25°C		← 1.1 →				mA/°C
Temperature						
Operating	T_J	← −65 to +175 →				°C
Storage	T_{STG}	← −65 to +200 →				°C

Power Dissipation

Heatsink Spacing From End of Diode Body	Power Dissipation at 25°C/mW⁽¹⁾	Steady State Thermal Resistance (°C/mW)
0.125 inches	700	0.230
0.250 inches	550	0.319
0.500 inches	460	0.438

Note 1: The maximum power dissipation is defined as the heat dissipating capability of the diode when operated at 25°C as an AC signal device within the absolute maximum voltage and current ratings specified above. The power rating is based on a maximum junction temperature of 200°C. The steady state thermal resistance (°C/mW) can be used to calculate the power dissipating capabilities, within the maximum voltage and current ratings, at temperatures other than 25°C.

MA1701,2,3,4

electrical characteristics: (25°C) (unless otherwise specified)

		MA1701		MA1702		MA1703		MA1704		
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Forward Voltage	V_F									
($I_F = 0.100$mA)		0.490	0.550	0.490	0.550	0.490	0.550	0.460	0.570	Volts
($I_F = 1.0$ mA)		0.590	0.650	0.590	0.650	0.590	0.650	0.570	0.680	Volts
($I_F = 10$ mA)		0.700	0.810	0.700	0.810	0.700	0.810	0.680	0.850	Volts
($I_F = 30$ mA) (2)		0.780	0.930	0.780	0.930	0.780	0.930	0.740	1.00	Volts
($I_F = 50$ mA) (2)		0.830	1.00	0.830	1.00	0.830	1.00	0.770	1.10	Volts
($I_F = 100$ mA) (2)		0.935	1.10	0.935	1.10	0.935	1.10	0.820	1.30	Volts
Reverse Current	I_R									
($V_R = 15$ Volts)									50	nA
($V_R = 20$ Volts)									100	nA
($V_R = 30$ Volts)			30		30		50			nA
($V_R = 30$ Volts, $T_A = 150$°C)			30		30		50			μA
($V_R = 50$ Volts)			50		50					nA
($V_R = 50$ Volts, $T_A = 150$°C)			50		50					μA
($V_R = 75$ Volts)			5							μA
Breakdown Voltage	$V_{(BR)R}$									
($I_R = 5\mu$A)				75		40		25		Volts
($I_R = 100\mu$A)		100								Volts
Stored Charge	Q_S									
($I_F = 10$mA) (3)			40		40		40		40	pC
Peak Forward Voltage	V_{FM}									
($I_F = 50$mA, $t_r = 10$nsec) (4)			3.0		2.75		1.75		1.75	Volts
Capacitance	C_O									
($V_R = 0$V, f = 1MHz, Signal Level = 50mV) (5)			1.0		1.0		2.0		3.0	pF

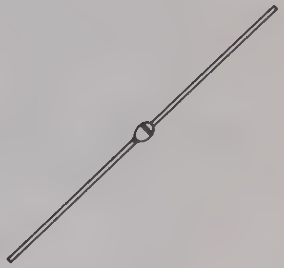
Note 2: Pulsed measurement with pulse width $\leq 350\mu$sec, duty cycle $\leq 2\%$.
Note 3: Test method per JEDEC suggested standard number for direct measurement of diode stored charge, B-Line Electronics Corporation stored charge meter Model QS-3 or equivalent.
Note 4: Measured per EIA Standard RS-286.
Note 5: Capacitance as measured on Boonton Electronics Model 75A Capacitance Bridge (or equivalent).

Multiple Pellet
Rectifier

1.0 Amp   1000-1500 Volts

MPR10
MPR12
MPR15

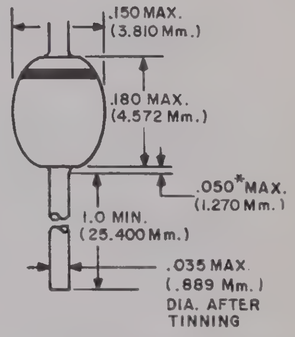
THE GENERAL ELECTRIC MPR SERIES ARE AXIAL LEADED, GENERAL PURPOSE RECTIFIERS. DUAL HEATSINK CONSTRUCTION AND TWO METALLURGICALLY BONDED PELLETS HAVE BEEN COMBINED TO PROVIDE A HIGH VOLTAGE OPERATING CAPABILITY AT CURRENT RATINGS USEFUL IN MANY APPLICATIONS.



absolute maximum ratings: (25°C unless otherwise specified)

	MPR10	MPR12	MPR15	
Reverse Voltage (−65 to +175°C T_J)				
Working Peak, V_{RM}(WKG)	1000	1200	1500	Volts
Repetitive Peak, V_{RM}(REP)	1000	1200	1500	Volts
DC, VR	1000	1200	1500	Volts
Average Forward Current, I_O				
75° C Ambient—see rating curves	←	1.0	→	Amps
Peak Surge Forward Current				
I_{FM} (surge) non-repetitive				
.0083 sec half sine wave				
Full load JEDEC method	←	25	→	Amps
No load 25°C	←	30	→	Amps
Peak Surge Forward Current				
Non-repetitive .001 sec				
Half sine wave				
Full load 175°C T_J	←	80	→	Amps
Junction Operating and Storage				
Temperature Range	←	−65 to +175°C	→	
I^2T, RMS for fusing .001 to .01 sec	←	3	→	Amp²sec
Peak Non-Repetitive Reverse				
Power Rating				
20μsec half sine wave at max T_J	←	600	→	Watts

Mounting: Any position. Lead temperature 290°C maximum to ⅛″ from body for 5 seconds maximum during mounting.

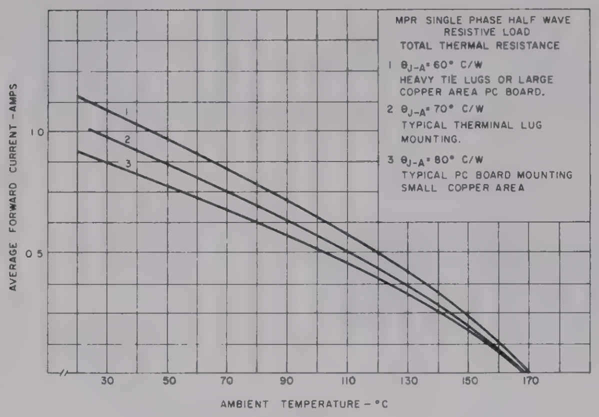


ALL DIMENTIONS ARE IN INCHES AND (METRIC)
*WELD AND SOLDER FLASH NOT CONTROLLED IN THIS AREA

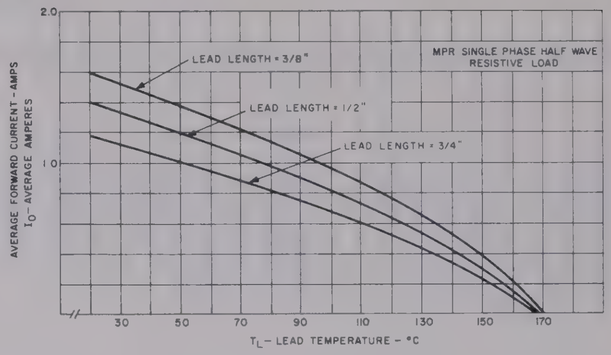
electrical characteristics:

	MPR10	MPR12	MPR15	
Maximum Forward Voltage Drop				
$I_F = 0.5A$, $T_A = 25°C$	←	1.9	→	Volts
Maximum Reverse Current, I_R				
at rated VR				
$T_J = 25°C$	←	5	→	μA
$T_J = 175°C$	200	200	150	μA
Typical I_R @ 25° C	←	1.0	→	μA
Typical Reverse Recovery Time, T_{RR}	←	2.5	→	μsec
Maximum Reverse Recovery Time, T_{RR}	←	5.0	→	μsec
Recovery Circuit Per MIL-S-19500/286B				

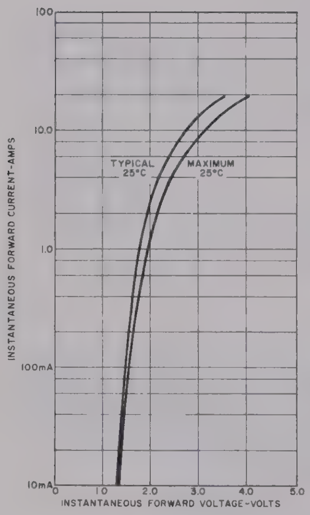
CIRCUIT DESIGN INFORMATION
MAXIMUM ALLOWABLE DC OUTPUT CURRENT RATINGS
SINGLE PHASE, RESISTIVE AND INDUCTIVE LOADS



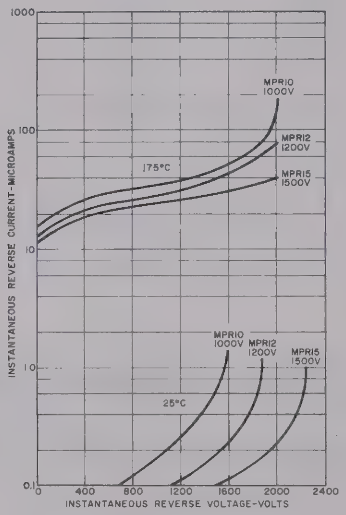
AMBIENT OPERATION



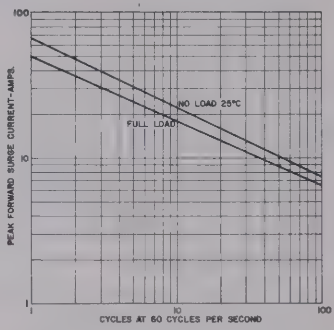
TIE POINT OPERATION



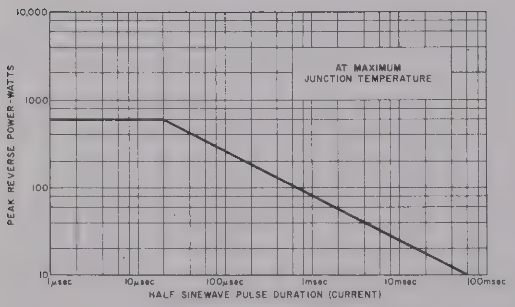
FORWARD CHARACTERISTICS



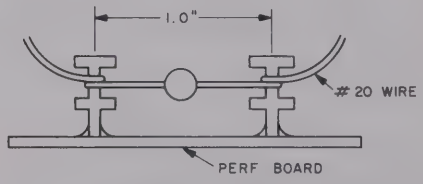
REVERSE CHARACTERISTICS



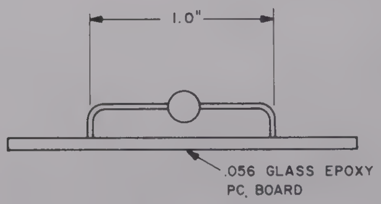
MAXIMUM NON-REPETITIVE MULTICYCLE FORWARD SINGLE CURRENT



MAXIMUM NON-REPETITIVE AVALANCHE SURGE POWER


1.0"
# 20 WIRE
PERF BOARD

TYPICAL TIE LUG MOUNTS


1.0"
.056 GLASS EPOXY
PC. BOARD

TYPICAL PC BOARD MOUNTING

Silicon
Transistors

NPN/NP

RA-1,2,3,A,B,C

The General Electric types RA-1, RA-2 and RA-3 are Reference Amplifiers designed for applications in power supplies where they can serve the dual function of a voltage reference element and an error voltage amplifier. They are integrated devices comprised of a Zener diode and a NPN transistor in a single pellet. Cancellation of temperature coefficients between the Zener diode and the transistor result in a transfer characteristic having a very low net temperature coefficient. Temperature differentials between the Zener diode and the transistor are minimized owing to the integrated structure with a consequent reduction in the transient variation and long term drift of the reference voltage.

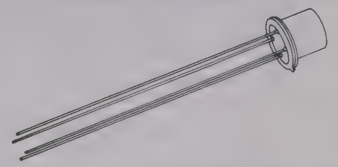
These transistors are grown junction devices manufactured in the fixed-bed mounting design for extremely high mechanical reliability under severe conditions of mechanical and thermal shock. For electrical reliability and parameter stability all transistors are subjected to a minimum 160 hours 200°C aging operation included in the manufacturing process.

USES:

- ► Super stable difference amplifiers
- ► Ultra stable power supplies
- ► Low cost power supplies

FEATURES:

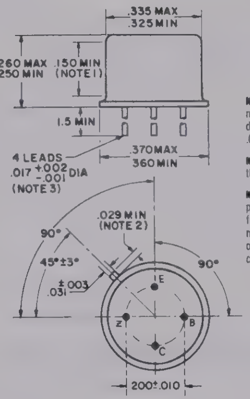
- ► Operation with no Zener bias
- ► Integrated structure with isolated case
- ► Guaranteed low temperature coefficient
- ► Wide operating temperature range



absolute maximum ratings: (25°C) (unless otherwise specified)

		RA-1 RA-1A RA-1B RA-1C	RA-2 RA-2A RA-2B	RA-3 RA-3A RA-3B	
Voltage					
Collector to Emitter	V_{CEO}	45	45	60	volts
Current					
Total Zener, (150°C or less)		6	6	6	ma
Collector	I_C	10	10	10	ma
Dissipation					
Total Power, (Free air 25°C)*	P_t	250	250	250	mw
Temperature					
Storage	T_{STG}	←—55 to +150—→			°C

*Derate 2.0 mw/°C increase in ambient temperature above 25°C.



DIMENSIONS WITHIN
JEDEC OUTLINE
TO-12

NOTE 1: This zone is controlled for automatic handling. The variation in actual diameter within this zone shall not exceed .010

NOTE 2: Measured from max. diameter of the actual device

NOTE 3: The specified lead diameter applies in the zone between .050 and .250 from the base seat. Between .250 and .5 maximum of .021 diameter is held. Outside of these zones the lead diameter is not controlled

electrical characteristics: (25°C) (unless otherwise specified)

	CIRCUIT CHARACTERISTICS*					TRANSISTOR CHARACTERISTICS					
	V_{CB} = 3 volts, I_C = 0.5 ma, I_Z = 0, R_B = 1 K					V_{CE}=3V, I_C=.5 ma		V_{CB} = 30V		V_{CB} = 45V	
	Temperature		V_{REF} (Volts)		Minimum Trans-conductance (μMHO) G_{MC}	h_{FE}		I_{CBO} (μa)		I_{CBO} (μa)	
Type	Coeff. %/°C	Range °C	Min.	Max.		Min.	Max.	Typ.	Max.	Typ.	Max.
RA1	.02	0 to 70	6.3	7.7	3,000	10	120	.004	1.0		
RA1A	.005										
RA1B	.002										
RA1C	.001										
RA2	.02	−55 to +150	6.65	7.35	6,000	40	120	.004	0.1		
RA2A	.005										
RA2B	.002										
	V_{CB} = 3 volts, I_C = 0.1 ma, I_Z = 5 ma, R_B = 1 K					V_{CE}=3V, I_C=.1 ma					
RA3	.02	−55 to +150	6.65	7.35	2,000	30	90			.006	0.1
RA3A	.005										
RA3B	.002										

*See test circuit Figure 2.

DEFINITIONS:

1. Base Source Resistance (R_B)

The base source resistance is the equivalent circuit resistance as seen by the base of the Reference Amplifier. In a regulated power supply this resistance corresponds to the Thevenin equivalent resistance of the resistance divider connected to the base of the reference amplifier.

2. Circuit Transconductance (G_{MC})

The circuit transconductance is the small signal ratio of collector current to reference voltage when the Reference Amplifier is biased under the specified conditions. The circuit transconductance includes the effects of base source resistance and Zener impedance and represents the error signal resulting at the collector for a small change in the reference voltage. It is thus of prime importance in the design of power supplies.

3. Reference Voltage (V_{ref})

The reference voltage is the base source voltage of the Reference Amplifier when it is biased under the specified conditions. In the design of a power supply this voltage represents the Thevenin equivalent voltage at the center of the output voltage divider. For a well designed supply, in which the temperature stability is determined primarily by the temperature stability of the Reference Amplifier, the percentage change in the output voltage of the supply will be equal to the percentage change in the reference voltage.

4. Temperature Coefficient

The temperature coefficient of the Reference Amplifier is determined by the equation:

$$\text{temperature coefficient } (\%/^\circ\text{C}) = \frac{V_{ref}(T_1) - V_{ref}(25C)}{V_{ref}(25C) \quad T_1 - 25C} \text{ X } 100\%$$

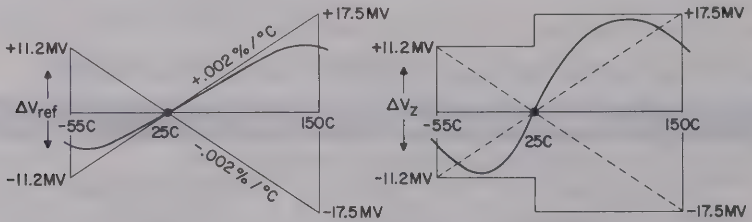
where $V_{ref}(T_1)$ is the reference voltage at temperature T_1 and V_{ref} (25C) is the reference voltage at 25C. The temperature coefficient of the Reference Amplifier as defined above shall not exceed the specified maximum value at any temperature over the entire operating temperature range. This definition is illustrated in Figure 1A together with a curve of $\triangle V_{ref}$ versus temperature for a typical unit. Note that the curve must lie entirely within the triangular areas to satisfy the specifications for the RA2B.

In contrast, the common method of specifying the temperature coefficient of a compensated Zener diode is to determine the voltage variation at each temperature extreme equivalent to the specified temperature coefficient and to guarantee only that this voltage variation will not be exceeded at temperatures between 25C and the temperature extreme. This definition is illustrated in Figure 1B together with a curve of $\triangle V_z$ versus temperature for a typical unit. Note that although the temperature range and maximum temperature coefficient is the same as for the Reference Amplifier in Figure 2A, the voltage variation is considerably higher for the Zener, particularly for temperatures in the vicinity of 25C.

The temperature coefficient specification applies only when the biasing conditions are identical to those given in the specification. Increasing the collector current or the bias current will tend to make the temperature coefficient more positive.

5. Zener Current (I_z)

The Zener current is defined as the current flowing into the terminal connected to the Zener diode cathode and the emitter of the transistor. The total current flowing through the Zener diode is the sum of I_z, the collector current, and the base current.



(A) (B)

FIGURE 1

TEST CIRCUIT:

The test circuit shown in Figure 2 is used to measure the temperature coefficient of the Reference Amplifier. This circuit is in effect a simple regulated power supply which automatically maintains the bias conditions constant while the Reference Amplifier is heated and cooled. Transistors Q_1 and Q_2 serve as constant current sources to regulate the collector current and the Zener current respectively to the Reference Amplifier. Variable resistors R_1 and R_2 are used to set the exact values of these currents. Potentiometer R_3 is used to set the collector to base voltage of the Reference Amplifier. The Reference Amplifier is heated or cooled separately from the test circuit while reading the reference voltage, V_{ref}, on an accurate differential voltmeter (Fluke or Keithley 660).

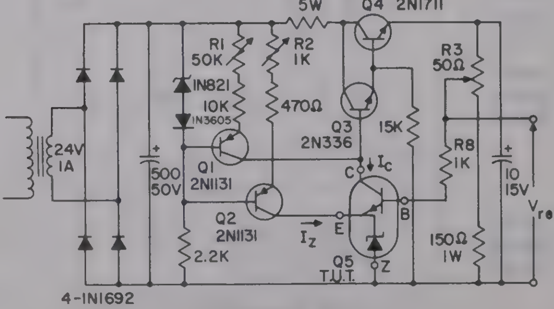


FIGURE 2

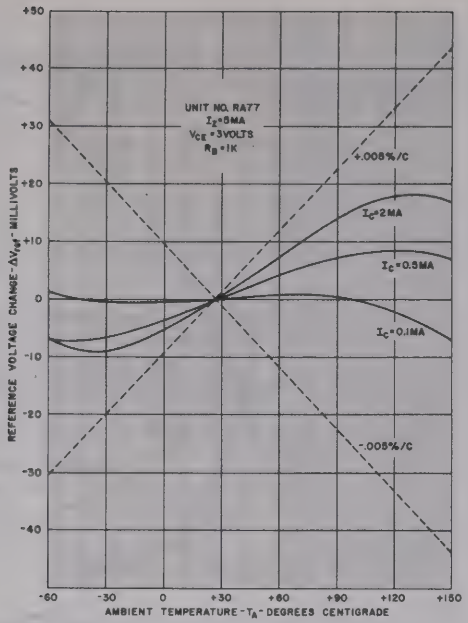


FIGURE 3

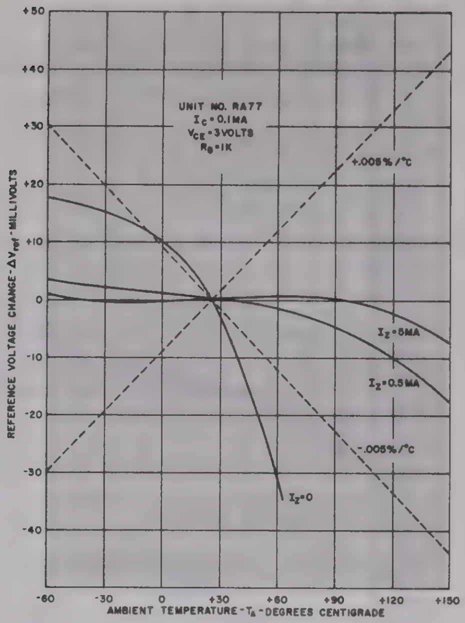


FIGURE 4

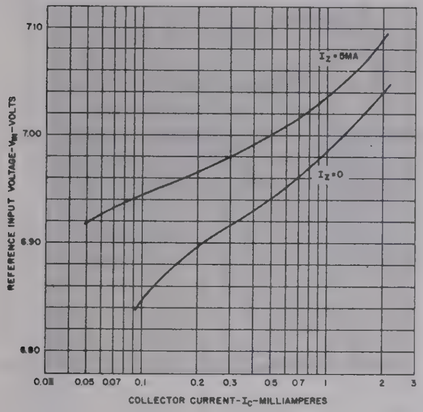


FIGURE 5

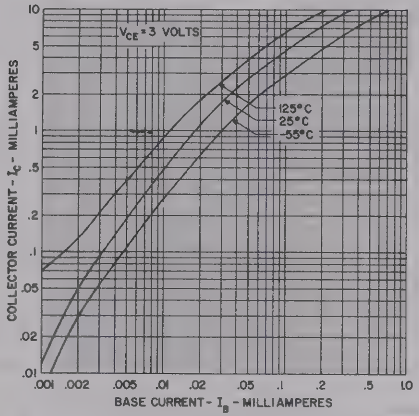


FIGURE 6

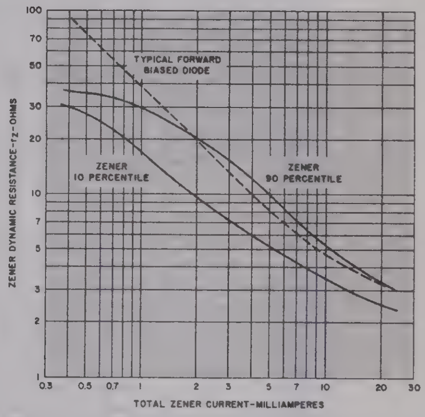


FIGURE 7

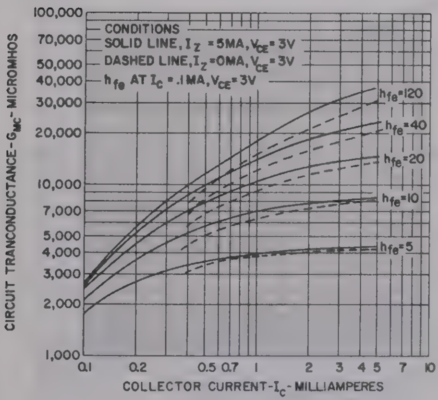


FIGURE 8

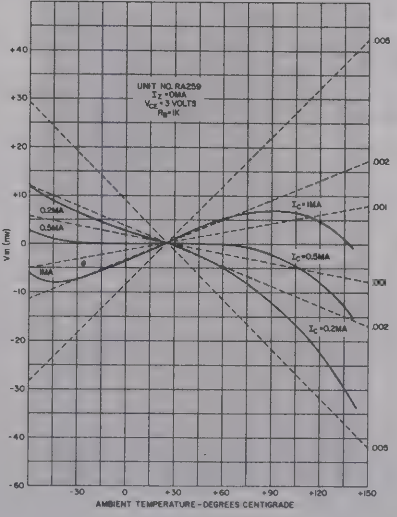


FIGURE 8A

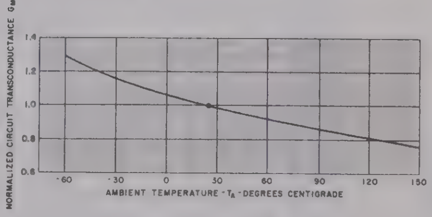


FIGURE 8B

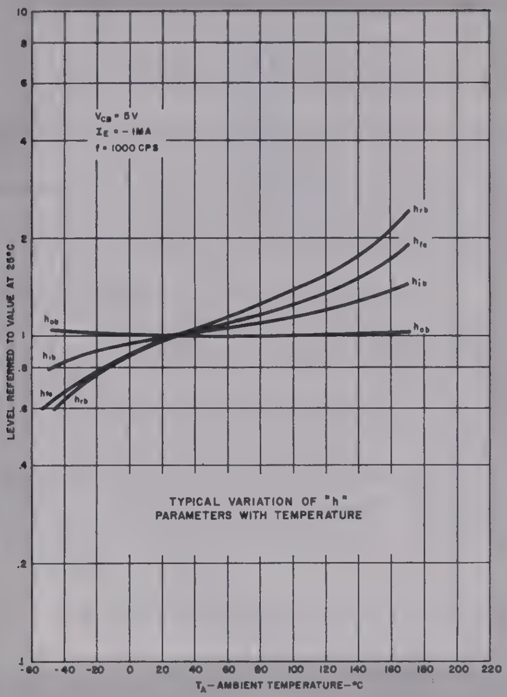


FIGURE 9

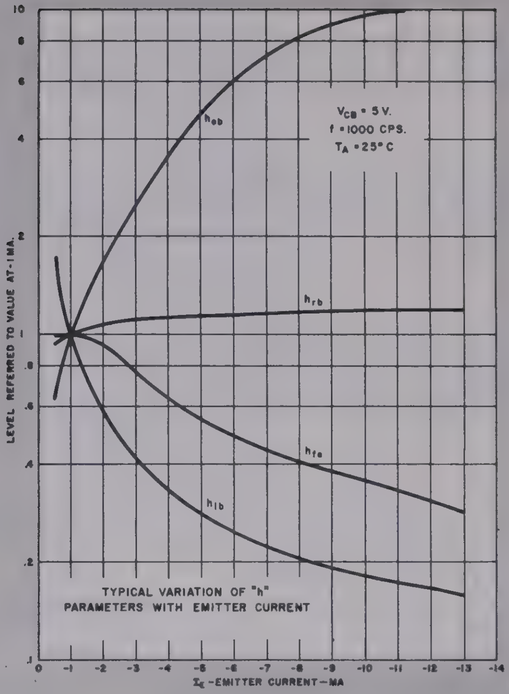


FIGURE 10

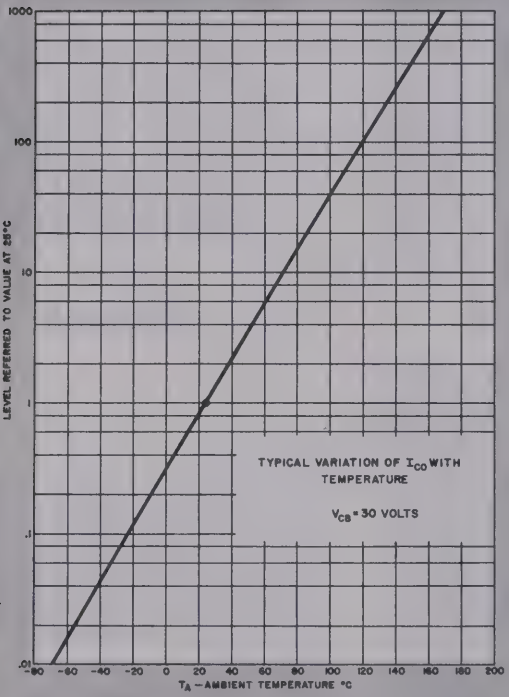


FIGURE 11

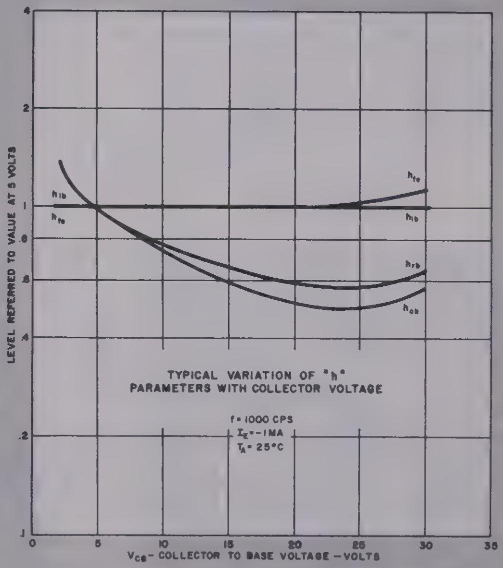


FIGURE 12

TYPICAL H PARAMETERS OF TRANSISTOR PORTION OF REFERENCE AMPLIFIER

$T_A = 25°C$, $I_E = -1$ ma, $V_{CB} = 5V$, $f = 1$ KC

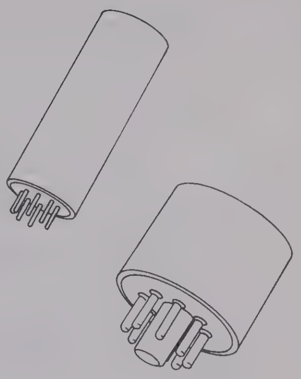
$h_{fe} = 65$
$h_{ie} = 2600$ ohms
$h_{oe} = 7.5$ umhos
$h_{re} = 1.7 \times 10^{-4}$

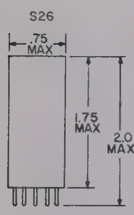
$h_{ib} = 40$ ohms
$h_{ob} = .14$ umhos
$h_{rb} = 1.2 \times 10^{-4}$
$f_{hfb} = 14$ mc

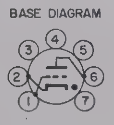
Solid State
Thyratron

S26,7

- Solid State Tyratron Assembly Featuring the Latest Technology in Semiconductors
- S26 is Direct Replacement for 2D21 in Many Applications*
- S27 is Direct Replacement for 2050 Tube in Many Applications*
- Improved Reliability—Designed to Provide Years of dependable Operation . . . Eliminates Costly Downtime.
- No Time Delay Before Operating . . . Eliminates Filament Power Requirements
- Cooler Operation
- Greater Efficiency . . . Low Voltage Drop
- Rugged Non-Fragile Construction . . . Less Sensitive to Vibration





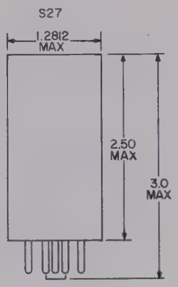


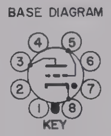
TERMINAL CONNECTIONS
PIN 1 - CONTROL GRID
PIN 2 - CATHODE
PIN 6 - ANODE
ALL OTHERS-NO CONNECTION

BASE-E7-1, MINATURE 7-PIN

MOUNTING POSITION-ANY PLANE

DIMENSIONS IN INCHES





TERMINAL CONNECTIONS
PIN 3 - ANODE
PIN 5 - CONTROL GRID
PIN 8 - CATHODE
ALL OTHERS-NO CONNECTION

BASE-B8-1, INTERMEDIATE-SHELL OCTAL BASE

MOUNTING POSITION-ANY PLANE

DIMENSIONS IN INCHES

MAXIMUM ALLOWABLE RATINGS (Ratings Apply to Free Convection Cooling)

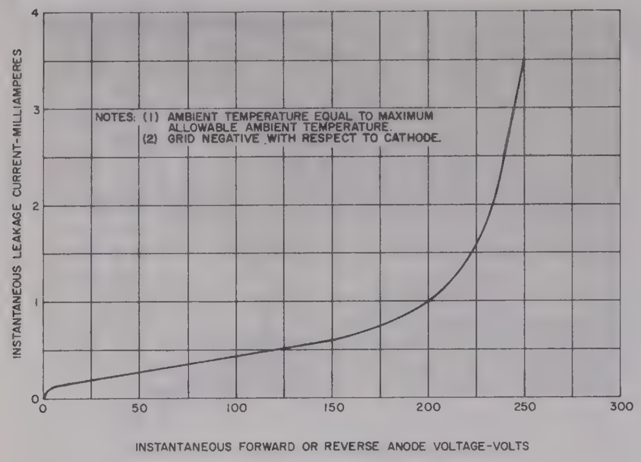
Peak Anode Voltage (Note 1) — Reverse (Inverse)	200 Volts
Forward	200 Volts
Cathode Current — Rms	1 Amp
Average (Frequency 50-400 cps)	See Charts 4, 5, 6, & 7
Fault (Half Sine Wave)	15 Amps Peak for .0083 seconds; 3 Amps Peak for 0.1 seconds.
Negative Control Grid Voltage (Note 2) — Before Conduction	50 Volts
During Conduction	10 Volts
Positive Control Grid Current — Anode Postive	10 ma Peak 5 ma Average
Anode Negative	10 ma Peak (See Charts 5 & 7)
Ambient Temperature Limits	−20°C to +90°C

CHARACTERISTICS

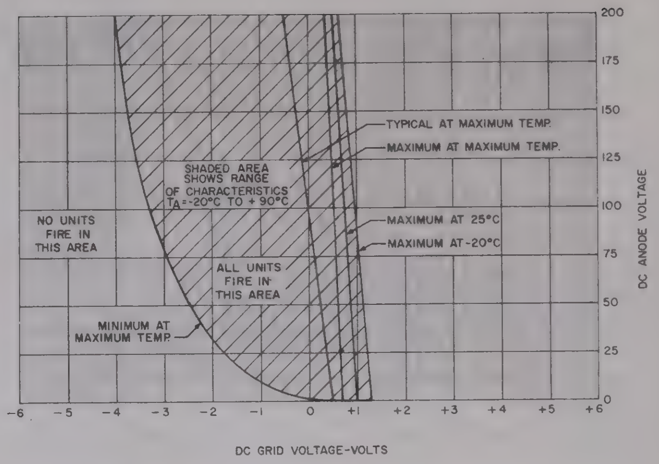
Control Grid Voltage to Fire (Note 2)	See Chart 2
Max. Control Grid Current Required to Fire (Note 2) — At 25°C	20 μamps
At −20°C	30 μamps
Rate of Application of Forward Blocking Voltage	See Chart 3
Typical Deionization Time (Turn Off Time) $E_{bb} = 125$ Volts, $I_b = 0.1$ Ampere, $E_{cc1} = -10$ Volts, $dv/dt = 20$ Volts/μsec	20 μsec
Typical Anode Voltage Drop, $I_b = 0.1$ Ampere	1 Volt
Typical Interelectrode Capacitance — Grid to Anode	50 $\mu\mu$fd
Grid to Cathode	200 $\mu\mu$fd
Typical Control Grid Internal Impedance	10 K ohms
Typical Blocking Leakage Currents (See Chart 1)	
At 200v Reverse	1ma
At 200v Forward	1 ma

WARNING

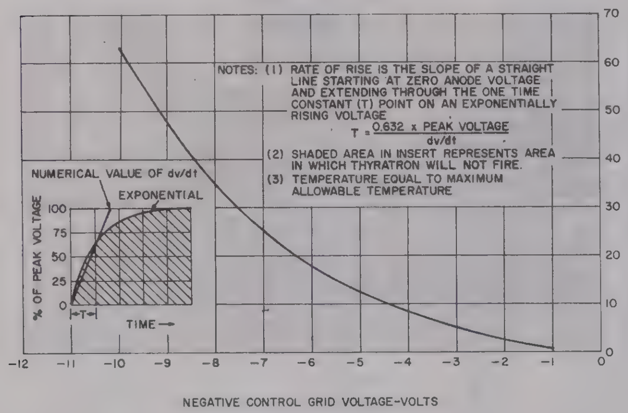
*These solid state thyratrons are *not* direct replacements in all gaseous thyratron sockets. Misapplication of these products could cause bodily injury or equipment damage. Before putting these devices into your equipment or circuit, please read carefully GE application note, *Solid State Thyratrons* Publication No. 200.36. For additional information, contact your local General Electric Rectifier Components Department Sales Office.



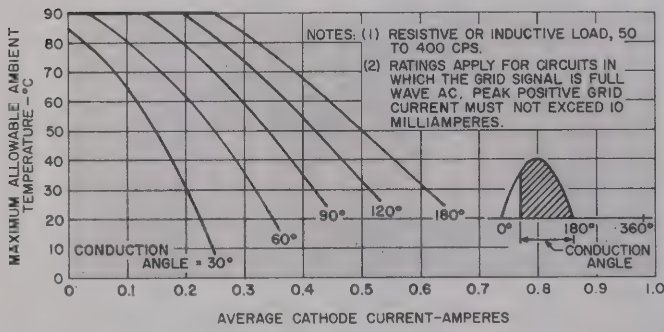
1. S26 AND S27 TYPICAL FORWARD AND REVERSE BLOCKING CHARACTERISTICS



2. S26 AND S27 GRID CONTROL CHARACTERISTICS



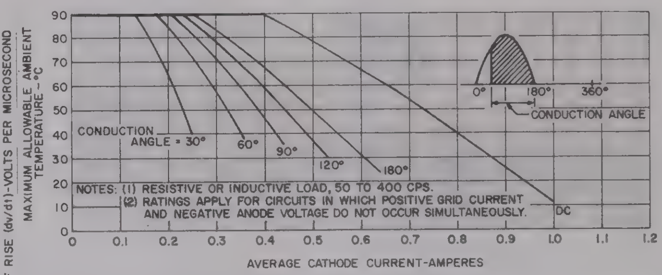
3. S26 AND S27 TYPICAL RATE OF RISE (DV/DT) OF ANODE VOLTAGE THAT WILL NOT FIRE THE SOLID STATE THYRATRON



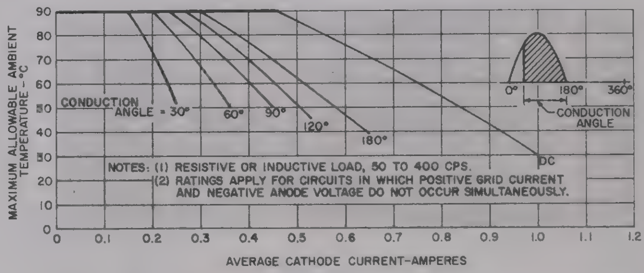
5. S26 MAXIMUM ALLOWABLE AMBIENT TEMPERATURE VERSUS AVERAGE CATHODE CURRENT

NOTES

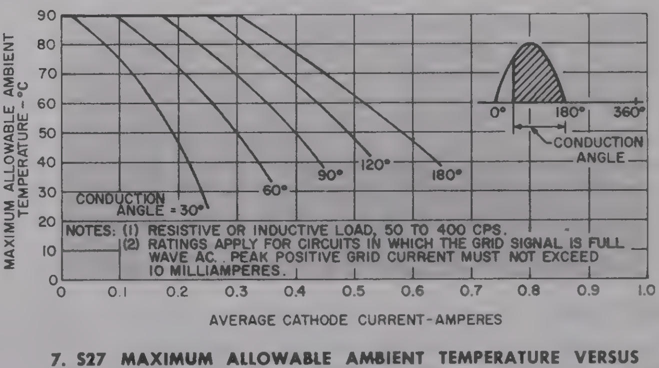
1. The solid state thyratron assembly is self protected against usual voltage transients. This protection causes increased leakage current at higher voltages (see Chart I). Higher voltage or lower leakage types are available upon special request.
2. The control grid voltage is the actual voltage appearing at the control grid pin. Since the internal input impedance between the control grid and cathode pins of the solid state thyratron assembly is only about 10 k ohms, and the impedance of the external thyratron grid supply is much higher than 10 k ohms, the voltage at the grid pin will normally be much less than the open circuit grid supply voltage due to the loading effect of the solid state thyratron assembly.



4. S26 MAXIMUM ALLOWABLE AMBIENT TEMPERATURE VERSUS AVERAGE CATHODE CURRENT

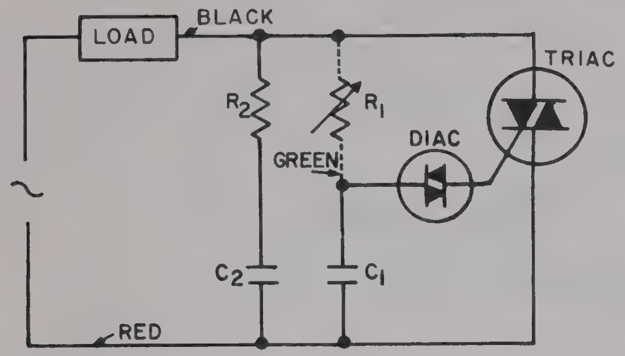


6. S27 MAXIMUM ALLOWABLE AMBIENT TEMPERATURE VERSUS AVERAGE CATHODE CURRENT



7. S27 MAXIMUM ALLOWABLE AMBIENT TEMPERATURE VERSUS AVERAGE CATHODE CURRENT

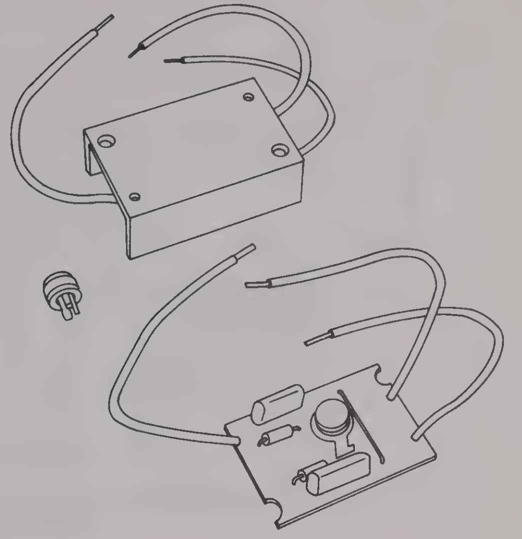
BASIC VARIABLE VOLTAGE CONTROL



S100A1-4 BASIC VARIABLE VOLTAGE ASSEMBLY

NOTE: For 120V RMS units use
$R_1 = 250{,}000$ ohms, 2 watts

For 240V RMS units use
$R_1 = 500{,}000$ ohms, 2 watts



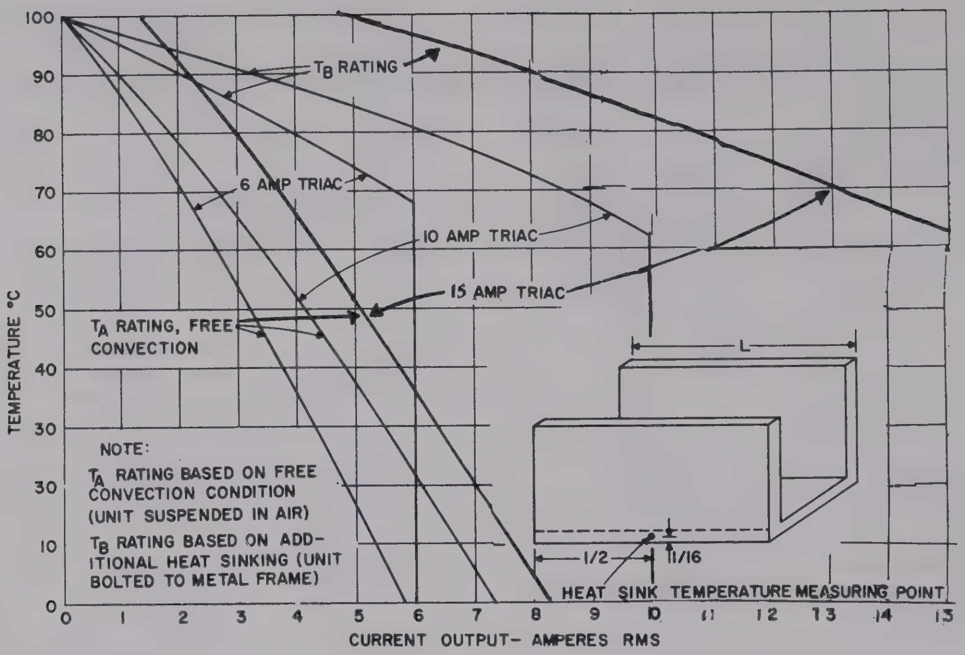
SUGGESTED USES: The basic circuit may be used in a wide variety of applications where the ability to vary applied voltage is desired. Examples of this type of application include resistance heat control, shaded pole or permanent-split capacitor type motor speed control, series-universal type motor speed control, incandescent lamp dimming, etc.

DESCRIPTION: All forms of this sub-assembly consist of a TRIAC (a-c semiconductor switch), a DIAC (bi-directional trigger diode) and a timing capacitor, mounted on a printed circuit board and equipped with an extruded aluminum heat sink. The potentiometer (R_1) shown in the above circuit is *not* included in this assembly since it will normally be located remotely. All current carrying components are electrically isolated from the heat sink allowing it to be bolted directly to the metal frame of the equipment being controlled. The TRIAC protects itself against damage from transient voltage surges by turning on during the half cycle during which the transient occurs. This particular assembly does *not* include radio frequency interference (RFI) suppression but it does include an R-C network to suppress erratic firing of the TRIAC due to dv/dt phenomena. The RFI suppression feature can be obtained by using the S100F1 through S100F4 assembly group.

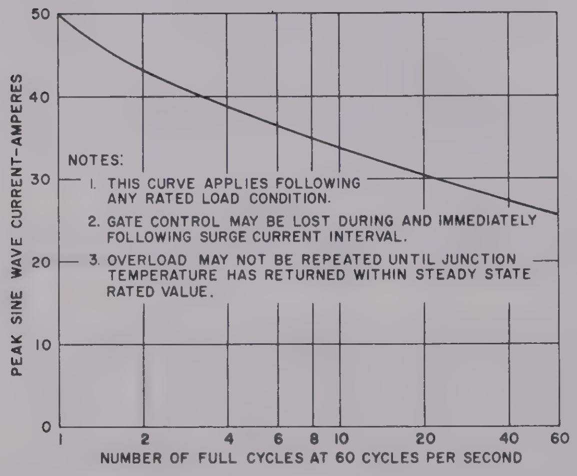
RATING: This sub-assembly is available with either 6 amp, 10 amp or 15 amp TRIACS for use in 120 or 240 volts. (RMS) a-c circuits:

MODEL S100A1	6 amp 120 VRMS	MODEL S100A2	6 amp 240 VRMS
MODEL S100A3	10 amp 120 VRMS	MODEL S100A4	10 amp 240 VRMS
MODEL S100A5	15 amp 120 VRMS	MODEL S100A6	15 amp 240 VRMS

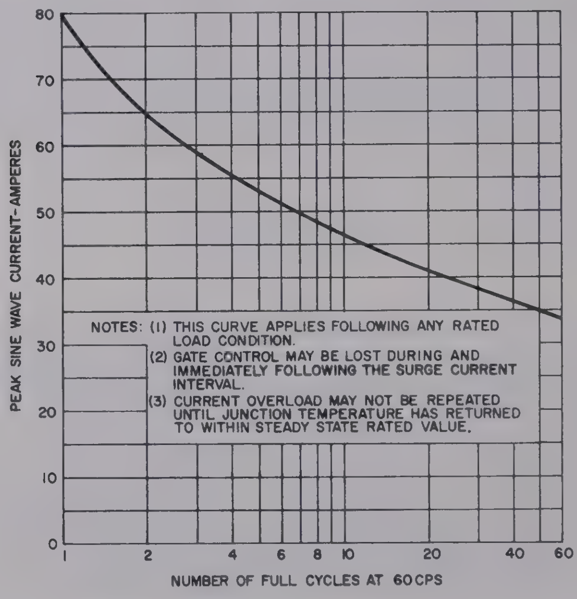
It should be noted that the current rating of this assembly is dependent on the temperature rise of the TRIAC being used. Curve 1 shows the relative current ratings of the TRIAC assemblies depending on their use (i.e. located in "free air" or bolted to an additional heat sink). It is suggested that a "heat run" or temperature rise test be conducted in the actual environment expected in the ultimate equipment, Curves on the S100A1-6 describe the surge current capabilities of the units.



1. MAXIMUM CONDUCTION RATING AS A FUNCTION OF HEAT SINK TEMPERATURE



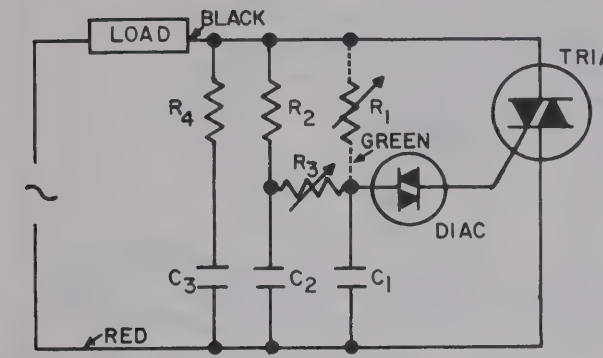
2. CURRENT SURGE CURVE
(1 & 2)



3. CURRENT SURGE CURVE
(3, 4, 5 & 6)

EXTENDED RANGE VARIABLE VOLTAGE CIRCUIT

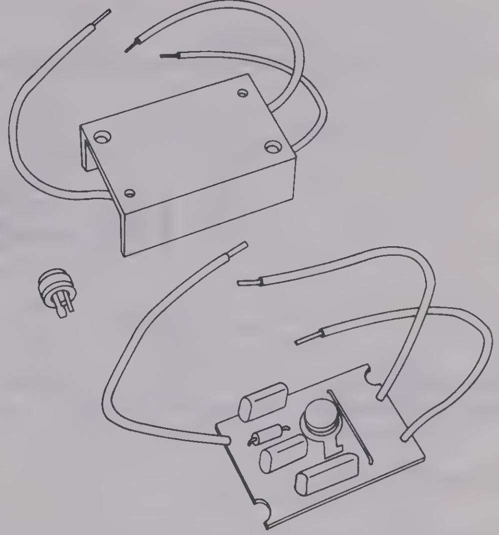
S100B1-6



S100B1-4 EXTENDED RANGE VARIABLE VOLTAGE ASSEMBLY

NOTE: For 120V RMS units use
$R_1 = 250{,}000$ ohms, 2 watts

For 240V RMS units use
$R_1 = 500{,}000$ ohms, 2 watts



SUGGESTED USES: This extended range circuit allows control of the voltage applied to the ultimate equipment from 0 to 100 per cent, making it ideal for such applications as incandescent lamp dimming. It may also be used for controlling speed of certain types of single phase a-c motors (shaded pole or permanent split capacitor type) as well as series-universal type motors. It can also be used to control resistance heating elements, etc.

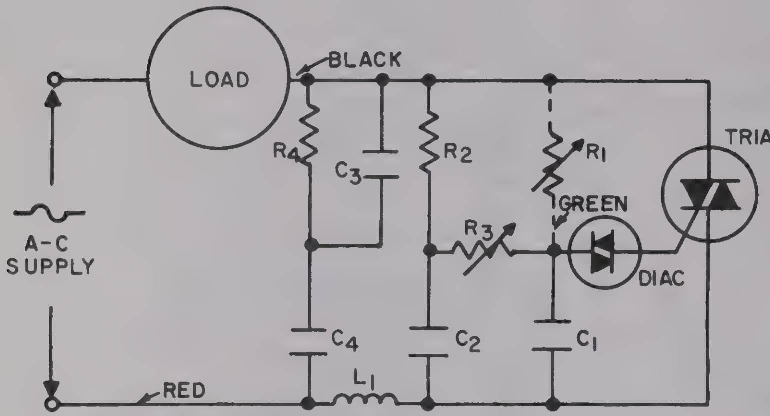
DESCRIPTION: All forms of this sub-assembly consist of a TRIAC (a-c semiconductor switch), a DIAC (bi-directional trigger diode), a timing capacitor, an added R-C timing network and a trimmer potentiometer, all mounted on a printed circuit board and equipped with an extruded aluminum heat sink. The potentiometer (R_1) shown in the above circuit is *not* included as part of this assembly since it will normally be located remotely. All current carrying components are electrically isolated from the heat sink allowing it to be bolted directly to the metal frame of the equipment being controlled. The TRIAC protects itself against damage from transient voltage surges by turning on during the half cycle during which the transient occurs. This particular assembly does *not* include radio frequency interference (RFI) suppression but it does include an R-C network to suppress erratic firing of the TRIAC due to dv/dt phenomena. The RFI suppression feature can be obtained by using the S100C1 through S100C4 assembly group.

RATING: This sub-assembly is available with either 6 amp, 10 amp or 15 amp TRIACS for use in 120 or 240 volts. (RMS) a-c circuits:

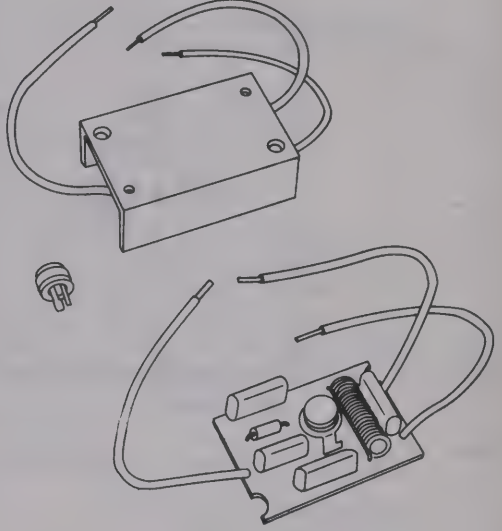
MODEL S100B1	6 amp 120 VRMS	MODEL S100B2	6 amp 240 VRMS
MODEL S100B3	10 amp 120 VRMS	MODEL S100B4	10 amp 240 VRMS
MODEL S100B5	15 amp 120 VRMS	MODEL S100B6	15 amp 240 VRMS

It should be noted that the current rating of this assembly is dependent on the temperature rise of the TRIAC being used. Curve 1 shows the relative current ratings of the TRIAC assemblies depending on their use (i.e. located in "free air" or bolted to an additional heat sink). It is suggested that a "heat run" or temperature rise test be conducted in the actual environment expected in the ultimate equipment, Curves on the S100A1-6 describe the surge current capabilities of the units.

EXTENDED RANGE VARIABLE VOLTAGE CIRCUIT (RFI SUPPRESSED)



S100C1-4 EXTENDED RANGE VARIABLE VOLTAGE ASSEMBLY (RFI SUPPRESSION)



NOTE: For 120V RMS units use
$R_1 = 250{,}000$ ohms, 2 watts

For 240V RMS units use
$R_1 = 500{,}000$ ohms, 2 watts

SUGGESTED USES: Because of this circuit's extended range capability and the fact that RFI suppression has been added, this sub-assembly is ideally suited for use in incandescent lamp dimming applications. It may also be used to control speed of certain types of single phase a-c motors (shaded pole and permanent split capacitor type) as well as series-universal type motors. It may also be used to control resistance heating elements, etc.

DESCRIPTION: All forms of this sub-assembly consist of a TRIAC (a-c semiconductor switch), a DIAC (bi-directional trigger diode), a timing capacitor, a trimmer potentiometer, an additional R-C timing network for extended voltage range capability, an L-C network for RFI suppression and an added R-C network for protection against erratic firing of the TRIAC due to dv/dt phenomena. The potentiometer (R_1) shown in the above circuit is *not* included as a part of this assembly since it will normally be located remotely. All current carrying components are electrically isolated from the extruded aluminum heat sink allowing it to be bolted directly to the metal frame of the equipment being controlled. The TRIAC protects itself against damage from transient voltage surges by turning on during the half cycle during which the transient occurs.

RATING: This sub-assembly is available with either 6 amp, 10 amp or 15 amp TRIACS for use in 120 or 240 volts. (RMS) a-c circuits:

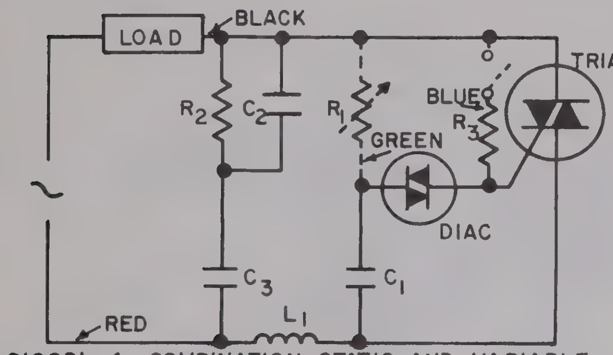
MODEL S100C1	6 amp 120 VRMS	MODEL S100C2	6 amp 240 VRMS
MODEL S100C3	10 amp 120 VRMS	MODEL S100C4	10 amp 240 VRMS
MODEL S100C5	15 amp 120 VRMS	MODEL S100C6	15 amp 240 VRMS

It should be noted that the current rating of this assembly is dependent on the temperature rise of the TRIAC being used. Curve 1 shows the relative current ratings of the TRIAC assemblies depending on their use (i.e. located in "free air" or bolted to an additional heat sink). It is suggested that a "heat run" or temperature rise test be conducted in the actual environment expected in the ultimate equipment, Curves on the S100A1-6 describe the surge current capabilities of the units.

COMBINATION VARIABLE VOLTAGE CIRCUIT & STATIC SWITCH

(RFI SUPPRESSED)

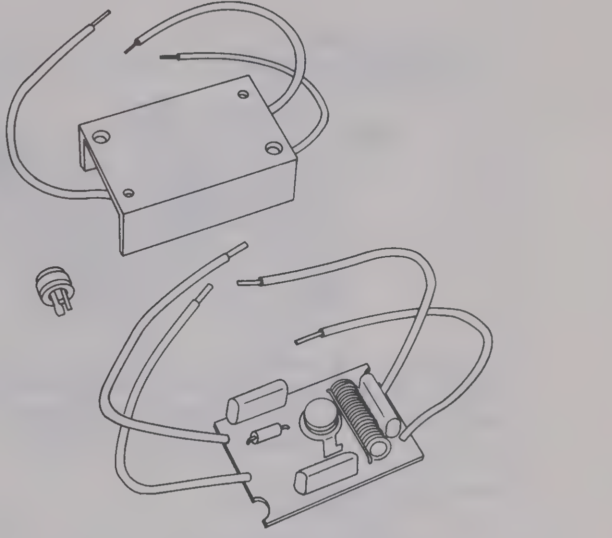
S100D1-6



S100DI-4 COMBINATION STATIC AND VARIABLE VOLTAGE CONTROL WITH RFI SUPPRESSION

NOTE: For 120V RMS units use
$R_1 = 250{,}000$ ohms, 2 watts

For 240V RMS units use
$R_1 = 500{,}000$ ohms, 2 watts



SUGGESTED USES: This circuit is ideally suited for applications in which you desire to automatically switch from a high fan motor speed to a pre-set low speed based on a single contact closure. An example of this type of application can be found in air cooled air conditioning condenser fans. Because condenser units are normally located outside the building whose ambient is being controlled, situations can arise which have undesirable effects on the evaporator portion of the system (located inside the building). If outside temperatures drop below a critical valve and the condenser fan runs at full speed, the refrigerant will be cooled to too low a temperature and this will tend to cause ice to form on the evaporator coils. This ice obstructs the flow of air over the coil and thus severely reduces the cooling capacity of the air conditioner. By connecting this type of control to an outdoor thermostat and to the condenser fan motor we can cause the motor to run at full speed as long as the temperature is above the critical temperature (thermostat contacts closed) and at a pre-set lower speed when temperature drops below the critical valve (thermostat contacts open). This type of control could be used with either shaded pole or permanent split capacitor types of motors. It could be used in controlling resistance heat elements, incandescent lamps or series-universal motors as well, so long as the external contact closure can be provided to switch from one mode to the other.

DESCRIPTION: All forms of this sub-assembly consist of a TRIAC (a-c semiconductor switch), a DIAC (bi-directional trigger diode), a timing capacitor, an L-C network for RFI (radio frequency interference) suppression and an additional R-C network to protect against erratic firing of the TRIAC due to dv/dt phenomena. All of this material is mounted on a printed circuit board. All current carrying components are electrically isolated from the extruded aluminum heat sink allowing it to be bolted directly to the metal frame of the equipment being controlled. The potentiometer (R_1) shown in the above circuit is *not* included as a part of this assembly since it will normally be located remotely. An additional lead is furnished to allow connection to a set of outside contacts (contained in an outdoor thermostat or other external signal type device). The TRIAC protects itself against damage from transient voltage surges by turning on during the half cycle during which the transient occurs.

RATING: This sub-assembly is available with either 6 amp, 10 amp or 15 amp TRIACS for use in 120 or 240 volts. MS) (RMS) a-c circuits:

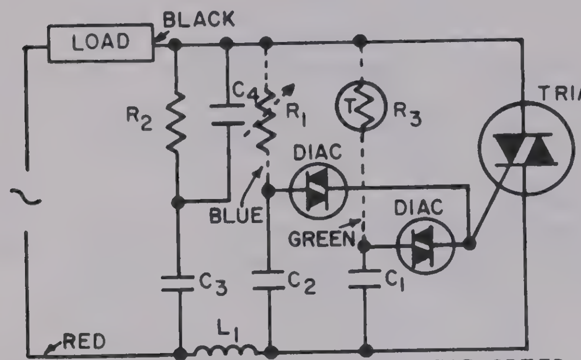
MODEL S100D1	6 amp 120 VRMS	MODEL S100D2	6 amp 240 VRMS
MODEL S100D3	10 amp 120 VRMS	MODEL S100D4	10 amp 240 VRMS
MODEL S100D5	15 amp 120 VRMS	MODEL S100D6	15 amp 240 VRMS

It should be noted that the current rating of this assembly is dependent on the temperature rise of the TRIAC being used. Curve 1 shows the relative current ratings of the TRIAC assemblies depending on their use (i.e. located in "free air" or bolted to an additional heat sink). It is suggested that a "heat run" or temperature rise test be conducted in the actual environment expected in the ultimate equipment, Curves on the S100A1-6 describe the surge current capabilities of the units.

BLOWER MOTOR SPEED CONTROL WITH SET LOW SPEED

S100E1-6

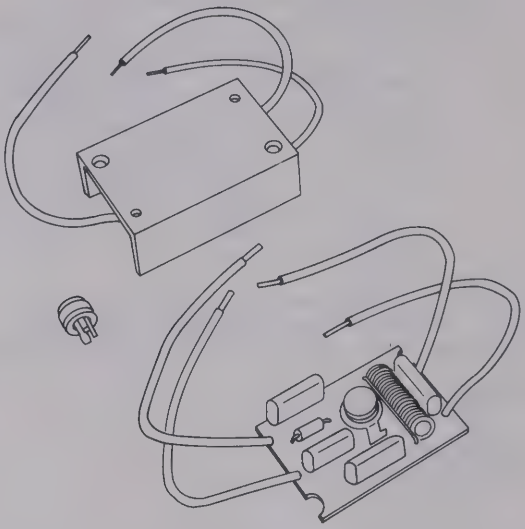
(RFI SUPPRESSED)



S100E1-4 FURNACE BLOWER MOTOR SPEED CONTROL WITH LOW SPEED LIMIT (RFI SUPPRESSION)

NOTE: For 120V RMS units use
R_1 = 250,000 ohms, 2 watts

For 240V RMS units use
R_1 = 500,000 ohms, 2 watts



SUGGESTED USES: This circuit is primarily designed for use with direct drive furnace blower motors. With this sub-assembly and a properly selected thermistor it is possible to obtain automatic speed control of the furnace blower motor based upon the temperature of air in the furnace bonnet. Since most of the motors used in this application are of the sleeve bearing type, they are limited to operation above a minimum speed recommended by the motor manufacturer (usually 600 RPM). At speeds below this minimum the lubrication system tends to malfunction. The potentiometer shown in the above circuit allows you to adjust the control so that the motor cannot run slower than the set speed even though the thermistor may be calling for lower speed operation.

DESCRIPTION: All forms of this sub-assembly consist of a TRIAC (a-c semiconductor switch), DIACS (bi-directional trigger diodes), two timing capacitors, an L-C network for RFI (radio frequency interference) suppression and an additional R-C network to protect against erratic firing of the TRIAC due to dv/dt phenomena. All of these components are mounted on a printed circuit board which in turn is fastened to an extruded aluminum heat sink. All current carrying components are electrically isolated from the heat sink, allowing it to be bolted directly to the metal frame of the equipment being controlled. The potentiometer and thermistor shown in the above circuit are *not* included in this assembly since they will normally be located remotely. The TRIAC protects itself against damage from transient voltage surges by turning on during the half cycle during which the transient occurs.

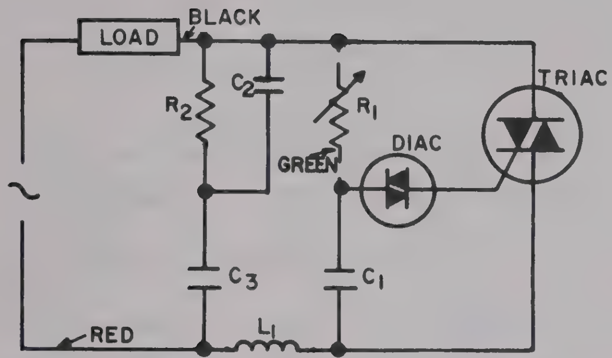
RATING: This sub-assembly is available with either 6 amp, 10 amp or 15 amp TRIACS for use in 120 or 240 volts. (RMS) a-c circuits:

MODEL S100E1	6 amp 120 VRMS	MODEL S100E2	6 amp 240 VRMS
MODEL S100E3	10 amp 120 VRMS	MODEL S100E4	10 amp 240 VRMS
MODEL S100E5	15 amp 120 VRMS	MODEL S100E6	15 amp 240 VRMS

It should be noted that the current rating of this assembly is dependent on the temperature rise of the TRIAC being used. Curve 1 shows the relative current ratings of the TRIAC assemblies depending on their use (i.e. located in "free air" or bolted to an additional heat sink). It is suggested that a "heat run" or temperature rise test be conducted in the actual environment expected in the ultimate equipment, Curves on the S100A1-6 describe the surge current capabilities of the units.

BASIC VARIABLE VOLTAGE CIRCUIT

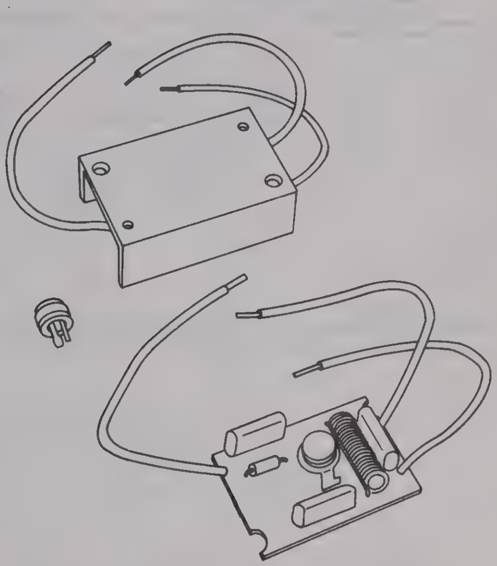
S100F1-6



S100F1-4 BASIC VARIABLE VOLTAGE ASSEMBLY WITH RFI SUPPRESION

NOTE: For 120V RMS units use
R_1 = 250,000 ohms, 2 watts

For 240V RMS units use
R_1 = 500,000 ohms, 2 watts



SUGGESTED USES: This basic circuit may be used in a wide variety of applications where the ability to vary applied voltage is desired. Examples of this type of application include resistance heat control, shaded pole or permanent split capacitor type motor speed control, series-universal type motor speed control, incandescent lamp dimming, etc.

DESCRIPTION: All forms of this sub-assembly consist of a TRIAC (a-c semiconductor switch), a DIAC (bi-directional trigger diode), a timing capacitor, an added L-C network for RFI (radio frequency interference) suppression and an added R-C network for protection against erratic firing of the TRIAC due to dv/dt phenomena. The potentiometer shown in the above circuit is *not* included in this assembly since it will normally be located remotely. All current carrying components are electrically isolated from the extruded aluminum heat sink allowing it to be bolted directly to the metal frame of the equipment being controlled. The TRIAC protects itself against transient voltage surges by turning on during the half cycle in which the transient occurs.

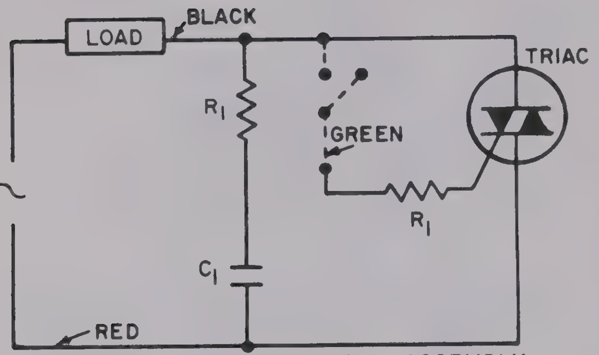
RATING: This sub-assembly is available with either 6 amp, 10 amp or 15 amp TRIACS for use in 120 or 240 volts. (RMS) a-c circuits:

MODEL S100F1	**6 amp 120 VRMS**	**MODEL S100F2**	**6 amp 240 VRMS**
MODEL S100F3	**10 amp 120 VRMS**	**MODEL S100F4**	**10 amp 240 VRMS**
MODEL S100F5	15 amp 120 VRMS	MODEL S100F6	15 amp 240 VRMS

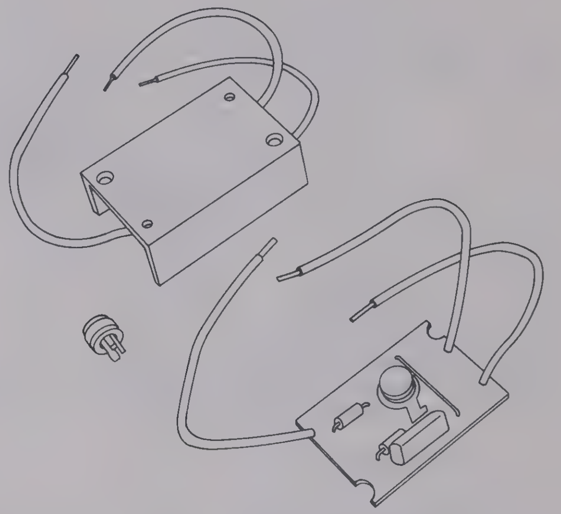
It should be noted that the current rating of this assembly is dependent on the temperature rise of the TRIAC being used. Curve I shows the relative current ratings of the TRIAC assemblies depending on their use (i.e. located in "free air" or bolted to an additional heat sink). It is suggested that a "heat run" or temperature rise test be conducted in the actual environment expected in the ultimate equipment, Curves on the S100A1-6 describe the surge current capabilities of the units.

AC STATIC SWITCH

S100G1-6



S100G1-4 A-C STATIC SWITCH ASSEMBLY



SUGGESTED USES: This basic a-c static switching circuit will find innumerable uses to replace electromechanical devices in applications involving large numbers of contact closures. It will also find use in certain hazardous atmospheres where its non-arcing features will make it ideal.

DESCRIPTION: All forms of this sub-assembly consist of a TRIAC (a-c semiconductor switch) and a resistor mounted on a printed circuit board and equipped with an extruded aluminum heat sink. An added R-C network is provided to protect against erratic firing of the TRIAC due to dv/dt phenomena. All current carrying components are electrically isolated from the heat sink, allowing it to be bolted directly to the metal frame of the equipment being controlled. The TRIAC protects itself against damage from transient voltage surges by turning on during the half cycle in which the transient occurs.

RATING: This sub-assembly is available with either 6 amp, 10 amp or 15 amp TRIACS for use in 120 or 240 volts. (RMS) a-c circuits:

MODEL S100G1	6 amp 120 VRMS	MODEL S100G2	6 amp 240 VRMS
MODEL S100G3	10 amp 120 VRMS	MODEL S100G4	10 amp 240 VRMS
MODEL S100G5	15 amp 120 VRMS	MODEL S100G6	15 amp 240 VRMS

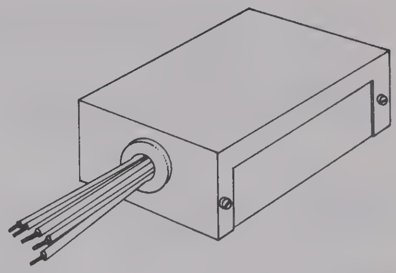
It should be noted that the current rating of this assembly is dependent on the temperature rise of the TRIAC being used. Curve 1 shows the relative current ratings of the TRIAC assemblies depending on their use (i.e. located in "free air" or bolted to an additional heat sink). It is suggested that a "heat run" or temperature rise test be conducted in the actual environment expected in the ultimate equipment, Curves on the S100A1-6 describe the surge current capabilities of the units.

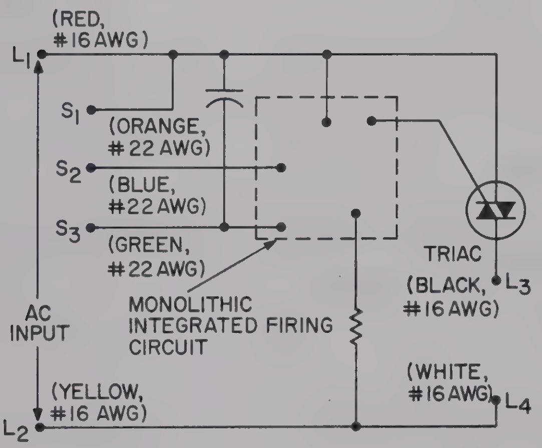
AC Power Controllers
Zero-Voltage Switching

S200A1,2,3,4
S200A21,41

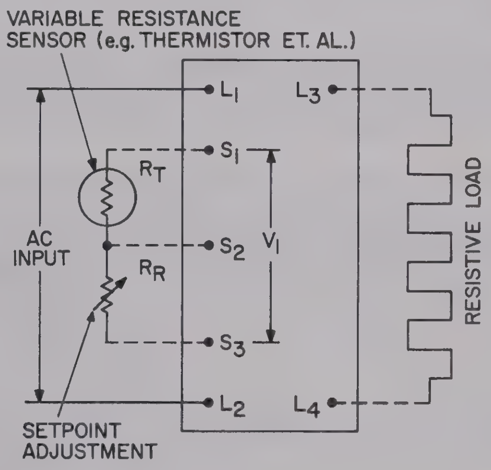
FEATURES:

- Available in ratings of 10 and 15 amperes (RMS) at 120, 240 and 277 volts (RMS), 50 and 60 Hertz, for controlling resistive loads from 500 to 4150 watts.
- "Zero-Voltage Switching" provides much lower RFI levels than are possible with mechanical contacts or phase-controlled semiconductors.
- All solid-state control, including monolithic integrated firing circuit, affords long life and high reliability.
- Capable of operating with a variety of variable resistance sensors such as thermistors, photo-resistors, humidity sensitive devices, etc.
- High input impedance allows use of sensors operating at any point from 5K to 100K ohms.
- Control point repeatability better than ±0.5% of sensor R_T (ohms at control point).
- R_T equal to reference resistor R_R ±5.0% at control point.




(RED, #16 AWG)
L1
S1
(ORANGE, #22 AWG)
S2
(BLUE, #22 AWG)
S3
(GREEN, #22 AWG)
AC INPUT
MONOLITHIC INTEGRATED FIRING CIRCUIT
TRIAC
(BLACK, #16 AWG)
L3
(WHITE, #16 AWG)
L4
(YELLOW, #16 AWG)
L2

INTERNAL CONNECTIONS


VARIABLE RESISTANCE SENSOR (e.g. THERMISTOR ET. AL.)
L1
L3
S1
RT
AC INPUT
S2
V1
RR
S3
L2
L4
RESISTIVE LOAD
SETPOINT ADJUSTMENT

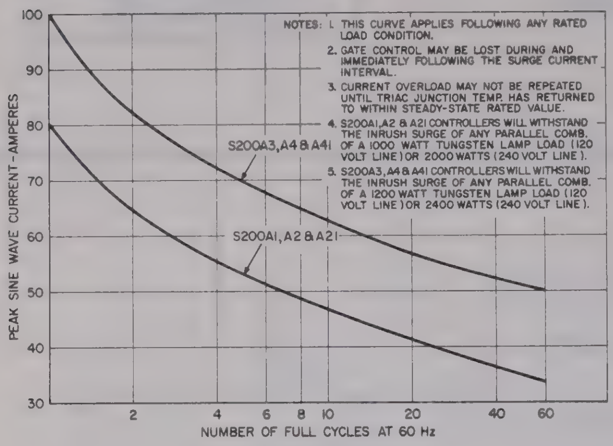
EXTERNAL CONNECTIONS

DESCRIPTION: The S200A Series of power control modules consists of a monolithic integrated control circuit and a triac (bi-directional triode thyristor) power switching semiconductor device with all additional parts to afford full-wave AC power control. The circuit provides precise error detection and true zero-voltage switching for minimum radio frequency interference (RFI). The user need only provide power, a resistive load (such as a resistance heater), a variable resistance sensor and a reference control resistor. All forms of this module are equipped with an extruded aluminum heatsink, electrically isolated from all current carrying components. More information concerning the mode of operation of these modules is contained in the *Application Information* section of this specification sheet.

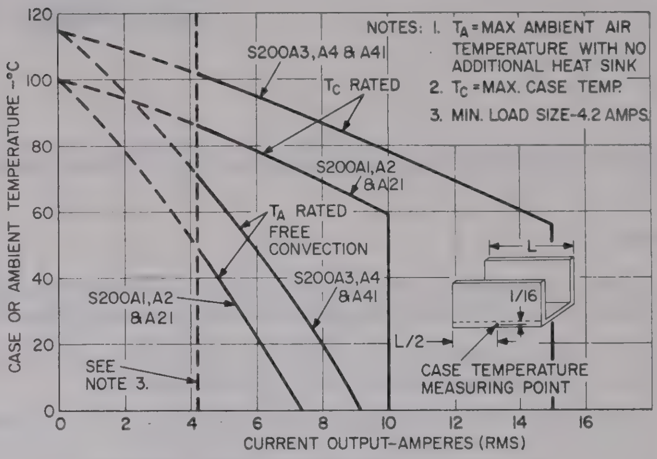
MODELS AVAILABLE:

Model S200A1 (10 amp, 120 volts RMS)	Model S200A2 (10 amp, 240 volts RMS)	Model S200A21 (10 amp, 277 volts RMS)
Model S200A3 (15 amp, 120 volts RMS)	Model S200A4 (15 amp, 240 volts RMS)	Model S200A41 (15 amp, 277 volts RMS)

S200A1,2,3,4,21,41



1. CURRENT SURGE CURVE



2. MAXIMUM CONDUCTION RATING AS A FUNCTION OF AIR OR HEAT SINK TEMPERATURE

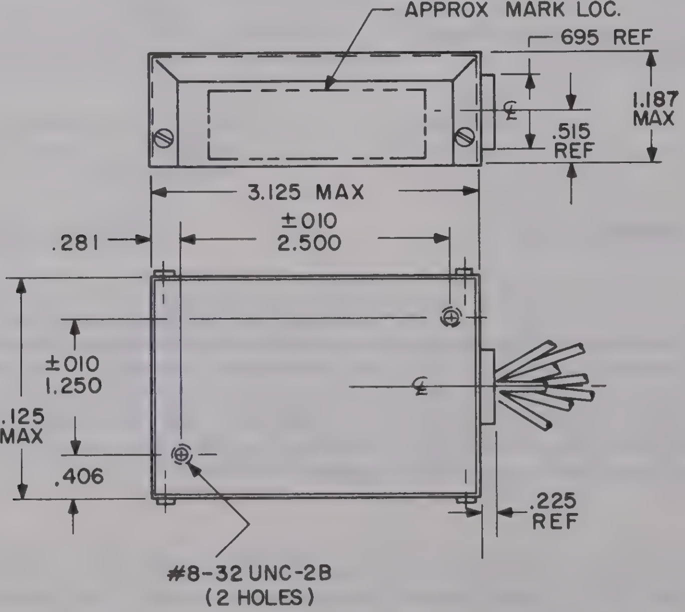
RATINGS AND CHARACTERISTICS	S200A1	S200A2	S200A21	S200A3	S200A4	S200A41	
Line Voltage (RMS), 60 Hz	120	240	277	120	240	277	Volts Nominal
Line Voltage (Peak)	200	400	500	200	400	500	Volts Maximum
Rated Load Current	10	10	10	15	15	15	Amps. Maximum
"ON" Condition (See Note 1)	4.2	4.2	4.2	4.2	4.2	4.2	Amps. Minimum
Power Dissipation at Full Rated Current	15	16.8	17.5	21.8	23.6	24.2	Watts Maximum
V_1 (Voltage developed between S_1 & S_3)			10				Volts Maximum
(See Note 2)			8				Volts Typical

Note 1: For proper operation of S200A modules, it is necessary that a resistive load of at least 4.2 amperes (RMS) rating be connected at all times. With loads of less than 4.2 amperes, the circuit may not operate satisfactorily. *Inductive loads cannot be controlled with these modules.*

Note 2: *CAUTION!* Sensor resistance has one side common with the AC line (S_1 is common with L_1).

Note 3: The S200A module will control properly with R_R up to 100K ohms. However, some accuracy is lost at $R_R > 50K$ ohms.

OUTLINE DRAWING



The monolithic integrated control circuit was developed in conjunction with the Research and Development Center, General Electric Company, at Schenectady, N.Y.

APPLICATION INFORMATION

For resistance heater or tungsten loads, and resistance sensors such as; thermistors, photo-resistors, pile-type pressure sensors, resistance-type humidity sensors, and other resistance sensors.

The S200A Series, AC power control module, is a high gain threshold and power control switch for resistance heater or tungsten lamp loads, and resistance sensors such as; thermistors, photo-resistors, pile-type pressure sensors, resistance-type humidity sensors, and other resistance sensors. For optimum performance in a feedback control system, transient response of the overall system external to the control module must be considered.

These power control modules are basically "On-Off" controllers. The power switching is done by a triac (bi-directional triode thyristor) which can be triggered by the monolithic integrated control circuit only at line voltage zero crossings. This mode of operation is known as "zero-voltage switching" (synchronous switching), and has the advantage of producing less radio frequency interference (RFI) than mechanical switching elements.

The integrated control circuit (I-C), in addition to generating the proper triggering signals for the triac, provides its own power supply and uses a differential amplifier to sense offset of a resistance bridge. This bridge consists of a user supplied sensor resistance and reference resistance on one side, and a matched-pair of resistors in the I-C on the other. Whenever the resistor R_T (see circuit diagram on front page) becomes greater than R_R, trigger pulses are generated and the load power is "On." The threshold, or control point, will occur when $R_T = R_R \pm 5.0\%$ production tolerance. With most negative coefficient thermistors, this will be within ± 1.2°C; any closer calibration than this requires some trimming.

Due to some inherent dissymmetry, there will usually be a small range of half-wave operation at the control point. The I-C temperature also has a small effect on the control point. These combined effects, including supply voltage variation of ± 10%, amount to less than ± 0.5% of sensor resistance change at the control point, or ± 0.12°C with most thermistors. This figure is known as the control point repeatability.

The useable range of sensor resistance is quite wide, 5K to 50K ohms, or up to 100K ohms at slightly less accuracy. Sensors can be used at lower resistance by adding series resistors to bring the total value up to 5K ohms. This, of course, is at a sacrifice of accuracy.

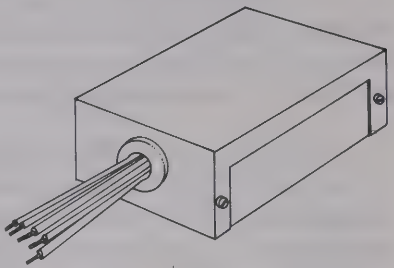
For an example of temperature control, suppose that a temperature is to be regulated to 120°C ± 5° with a thermistor having a value of 12K ohms at 120°C and a slope of 3% per °C. A S200A Series controller is connected to the heater, to the thermistor at R_T, and to a fixed 12K ohm resistance at R_R. Power is applied and the heater will then be "On," heating the thermistor. As the thermistor heats, its resistance will drop until it reaches a value of around 12K ohms. At this point the power will go "Off" and regulate at this point. The controlled temperature will be 120°C ± 1.7° (± 5.0% of thermistor resistance at 3% per °C slope) provided the thermal system is stable. This calibration error can be reduced by an order of magnitude through minor adjustment of R_R.

Phase Control Power Module

S300A1-6

FEATURES:

- Available in ratings of 6, 10 and 15 amperes (RMS) at 120 and 240 volts (RMS), 50 and 60 Hertz, for controlling resistive or induction motor loads up to 3600 watts.
- All solid state control, including monolithic, integrated triggering circuit, affords long life and high reliability.
- Capable of operating with a wide variety of variable resistance sensors (thermistors, photo-resistors, humidity sensitive resistors, etc.) as well as d-c tachometer signals.
- High gain trigger circuitry allows wide range of controlled output with small changes in input signal
- Adjustable gain feature allows control to be used in wide variety of a-c motor speed control applications
- High input impedance allows use of sensors operating at any point from 5K to 100K ohms
- Zener regulated control circuit provides stability in case of supply voltage variations
- Inductive load logic allows use with any resistive or lagging power factor motor loads. Minimizes d-c components commonly found in phase controlled inductive load circuits
- Ambient compensated for stability during temperature fluctuations
- Radio Frequency Interference (RFI) suppression network included to minimize conducted and radiated RFI



MODELS AVAILABLE:

S300A1	(6 amp 120 volts RMS)	S300A2	(6 amp 240 volts RMS)
S300A3	(10 amp 120 volts RMS)	S300A4	(10 amp 240 volts RMS)
S300A5	(15 amp 120 volts RMS)	S300A6	(15 amp 240 volts RMS)

DESCRIPTION:

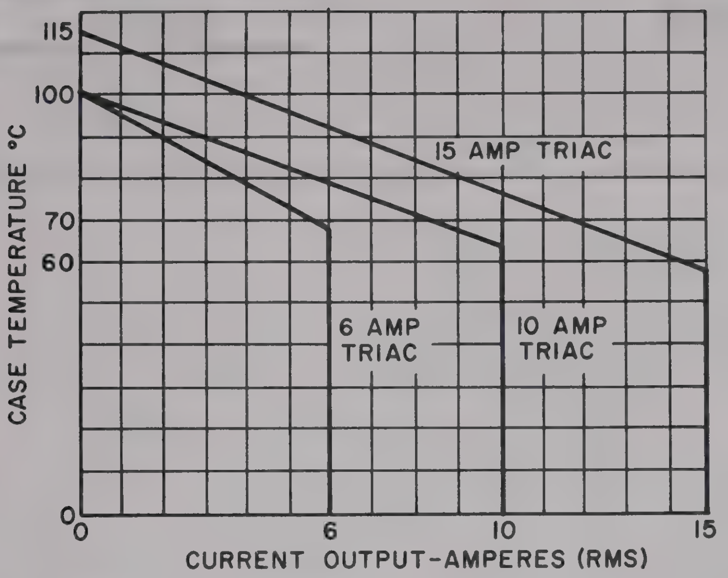
The S300A series of Phase Control Power Modules consists of a monolithic integrated control circuit and a triac (bi - directional triode thyristor) power switching semiconductor device with all additional parts needed to afford full a-c phase control of resistive or induction motor loads. The user need only provide a variable resistance sensor and a reference control resistor. Control can be made responsive to variations in temperature, light level, humidity or other physical parameters. All forms of these modules are equipped with an extruded aluminum heatsink, electrically isolated from all current carrying components. More detailed information on the actual mode of operation of this control circuitry is contained in Specification Sheet 85.31 entitled, PA 436 Phase Control Integrated Circuit.

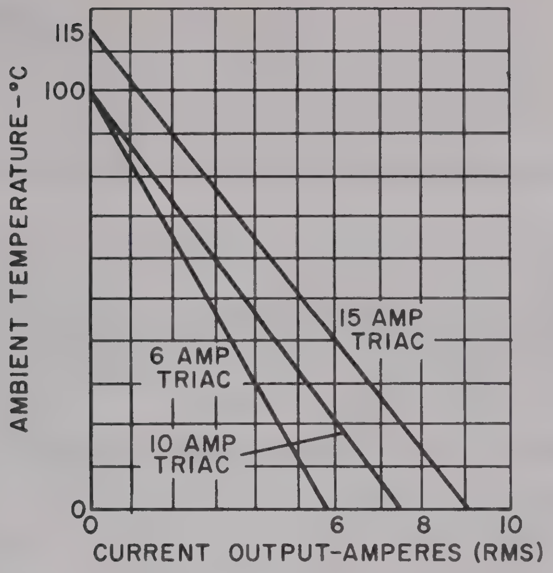
RATINGS AND CHARACTERISTICS:

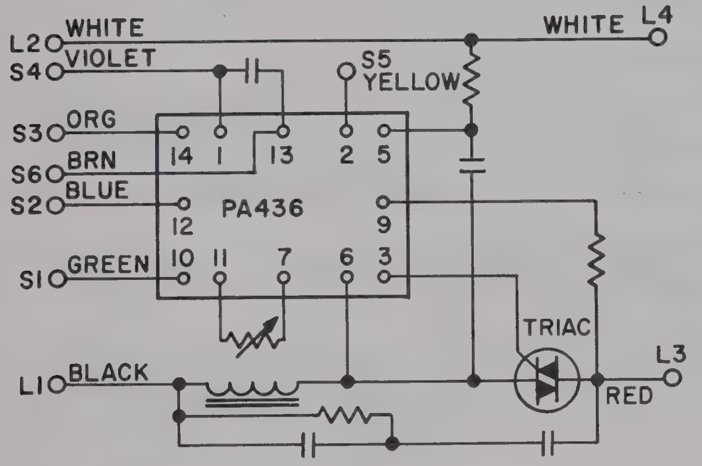
	S300A1	S300A2	S300A3	S300A4	S300A5	S300A6	
Line Volts-RMS 50/60 Hz	120	240	120	240	120	240	Volts Nominal
Line Volts-Peak	200	400	200	400	200	400	Volts Maximum
Rated Load Current	6	6	10	10	15	15	Amps Maximum
Power Dissipation at Full Rated Current	10.5	12.5	15.0	16.8	17.5	21.8	Watts Maximum
V_1 (Voltage Developed	11.5						Volts Maximum
Between S1 & S4)	9.4						Volts Typical

Note 1: CAUTION! Sensor terminals are not isolated from a-c line voltage.

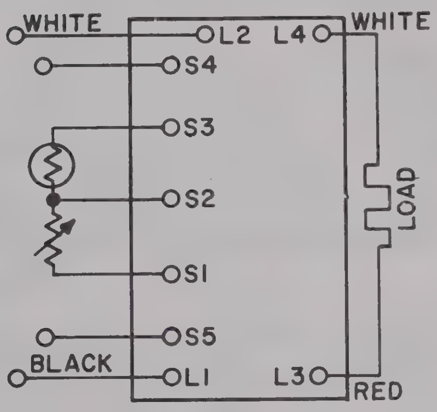
S300A1-6



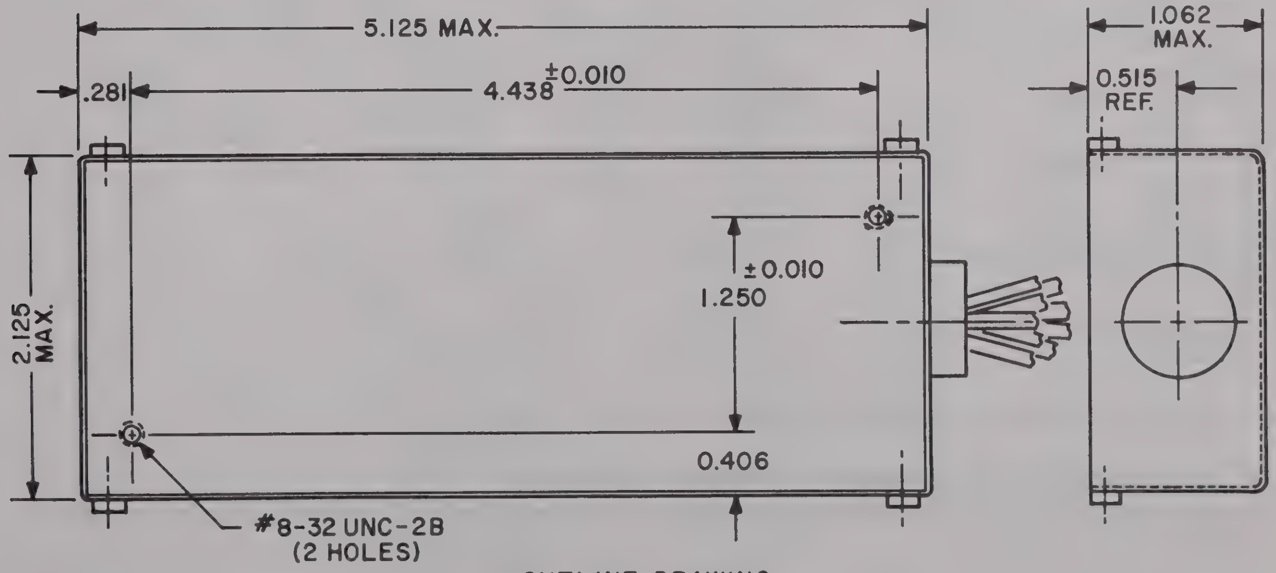



L2
WHITE
S4
VIOLET
S3
ORG
S6
BRN
S2
BLUE
S1
GREEN
L1
BLACK
WHITE
L4
S5
YELLOW
14
1
13
2
5
PA436
12
9
10
11
7
6
3
TRIAC
L3
RED

INTERNAL CONNECTIONS


WHITE
L2
L4
WHITE
S4
S3
S2
S1
S5
LOAD
BLACK
L1
L3
RED

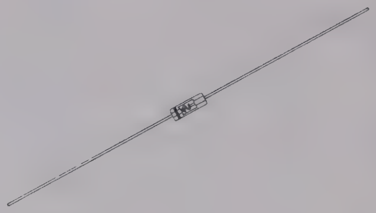
EXTERNAL CONNECTIONS


5.125 MAX.
.281
4.438 ±0.010
1.062 MAX.
0.515 REF.
2.125 MAX.
±0.010
1.250
0.406
#8-32 UNC-2B
(2 HOLES)

OUTLINE DRAWING

Silicon Diodes

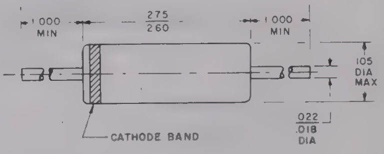
S321,2,4,5
S334,7



These General Electric Signal Diodes are very low leakage diodes for general application. They incorporate an oxide passivated planar structure built in a high resistivity epitaxial layer grown on a low resistivity silicon substrate. This structure makes possible a diode having high conductance, low leakage, and low capacitance, combined with improved uniformity and reliability. They are housed in a standard DO-7 glass diode package.

absolute maximum ratings: (25°C) (unless otherwise specified)

Current	
Average Rectified	75 ma
Forward Steady - State DC	50 ma
Recurrent Peak Forward	225 ma
Peak Forward Surge (1.0 usec pulse)	2000 ma
Power	
Dissipation (25°C)*	250mw
Temperature	
Operating	-65 to + 175°C
Storage	-65 to + 200°C



NOTES

1. ALL DIMENSIONS ARE IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.
2. LEAD DIAMETER NOT CONTROLLED WITHIN .050" OF THE BODY.

electrical characteristics: (25°C) (unless otherwise specified)

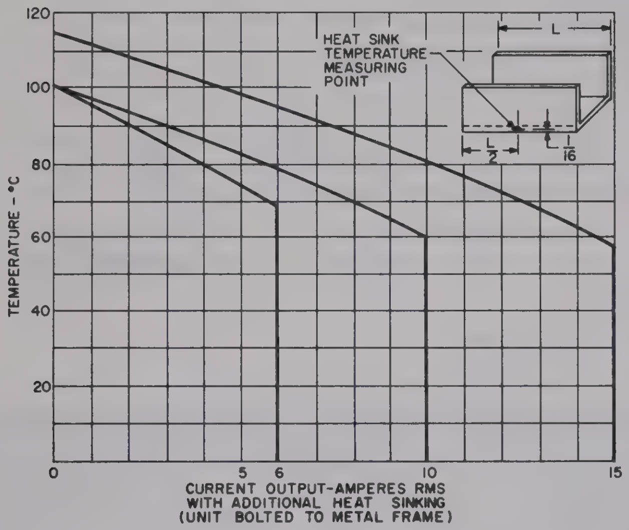
	S321		S322		S324		S325		S334		S337		
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
FORWARD VOLTAGE (VF)													
(I_F =10 uA)	0.500	0.600	0.500	0.600					0.500	0.600	0.500	0.600	volts
(I_F =100 uA)	0.590	0.690	0.590	0.690					0.590	0.690	0.590	0.690	volts
(I_F =1.0 mA)	0.680	0.780	0.680	0.780					0.680	0.780	0.680	0.780	volts
(I_F =10 mA)	0.780	0.880	0.780	0.880					0.780	0.880	0.780	0.880	volts
(I_F =50 mA)						1.0		1.0					volts
(I_F =100mA)(Note 1)	0.880	1.200	0.880	1.200					0.880	1.200	0.880	1.200	volts
REVERSE CURRENT(IR)													
(V_R =20 Volts)				200		100		250				100	pA
(V_R =20 Volts,T_A=150°C)				0.500		0.250		0.500				0.250	uA
(V_R =30 Volts)		2.0									1.0		nA
(V_R =30 Volts,T_A=150°C)		4.0								2.0			uA
(V_R =50 Volts)				5.0								2.0	nA
(V_R =50 Volts,T_A =150°C)				10.0								4.0	uA
BREAKDOWN VOLTAGE(BV)													
(I_R =5 uA)	40								40				volts
CAPACITANCE(Co)													
(V_R =0(Note 2)		4		4		6		6		4		4	pF

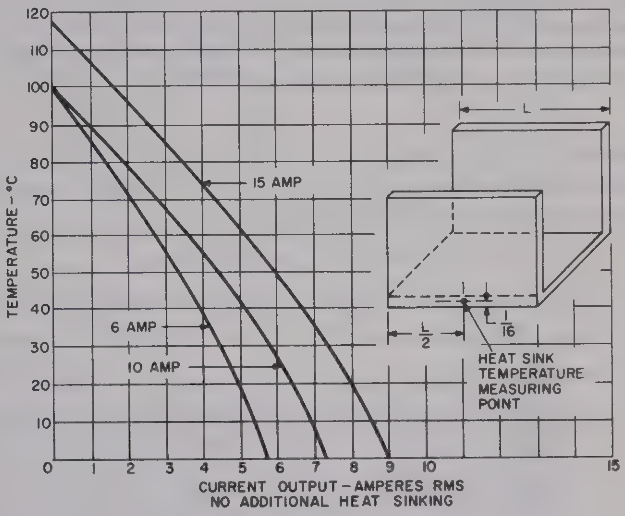
*Derate 1.43 mW/°C temperature above 25°C based on T_J max. = 200°C

Note 1: Pulsed measurement (pulse width≦300 usec, duty cycle≦2%)

Note 2: Capacitance as measured on Boonton model 75A capacitance bridge at a signal level of 50 mv and a frequency of 1 mc.

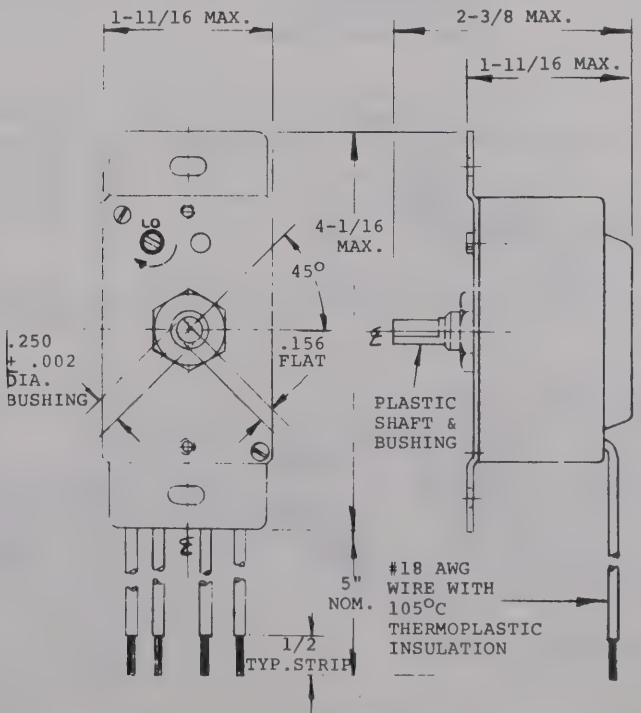
Operation:
The S400A controls are equipped with both a main control potentiometer and a trimmer potentiometer. With the trimmer potentiometer adjusted to a desired level, a minimum voltage is established below which the output will not go, regardless of the setting of the main control potentiometer. This feature allows the user to prevent motor speed from going below a value which may be specified by the motor manufacturer (to prevent possible bearing damage due to lack of lubrication).





For further information concerning surge current rating, etc., on the Triac, please refer to Specification Sheet #175.15 which can be obtained from your nearest General Electric sales office.

Note: Since the current carrying capacity of the unit is dependent upon the temperature of the Triac, it is recommended that a "heat run" or temperature test be performed with the unit in the ambient in which it is to be used (while physically designed to fit into a standard "handy box," the current carrying capability of the unit may be reduced due to an increase in ambient temperature). Refer to Figure 1 for temperature/current characteristics of the unit. (Higher current and voltage customized units will also be available for some applications. Consult your nearest General Electric sales office.)

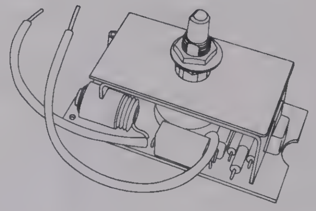

1-11/16 MAX.
2-3/8 MAX.
1-11/16 MAX.
LO
4-1/16 MAX.
45°
.250 ± .002 DIA. BUSHING
.156 FLAT
PLASTIC SHAFT & BUSHING
5" NOM.
#18 AWG WIRE WITH 105°C THERMOPLASTIC INSULATION
1/2 TYP. STRIP

Solid-State
Fan Motor Speed Control

S400A1
S400A1SC
S400A1SC1

Description:

The S400 line of speed controls consists of an AC power semiconductor and all necessary control circuitry and heatsinking to afford manual speed control of fan motors of the permanent split-capacitor and shaded-pole types. These units have all devices mounted on a printed circuit board and are designed for direct mounting by means of the potentiometer bushing provided.



Features:

All models are rated at 5 amps, 120 volts (RMS). Three models are available, each incorporates some or all of the following:

- UL approved line switch on all models.
- Minimum output voltage set-point potentiometer on all models.
- Printed circuit board (1⁄16″ XXXP material—UP approved) for all models.
- Copper heatsink in all models for proper cooling of the Triac.
- Radio frequency interference (RFI) suppression on Models S400A1S and S400A1SC only.
- Line voltage compensation* (S400A1SC only).

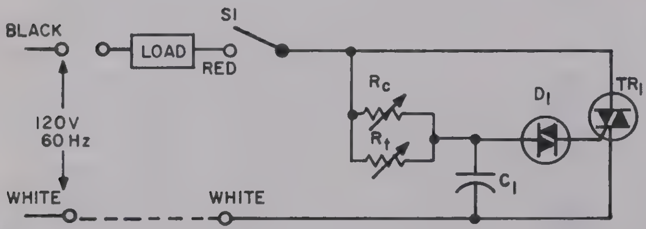
Suggested Uses:

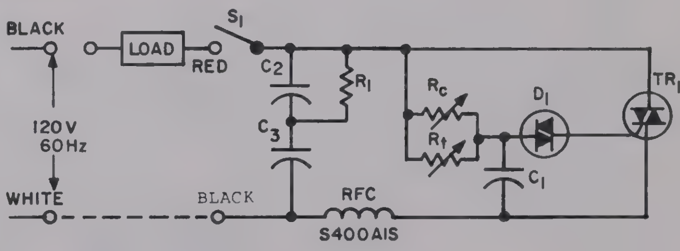
The S400A line of controls is ideally suited to the control of shaded-pole and permanent split-capacitor type motors of appropriate current rating. The control can also be used effectively in the control of series-universal type motors in many applications. A partial list of potential S400A applications is shown below:

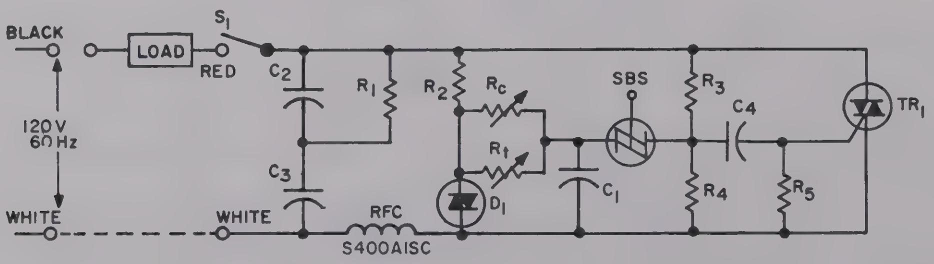
Room air conditioners
Window fans
Fan & coil air conditioners
Range hood fans

Kitchen exhaust fans
Bathroom ventilators
Roof ventilators
Unit heaters & coolers

Humidifiers
Dehumidifiers
Evaporative coolers
Air purifiers


BLACK
LOAD
SI
RED
120V
60 Hz
WHITE
WHITE
Rc
Rt
D1
TR1
C1


BLACK
LOAD
S1
RED
120V
60 Hz
WHITE
BLACK
C2
R1
C3
RFC
S400AIS
Rc
Rt
D1
C1
TR1


BLACK
LOAD
S1
RED
120V
60 Hz
WHITE
WHITE
C2
R1
C3
RFC
S400AISC
R2
Rc
Rt
D1
C1
SBS
R3
C4
R4
R5
TR1

Bi-Directional Triode Thyristor

3A RMS Up to 400 Volts

SC35,6

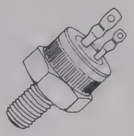
General Electric's Triac is a bi-directional triode thyristor which may be gate triggered from a blocking to a conducting state for either polarity of applied voltage. This device will perform most of the functions of two SCR's (silicon controlled rectifiers) connected in inverse parallel.

The GE SC35/SC36 series Triac is designed for 120 and 240 volt, 50 and 60 Hz AC switching and control applications such as lamp dimming, motor speed and temperature controlling, and static switching. The device is able to withstand the inrush surge of any parallel combination of tungsten lamp loads totaling 360 watts on a 120-volt line or 720 watts on a 240-volt line.

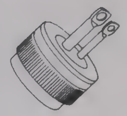
An important feature of the SC35/SC36 is its ability to switch into the conducting state should a breakover voltage in either polarity be exceeded, thus providing inherent immunity from transient voltage damage which generally eliminates the need for auxiliary protective devices.

Available as a stud-mounted unit (SC35) or a press-fit type (SC36), these devices are also available with special mounting variations for printed board work.

SC35



SC36



MAXIMUM ALLOWABLE RATINGS

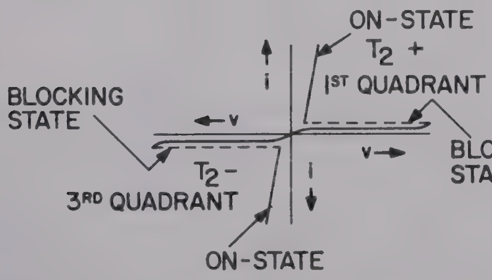
TYPE	RMS CURRENT, On-State*	PEAK FORWARD BLOCKING VOLTAGE, V_{FOM}** T_J = Max. Allowable Operating Junction Temperature				PEAK ONE-CYCLE SURGE FORWARD CURRENT, I_{FM} (surge)***	OPERATING TEMPERATURE, T_J
	Amperes	F Volts	A Volts	B Volts	D Volts		
SC35 F, A, B, D SC36 F, A, B, D	3	50	100	200	400	30	−40°C to +100°C

* See Figure 4 (Maximum Allowable Case Temperature For Conduction Current).

** Ratings apply for zero gate voltage only. Maximum case-to-ambient thermal resistance for which V_{FOM} ratings apply equals 18°C/watt. Values apply in either direction.

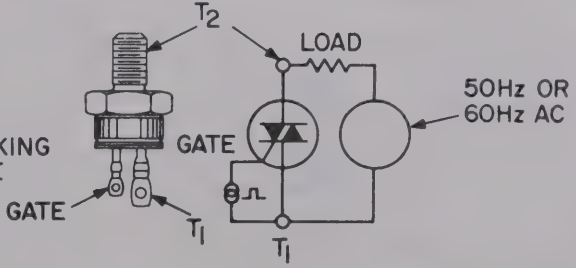
*** One full cycle of a 60 Hz sine wave. Refer to Figure 3 (Peak Current Surge).

Peak Gate Power Dissipation, P_{GM}	10 watts
Average Gate Power Dissipation, $P_{G(AV)}$	0.5 watts
Storage Temperature, T_{STG}	−40°C to +125°C
Stud Torque	25 Lb-in (29 Kg-cm)



TYPICAL E−I CHARACTERISTICS

Note: T_2 and gate terminal polarity is always referenced to T_1.



TERMINAL ARRANGEMENT

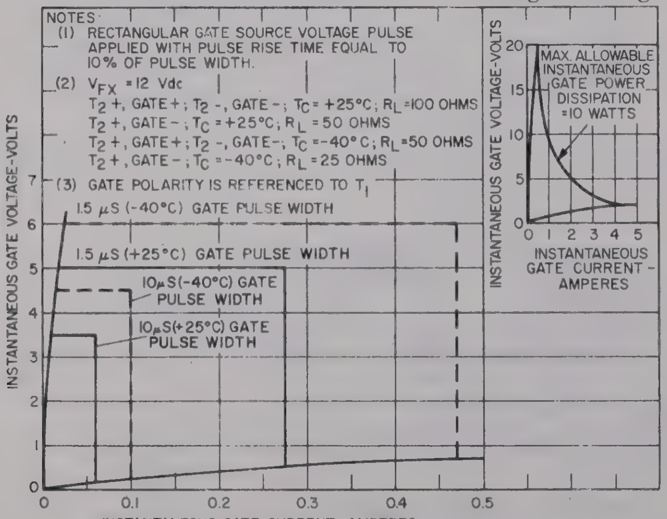
FOR TRIAC TRIGGERS SEE PAGE 153

CHARACTERISTICS

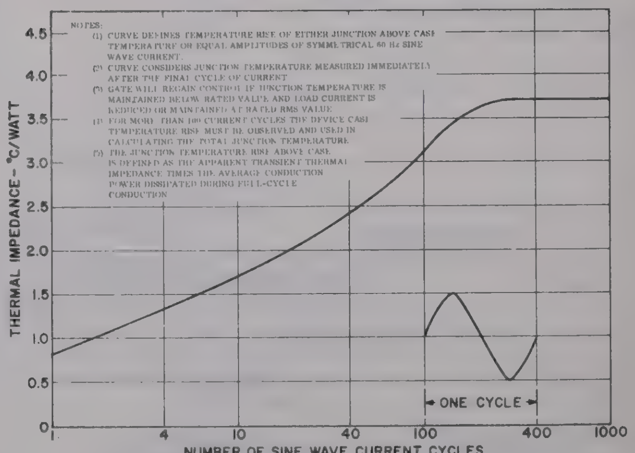
TEST	SYMBOL	MIN.	MAX.	UNITS	TEST CONDITIONS
PEAK FORWARD BLOCKING CURRENT	I_{FOM}	—	2*	mA	$T_C = +100°C$, V_{FOM} = Max. Allowable Peak Forward Blocking Voltage.
GATE TRIGGER CURRENT**	I_{GT}	— —	50 50	mAdc	$T_C = +25°C$; $V_{FX} = 12$ Vdc; Gate Pulse Width $\geqq 50$ μsec. T_2+, Gate+; T_2-, Gate−; $R_L = 100$ ohms; T_2+, Gate−; $R_L = 50$ ohms
		— —	80 80		$T_C = -40°C$; $V_{FX} = 12$ Vdc; Gate Pulse Width $\geqq 50$ μsec. T_2+, Gate+; T_2-, Gate−; $R_L = 50$ ohms; T_2+, Gate−; $R_L = 25$ ohms
GATE TRIGGER VOLTAGE**	V_{GT}	— —	3 3	Vdc	$T_C = +25°C$; $V_{FX} = 12$ Vdc; Gate Pulse Width $\geqq 50$ μsec. T_2+, Gate+; T_2-, Gate−; $R_L = 100$ ohms; T_2+, Gate−; $R_L = 50$ ohms
		— —	4 4		$T_C = -40°C$; $V_{FX} = 12$ Vdc; Gate Pulse Width $\geqq 50$ μsec. T_2+, Gate+; T_2-, Gate−; $R_L = 50$ ohms; T_2+, Gate−; $R_L = 25$ ohms
		.15	—		$T_C = +100°C$, V_{FXM} = Max. Allowable Peak Forward Blocking Voltage. $R_L = 1000$ ohms, Gate Pulse Width = dc. T_2+, Gate+; T_2-, Gate−; T_2+, Gate−; T_2-, Gate+
PEAK ON-VOLTAGE	V_{FM}	—	2.3*	Volts	$T_C = +25°C$, $I_{FM} = 10$ msec. Pulse Width, Duty Cycle $\leqq 1\%$. $I_{FM} = 4.25$A Peak
HOLDING CURRENT	I_{HO}	— —	50* 100*	mAdc	$V_{FX} = 24$ Vdc; Gate Supply = 7 Volts, 20 ohms. Initial on-state current pulse = 1.0 amps; 0.1 msec. to 10 msec. wide. $T_C = +25°C$ $T_C = -40°C$
LATCHING CURRENT	I_{LX}	— — — —	100 200 200 400	mAdc	$V_{FX} = 24$ Vdc; Gate Supply = 30 Volts, 200 ohms. 50 μsec. pulse width. $T_C = +25°C$ } T_2+, Gate+; T_2-, Gate− $T_C = -40°C$ } $T_C = +25°C$ } T_2+, Gate− $T_C = -40°C$ }
EFFECTIVE THERMAL RESISTANCE (DC)	θ_{J-C}	—	4.5*	°C/watt	Junction to Case.
MAXIMUM RATE OF RISE OF TERMINAL VOLTAGE THAT WILL ALLOW TRIAC TO COMMUTATE	$dv/dt_{(c)}$	2*	—	Volts/ μsec	RMS Current, On-State = Rated. T_C = Max. Allowable @ Rated RMS Current, V_{FXM} = Rated. Gate bias @ commutation = 0 Volts, 10,000 ohms. di/dt @ commutation = 1.6 A/msec.

*Values apply in either direction.

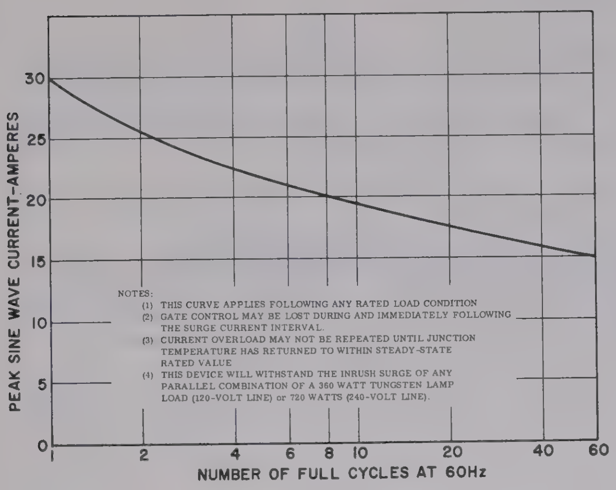
**Selection of T_2-, Gate+ trigger current and voltage upon request. (Refer to Figure 1 for gate pulse widths less than 50 μsec.)



1. MAXIMUM PULSE GATE TRIGGER CHARACTERISTICS

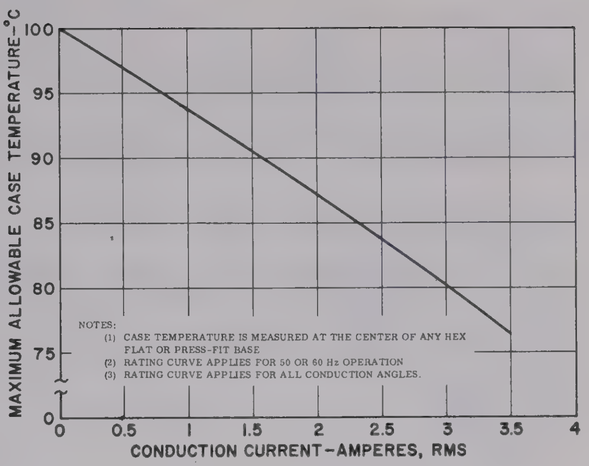


2. MAXIMUM 60 Hz SINE WAVE APPARENT TRANSIENT THERMAL IMPEDANCE



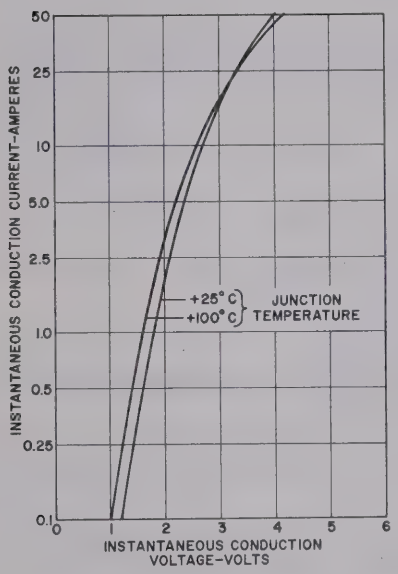
NOTES:
(1) THIS CURVE APPLIES FOLLOWING ANY RATED LOAD CONDITION
(2) GATE CONTROL MAY BE LOST DURING AND IMMEDIATELY FOLLOWING THE SURGE CURRENT INTERVAL.
(3) CURRENT OVERLOAD MAY NOT BE REPEATED UNTIL JUNCTION TEMPERATURE HAS RETURNED TO WITHIN STEADY-STATE RATED VALUE
(4) THIS DEVICE WILL WITHSTAND THE INRUSH SURGE OF ANY PARALLEL COMBINATION OF A 360 WATT TUNGSTEN LAMP LOAD (120-VOLT LINE) or 720 WATTS (240-VOLT LINE).

3. PEAK CURRENT SURGE

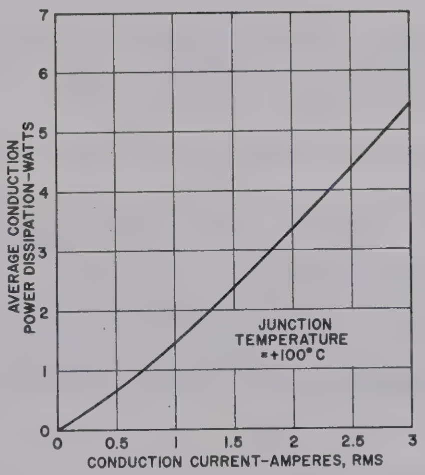


NOTES:
(1) CASE TEMPERATURE IS MEASURED AT THE CENTER OF ANY HEX FLAT OR PRESS-FIT BASE
(2) RATING CURVE APPLIES FOR 50 OR 60 Hz OPERATION
(3) RATING CURVE APPLIES FOR ALL CONDUCTION ANGLES.

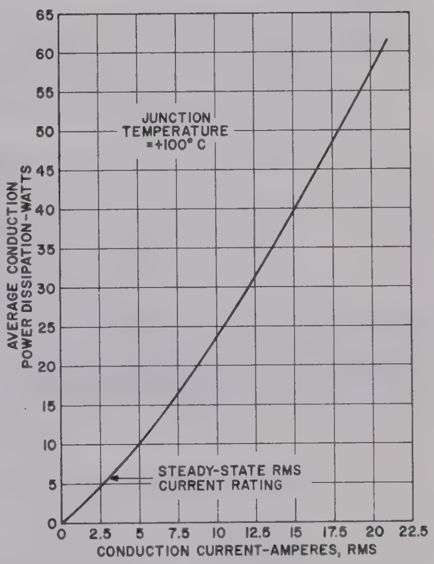
4. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR CONDUCTION CURRENT



5. MAXIMUM CONDUCTION CHARACTERISTICS FOR CONDUCTION IN EITHER DIRECTION

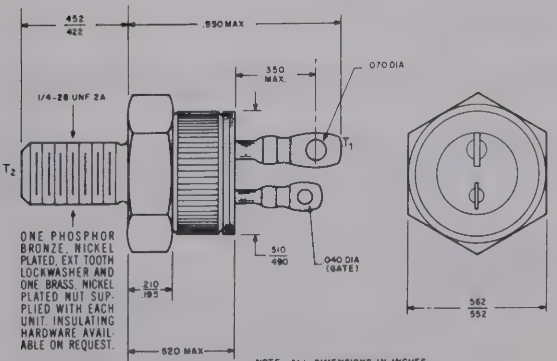


6. MAXIMUM CONDUCTION POWER DISSIPATION AS A FUNCTION OF CONDUCTION CURRENT FOR FULL CYCLE 50 OR 60 Hz SINE WAVE OF CURRENT



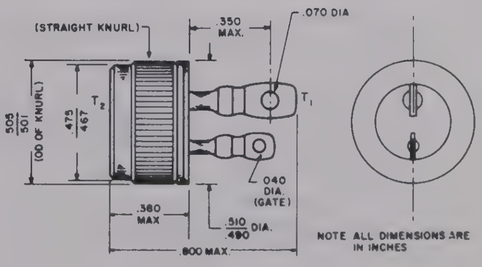
7. MAXIMUM CONDUCTION POWER DISSIPATION AS A FUNCTION OF CONDUCTION CURRENT FOR FULL CYCLE 50 OR 60 Hz SINE WAVE OF CURRENT (HIGH LEVEL)

OUTLINE DRAWINGS


.452
.422
.950 MAX
.350 MAX.
.070 DIA
1/4-28 UNF 2A
T1
T2
.510
.490
.040 DIA (GATE)
.210
.195
.520 MAX
.562
.552

ONE PHOSPHOR BRONZE, NICKEL PLATED, EXT TOOTH LOCKWASHER AND ONE BRASS, NICKEL PLATED NUT SUPPLIED WITH EACH UNIT. INSULATING HARDWARE AVAILABLE ON REQUEST.

NOTE. ALL DIMENSIONS IN INCHES


(STRAIGHT KNURL)
.350 MAX.
.070 DIA
.505
.501
(OD OF KNURL)
.475
.467
T2
T1
.040 DIA. (GATE)
.380 MAX
.510
.490
DIA.
.800 MAX.

NOTE ALL DIMENSIONS ARE IN INCHES

INSTALLATION OF PRESS-FIT DEVICES

When press fitting a Triac into a heatsink, the following specifications and recommendations apply:

1. Heatsink materials may be copper, aluminum or steel. For maximum heat transfer and minimum corrosion problems, copper is recommended. The heatsink thickness, or amount of heatsink wall, in contact with the Triac should be ⅛ inch.
2. The hole diameter into which the Triac is pressed must be 0.4975 ± .001 inch. A slight chamfer on the hole should be used. This hole may be punched in a flat plate and reamed, or extruded and sized in sheet metal.
3. The entire knurled section of the Triac should be in contact with the heatsink to insure maximum heat transfer. The Triac must not be inserted into a heatsink deeper than the knurl height.
4. The Triac insertion force must not exceed 800 pounds. If the insertion force approaches this value before complete insertion, either the Triac is misaligned with the hole or the Triac-to-hole interference is excessive. The insertion force must be uniformly applied to the top face (terminal end) of the Triac within an annular ring which has an inside diameter of not less than 0.370 inch and not larger than 0.390 inch; the outside diameter of the insertion force must not be less than 0.500 inch.
5. The thermal resistance between the Triac case and a copper heatsink will not exceed 0.5°C/W, if the Triac is inserted in the manner described.

SYMBOLS AND DEFINITIONS OF TERMS FOR TRIACS

Symbol	***Definition***
I_{FM} (surge)	**Peak One-Cycle Surge Forward Current.** The peak one-cycle surge forward current is the maximum allowable forward current having a single forward cycle (16.7 msec. duration) in a 60 Hz single-phase resistive load system. The surge may be preceded and followed by maximum rated voltage, current, and junction temperature conditions and maximum allowable gate power may be concurrently dissipated. However, limitations on anode current during switching should not be exceeded.
V_{FOM}	**Peak Forward Blocking Voltage, Gate Open.** The peak forward blocking voltage is the peak forward voltage when the device is in the off-state.
V_{FX}	**DC Forward Blocking Voltage, Gate Terminal Returned to the Main Terminal 1 Through an Impedance and/or Bias Voltage.** The DC forward blocking voltage is the DC forward voltage when the device is in the off-state.
V_{FXM}	**Peak Forward Blocking Voltage, Gate Terminal Returned to the Main Terminal 1 Through an Impedance and/or Bias Voltage.** The peak forward blocking voltage is the peak forward voltage when the device is in the off-state.
V_{FM}	**Peak On-Voltage.** The peak on-voltage is the peak forward voltage for a stated forward current when the device is in the on-state.
I_{FOM}	**Peak Forward Blocking Current, Gate Open.** The peak forward blocking current is the peak current through the collector junction when the device is in the off-state for a stated main terminal voltage.
I_{FM}	**Peak Forward Current, On-State.** The peak forward current is the peak current through the collector junction.
I_{HO}	**Holding Current, Gate Open.** The holding current is the minimum current through the collector junction required to maintain the device in the on-state for stated conditions and load.
I_{LX}	**Latching Current, Gate Terminal Returned to the Main Terminal I Through an Impedance and/or Bias Voltage.** The latching current is the minimum current which must pass through the collector junction in order for the device to switch to the on-state and remain in the on-state after removal of the gate trigger voltage, for stated conditions.
V_{GT}	**Gate Trigger Voltage, DC.** The DC gate trigger voltage is the DC voltage between the gate and the Main Terminal 1 required to produce the DC gate trigger current.
I_{GT}	**Gate Trigger Current, DC.** The DC gate trigger current is the minimum DC gate current required to cause switching from the off-state to the on-state for a stated main terminal voltage.
P_{GM}	**Peak Gate Power Dissipation.** Peak gate power dissipation is the maximum allowable instantaneous value of gate power dissipation permitted between the gate and Main Terminal 1.
$P_{G(AV)}$	**Average Peak Gate Power Dissipation.** Average gate power dissipation is the maximum allowable gate power dissipation between the gate and Main Terminal 1, averaged over a full cycle.
θ_{J-C}	**Thermal Resistance, Junction to Case (effective).** The thermal resistance of a semiconductor device is the effective temperature rise per unit power dissipation of a designated junction above the temperature of the case, under conditions of thermal equilibrium.
$dv/dt_{(c)}$	**Rate of Rise of Main Terminal to Main Terminal Voltage During Commutation.** As specified for the device, this value will permit the device to commutate rated voltage under stated conditions. This rate of rise is defined as the maximum instantaneous slope occurring during the first 100 μsec., starting when the voltage across the test device passes through 0.

T_C = Case Temperature
T_{STG} = Storage Temperature
T_J = Junction Temperature
R_L = Load Resistor
T_1 = Main Terminal 1
T_2 = Main Terminal 2

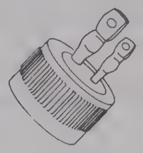
Bi-Directional Triode Thyristor

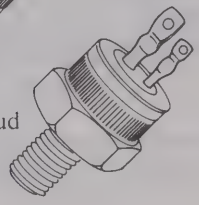
SC40,1

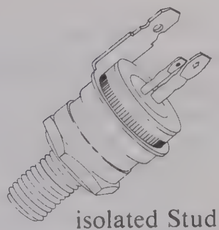
6A RMS Up to 500 Volts

Variations

Mechanical	Electrical
Press-Fit	Zero Voltage Switch Type
Stud	Selected Gate Type
Isolated Stud	400 Hertz Type


Press-Fit


Stud


isolated Stud

The Triac is a bi-directional triode thyristor which may be gate triggered from an OFF to an ON state for either polarity of applied voltage. This device will perform most of the functions of two SCR's connected in inverse parallel.

Features:

- 80A Peak One Full Cycle Surge Rating
- 600 watt load (120V line)
- 1200 watt load (240V line)
- Inherent immunity from transient voltage damage (can be broken over safely in either direction)
- Press-Fit, Stud, and Isolated Stud Packages available
- Standard Electrical Variations available:
  (1) Selected for use with the General Electric PA424 Zero Voltage Switch
  (2) Selected for 25mA Maximum Gate Trigger Current in all four modes.
  (3) Selected for Operation at 400 Hz.

TYPICAL TRIAC APPLICATIONS

GENERAL FUNCTIONS

TYPES OF EQUIPMENT	Heat Control	Motor Speed Control	Light Control	Solid State Contactors and Relays	Power Regulation
Photographic Dev. Equip.	X		X		
Process Control	X	X	X	X	X
Reproduction Equipment	X	X	X	X	
Bio-Medical	X	X	X	X	X
Air Conditioners		X			
Blenders, Mixers		X			
Computer Tape Decks		X			
Fans		X			
Hand Tools		X			
Machine Tools/Misc. Mfg.		X		X	
Sewing Machines		X			
Laundry				X	
Farm Equipment	X	X	X	X	
Light Dimmers			X		
Photographic Equipment	X		X	X	
Outdoor Signs			X	X	
Clutches/Brakes				X	
Industrial Timers				X	
Traffic Signal Control			X	X	
Vending Machines	X			X	
Aircraft	X	X	X	X	
Computer Power Supplies					X
Home Entertainment	X	X	X	X	X

FOR TRIAC TRIGGERS SEE PAGE 153

MAXIMUM ALLOWABLE RATINGS—ALL TYPES

PACKAGE	ELECTRICAL TYPE				Repetitive Peak Off-State Voltage $V_{DRM}^{(1)}$ $T_C = -40°C$ to $+100°C$
	Standard Type	Zero Voltage Switch	Selected Gate	400 Hz Operation	
PRESS-FIT	SC41B	SC41B12	SC41B13	SC41B14	200 Volts
STUD	SC40B	SC40B12	SC40B13	SC40B14	
ISOLATED STUD	SC40B2	SC40B22	SC40B23	SC40B24	
PRESS-FIT	SC41D	SC41D12	SC41D13	SC41D14	400 Volts
STUD	SC40D	SC40D12	SC40D13	SC40D14	
ISOLATED STUD	SC40D2	SC40D22	SC40D23	SC40D24	
PRESS-FIT	SC41E	SC41E12	SC41E13	SC41E14	500 Volts
STUD	SC40E	SC40E12	SC40E13	SC40E14	
ISOLATED STUD	SC40E2	SC40E22	SC40E23	SC40E24	

RMS On-State Current, $I_{T(RMS)}$ .... 6 Amperes

Peak One Full Cycle Surge (non-rep) On-State Current, I_{TSM} (50 Hz) .... 74 Amperes

(60 Hz) .... 80 Amperes

(400 Hz) .... 173 Amperes

I^2t (for fusing), for time at$^{(2)}$ { 1.0 millisecond .... 18 } Ampere² seconds

{ 8.3 millisecond .... 26.5 } (See Chart 14)

Peak Gate Power Dissipation, $P_{GM}^{(3)}$ .... 10 Watts for 10 microseconds (See Chart5)

Average Gate Power Dissipation, $P_{G(AV)}$ .... 0.5 Watts

Peak Gate Current, $I_{GM}^{(3)}$ .... See Chart 5

Peak Gate Voltage, $V_{GM}^{(3)}$ .... See Chart 5

Critical Rate-of-Rise of On-State Current, di/dt$^{(2)}$:

Breakover voltage triggered operation .... 10 Amperes per microsecond

Storage Temperature, T_{STG} .... −40°C to +125°C

Operating Temperature, T_J .... −40°C to +100°C

Stud Torque—**(STUD & ISOLATED STUD TYPES)** .... 25 Lb-in (29 Kg-cm)

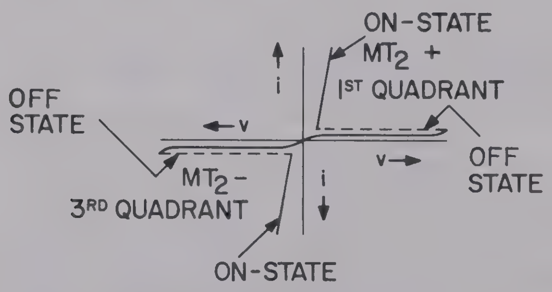
Insertion Pressure—**(PRESS-FIT TYPE)** .... 800 lbs (364 Kg)

NOTES:

[1] Ratings apply for zero gate voltage only. Maximum case-to-ambient thermal resistance for which V_{DRM} ratings apply equals 18°C/watt. Ratings apply for either polarity of main terminal 2 voltage referenced to main terminal 1.

[2] Ratings apply for either polarity of main terminal 2 referenced to main terminal 1.

[3] Ratings apply for either polarity of gate terminal referenced to main terminal 1.



TYPICAL E-I CHARACTERISTICS

WARNING

Isolated stud products described in this specification sheet should be handled with care. The ceramic portion of these thyristors contains BERYLLIUM OXIDE as a major ingredient.

Do not crush, grind, or abrade these portions of the thyristors because the dust resulting from such action may be hazardous if inhaled.

TABLE I—STANDARD TYPE

CHARACTERISTICS										Reference Note
Type	Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions			
All types	Peak Off-state current	I_{DRM}				mA	V_{DRM} = Maximum Allowable Peak Off-state voltage Gate Open Circuited			1
			—	—	0.5		T_C = + 25°C			
			—	—	2.0		T_C = +100°C			
All types	Peak-On-State Voltage	V_{TM}	—	—	1.83	Volts	T_C = +25°C, I_{TM} = 8.5 A peak. 1 millisecond wide pulse, Duty cycle ≦ 2%			2
All types	Critical Rate of Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt	—	20	—	Volts/μsec	T_C = +100°C, Rated V_{DRM} Gate Open Circuited, Exponential Waveform			2
All except 400 Hertz Type (Refer to Table IV)	Critical Rate of Rise of Commutating Off-State Voltage (Commutating dv/dt)	dv/dt(c)	2.0	—	—	Volts/μsec	T_C = +75°C, $I_{T(RMS)}$ = Rated Max. Allowable RMS On-State Current, V_{DRM} = Rated Maximum Allowable Peak Off-State Voltage, Gate Open Circuited, Commutating di/dt = 3.2 A/msec			2
All except selected gate type (Refer to Table III)	D.C. Gate Trigger Current	I_{GT}				mAdc	V_D = 12 Vdc			3
							Trigger Mode	R_L	T_C	
			—	—	50		MT2+ Gate+	100 ohms	25°C	
			—	—	50		MT2− Gate−	100 ohms		
			—	—	50		MT2+ Gate−	50 ohms		
			—	—	80		MT2+ Gate+	50 ohms	−40°C	
			—	—	80		MT2− Gate−	50 ohms		
			—	—	80		MT2+ Gate−	25 ohms		
All except selected gate type (Refer to Table III)	D.C. Gate Trigger Voltage	V_{GT}				Vdc	V_D = 12 Vdc			3
							Trigger Mode	R_L	T_C	
			—	—	2.5		MT2+ Gate+	100 ohms	25°C	
			—	—	2.5		MT2− Gate−	100 ohms		
			—	—	2.5		MT2+ Gate−	50 ohms		
			—	—	3.5		MT2+ Gate+	50 ohms	−40°C	
			—	—	3.5		MT2− Gate−	50 ohms		
			—	—	3.5		MT2+ Gate−	25 ohms		
			0.20	—	—		MT2+ Gate+ MT2− Gate− MT2+ Gate− MT2− Gate+	1000 ohms	100°C	3,4
All Types	Holding Current	I_H				mAdc	Main Terminal Source Voltage = 24 Vdc, Peak initiating on-state current = 0.5A, 0.1 milliseconds to 10 milliseconds wide pulse, Gate trigger source = 7 V, 20 Ohms			2
			—	—	50		T_C = 25°C			
			—	—	100		T_C = −40°C			
All Types	Latching Current	I_L				mAdc	Main Terminal Source Voltage = 24 Vdc, Gate trigger source = 15 V, 100 Ohms, 50 μsec pulse width, 5 μsec rise and fall times max			3
							Trigger Mode		T_C	
			—	—	100		MT2+ Gate+		25°C	
			—	—	100		MT2− Gate−			
			—	—	200		MT2+ Gate−			
			—	—	200		MT2+ Gate+		−40°C	
			—	—	200		MT2− Gate−			
			—	—	400		MT2+ Gate−			
Press-fit & stud type	Steady-State Thermal Resistance	$R_{\theta JC}$	—	—	2.8	°C/Watt	Junction to Case			2
Isolated stud type			—	—	3.1					

NOTES

[1] Maximum case-to-ambient thermal resistance for which maximum V_{DRM} ratings apply equals 18°C per watt. Values apply for either polarity of main terminal 2 characteristic referenced to main terminal 1.

[2] Values apply for either polarity of main terminal 2 characteristic referenced to main terminal 1.

[3] Main terminal 1 is the reference terminal for main terminal 2 and gate terminal.

[4] With V_D equal to maximum allowable off-state voltage.

TABLE II—ZERO VOLTAGE SWITCH TYPE (FOR USE WITH PA424 ZERO VOLTAGE SWITCH)

NOTE: ALL STANDARD CHARACTERISTICS APPLY EXCEPT AS INDICATED

CHARACTERISTICS									Reference Note
Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions			
Pulse Gate Trigger Current	I_{GT}				mAdc	$V_D = 3$ Vdc, Gate Pulse width = 50 μsec			1
						Trigger Mode	R_L	T_C	
		—	—	30		MT2− Gate−	20 ohms	25°C	
						MT2+ Gate−			
		—	—	46		MT2− Gate−	14 ohms	−20°C	
						MT2+ Gate−			
Pulse Gate Trigger Voltage	V_{GT}				Volts	$V_D = 3$ Vdc, Gate Pulse width = 50 μsec			1
						Trigger Mode	R_L	T_C	
		—	—	2.0		MT2− Gate−	20 ohms	25°C	
						MT2+ Gate−			
		—	—	2.75		MT2− Gate−	14 ohms	−20°C	
						MT2+ Gate−			
Latching Current	I_L				mAdc	Main Terminal Source Voltage = 3 Vdc, Gate trigger source = PA424			1
						Trigger Mode	T_C		
		—	—	115		MT2− Gate−	25°C		
						MT2+ Gate−			
		—	120	—		MT2− Gate−	−20°C		
						MT2+ Gate−			

TABLE III—SELECTED GATE TYPE

NOTE: ALL STANDARD CHARACTERISTICS APPLY EXCEPT AS INDICATED

CHARACTERISTICS									Reference Note
Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions			
D.C. Gate Trigger Current	I_{GT}				mAdc	$V_D = 12$ Vdc			1
						Trigger Mode	R_L	T_C	
		—	—	25		MT2+ Gate+	100 ohms	25°C	
		—	—	25		MT2− Gate−	100 ohms		
		—	—	25		MT2+ Gate−	50 ohms		
		—	—	25		MT2− Gate+	50 ohms		
		—	—	50		MT2+ Gate+	50 ohms	−40°C	
		—	—	50		MT2− Gate−	50 ohms		
		—	—	50		MT2+ Gate−	25 ohms		
		—	—	50		MT2− Gate+	25 ohms		
D.C. Gate Trigger Voltage	V_{GT}				Vdc	$V_D = 12$ Vdc			1
						Trigger Mode	R_L	T_C	
		—	—	2.0		MT2+ Gate+	100 ohms	25°C	
		—	—	2.0		MT2− Gate−	100 ohms		
		—	—	2.0		MT2+ Gate−	50 ohms		
		—	—	2.0		MT2− Gate+	50 ohms		
		—	—	3.0		MT2+ Gate+	50 ohms	−40°C	
		—	—	3.0		MT2− Gate−	50 ohms		
		—	—	3.0		MT2+ Gate−	25 ohms		
		—	—	3.0		MT2− Gate+	25 ohms		

TABLE IV—400 HZ OPERATION TYPE

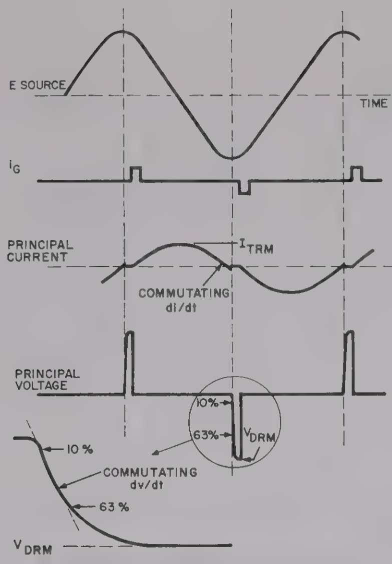
NOTE: ALL STANDARD CHARACTERISTICS APPLY EXCEPT AS INDICATED

CHARACTERISTICS							Reference Note
Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions	
Critical Rate of Rise of Commutating Off-State Voltage (Commutating dv/dt)	dv/dt(c)	2.0	—	—	Volts/μsec	$T_C = +75°C$, $I_{T(RMS)}$ = Rated Max. Allowable RMS On-State Current V_{DRM} = Rated Maximum Allowable Peak Off-State Voltage Gate Open Circuited Commutating di/dt = 21.5 A/msec	2

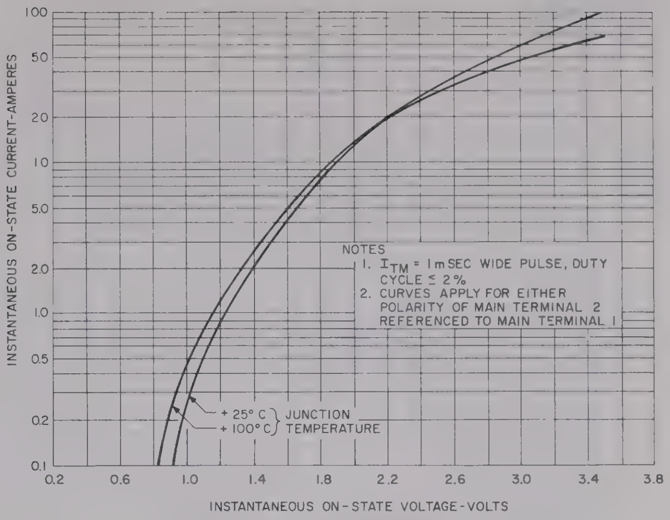
NOTES

[1] Main terminal 1 is the reference terminal for main terminal 2 and gate terminal.

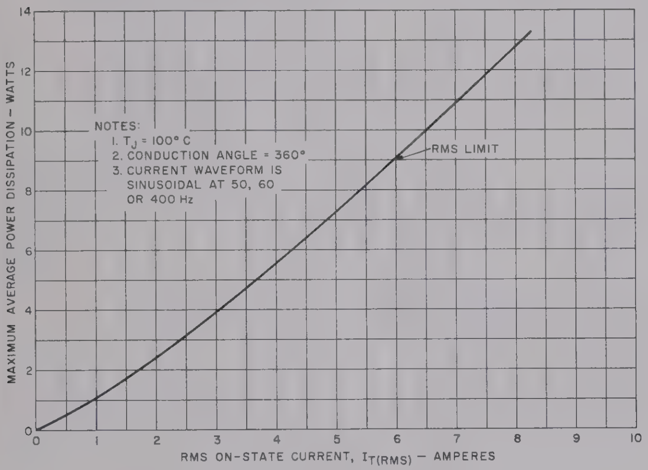
[2] Values apply for either polarity of main terminal 2 characteristic referenced to main terminal 1.


E SOURCE
TIME →
I_G
PRINCIPAL CURRENT
I_{TRM}
COMMUTATING dI/dt
PRINCIPAL VOLTAGE
10%
63%
V_{DRM}
10 %
COMMUTATING dv/dt
63 %
V_{DRM}

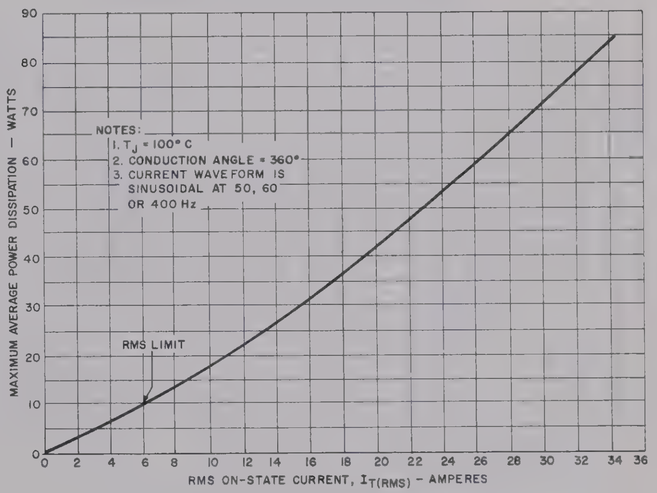
1. Waveform of Commutating dv/dt



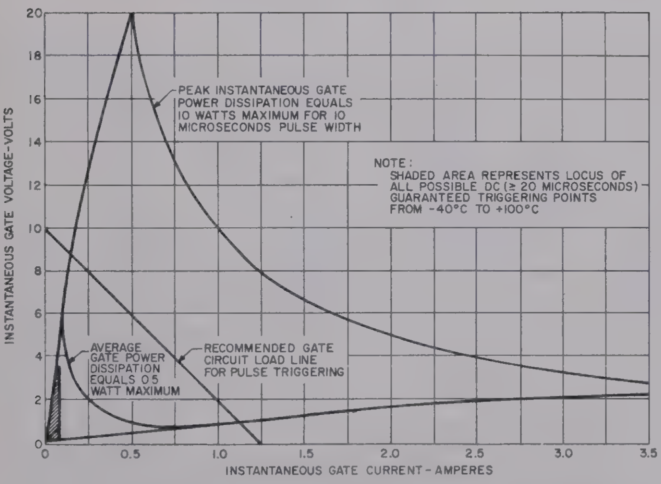
2. Maximum On-State Voltage vs. On-State Current



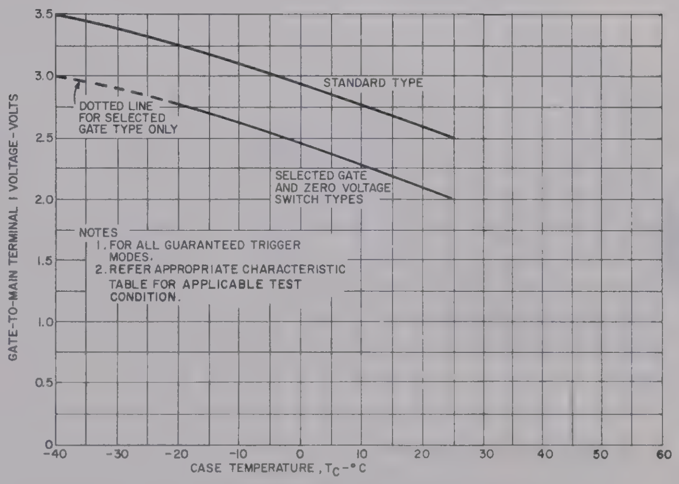
3. Maximum Average Power Dissipation vs. RMS On-State Current



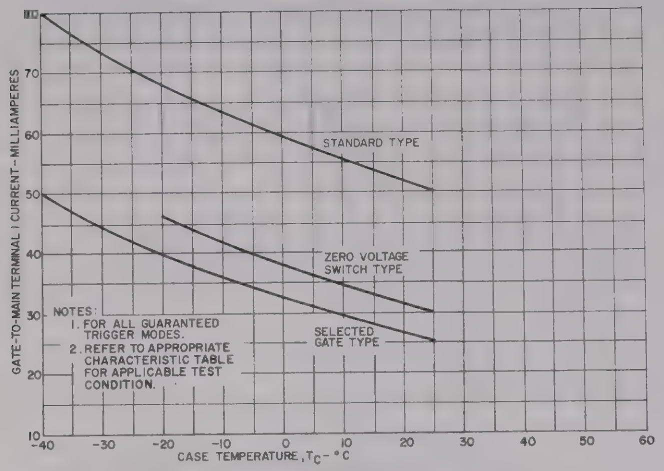
4. Maximum Average Power Dissipation vs. RMS On-State Current (High Level)



5. Gate Characteristics and Ratings

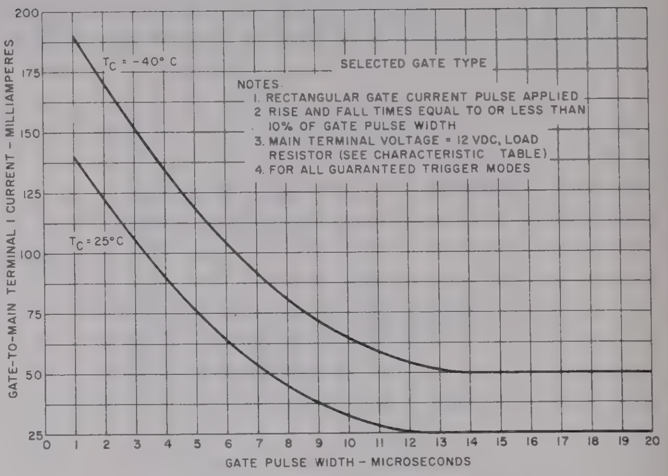


6. Maximum DC Gate Trigger Voltage vs. Case Temperature



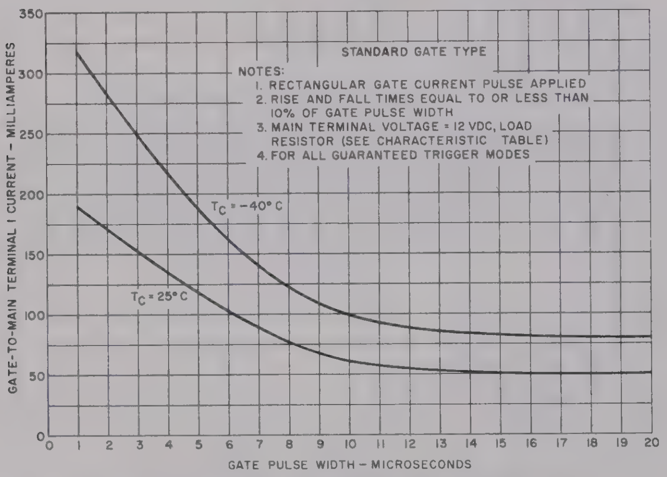
NOTES:
1. FOR ALL GUARANTEED TRIGGER MODES.
2. REFER TO APPROPRIATE CHARACTERISTIC TABLE FOR APPLICABLE TEST CONDITION.

7. Maximum DC Gate Trigger Current vs. Case Temperature



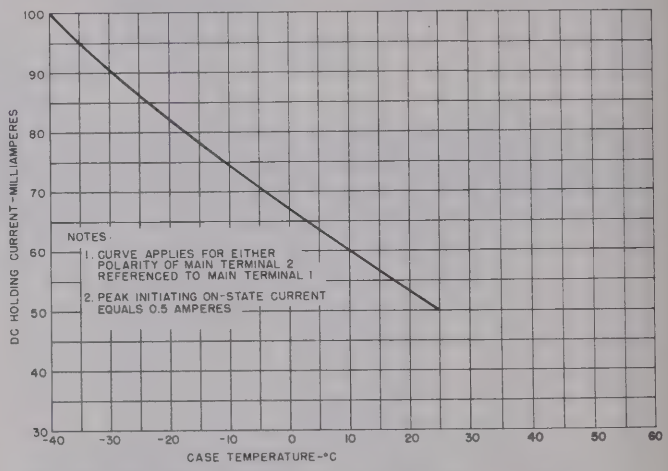
NOTES:
1. RECTANGULAR GATE CURRENT PULSE APPLIED
2. RISE AND FALL TIMES EQUAL TO OR LESS THAN 10% OF GATE PULSE WIDTH
3. MAIN TERMINAL VOLTAGE = 12 VDC, LOAD RESISTOR (SEE CHARACTERISTIC TABLE)
4. FOR ALL GUARANTEED TRIGGER MODES

8. Maximum Gate Trigger Current vs. Gate Pulse Width (Selected Gate Type)



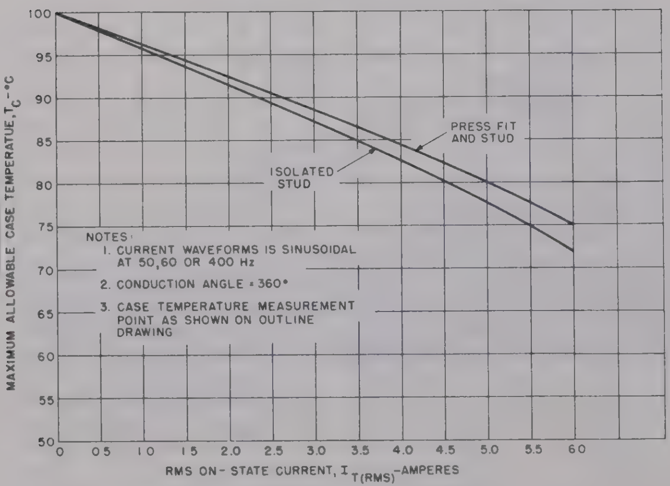
NOTES:
1. RECTANGULAR GATE CURRENT PULSE APPLIED
2. RISE AND FALL TIMES EQUAL TO OR LESS THAN 10% OF GATE PULSE WIDTH
3. MAIN TERMINAL VOLTAGE = 12 VDC, LOAD RESISTOR (SEE CHARACTERISTIC TABLE)
4. FOR ALL GUARANTEED TRIGGER MODES

9. Maximum Gate Trigger Current vs. Gate Pulse Width (Standard Gate Type)



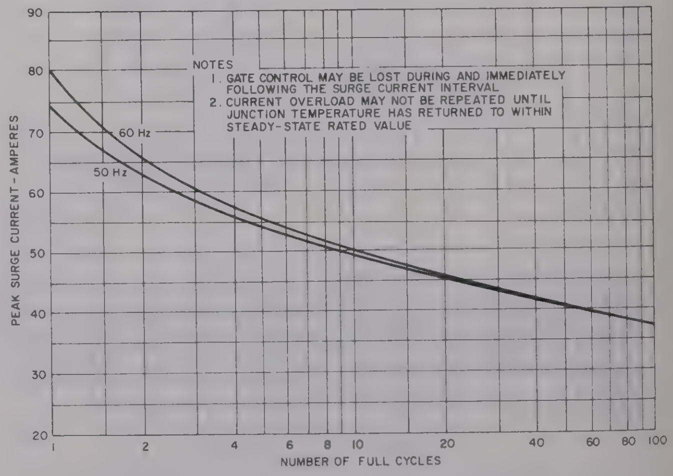
NOTES:
1. CURVE APPLIES FOR EITHER POLARITY OF MAIN TERMINAL 2 REFERENCED TO MAIN TERMINAL 1
2. PEAK INITIATING ON-STATE CURRENT EQUALS 0.5 AMPERES

10. Maximum DC Holding Current vs. Case Temperature



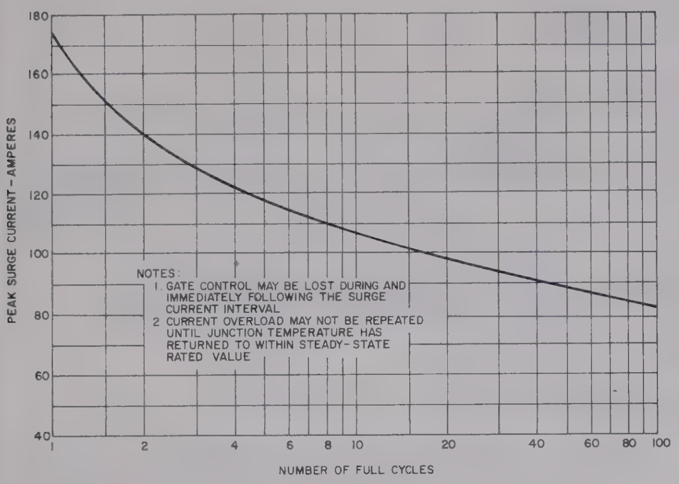
NOTES:
1. CURRENT WAVEFORMS IS SINUSOIDAL AT 50,60 OR 400 Hz
2. CONDUCTION ANGLE = 360°
3. CASE TEMPERATURE MEASUREMENT POINT AS SHOWN ON OUTLINE DRAWING

11. Maximum Allowable Case Temperature vs. RMS On-State Current



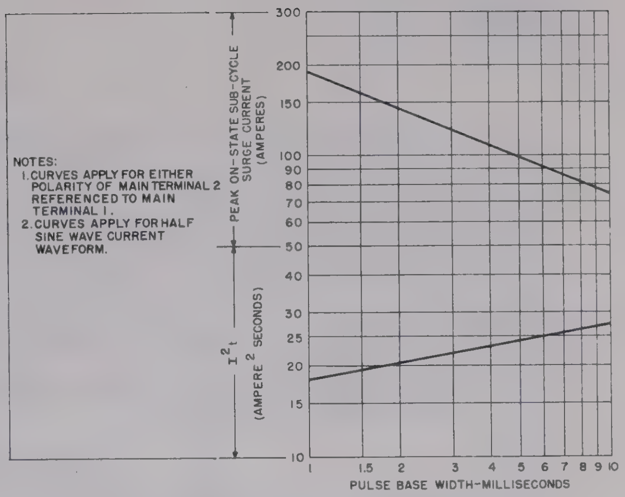
NOTES
1. GATE CONTROL MAY BE LOST DURING AND IMMEDIATELY FOLLOWING THE SURGE CURRENT INTERVAL
2. CURRENT OVERLOAD MAY NOT BE REPEATED UNTIL JUNCTION TEMPERATURE HAS RETURNED TO WITHIN STEADY-STATE RATED VALUE

12. Maximum Allowable Full Cycle Surge Current Following Rated Load Conditions



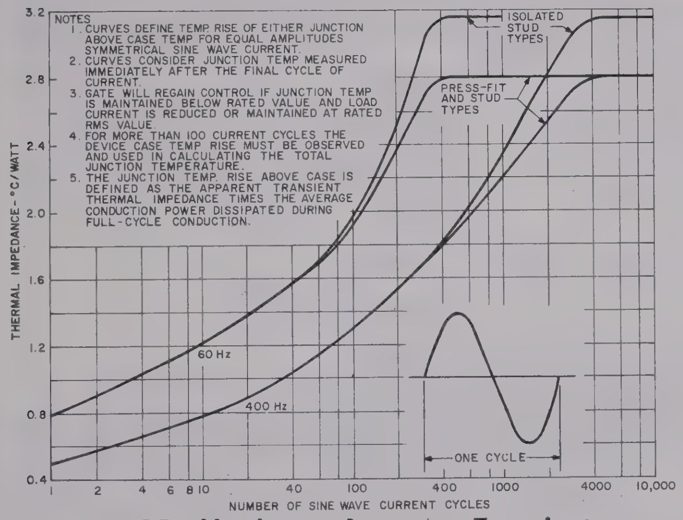
NOTES:
1. GATE CONTROL MAY BE LOST DURING AND IMMEDIATELY FOLLOWING THE SURGE CURRENT INTERVAL
2. CURRENT OVERLOAD MAY NOT BE REPEATED UNTIL JUNCTION TEMPERATURE HAS RETURNED TO WITHIN STEADY-STATE RATED VALUE

13. Maximum Allowable Full Cycle Surge Current Following Rated Load Conditions (400 Hz)



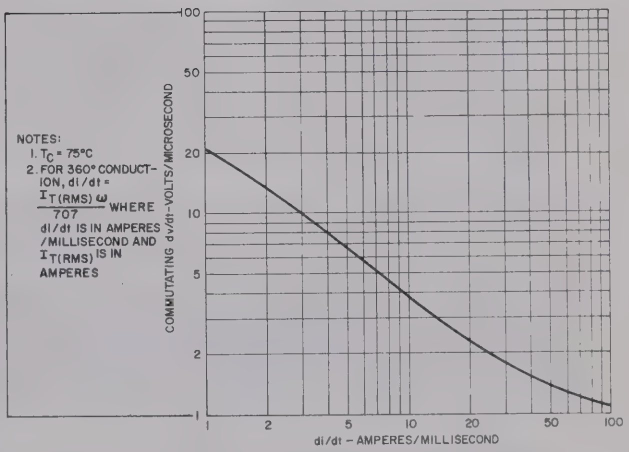
NOTES:
1. CURVES APPLY FOR EITHER POLARITY OF MAIN TERMINAL 2 REFERENCED TO MAIN TERMINAL 1.
2. CURVES APPLY FOR HALF SINE WAVE CURRENT WAVEFORM.

14. Sub-Cycle Surge and I^2t Ratings Following Rated Load Conditions



NOTES
1. CURVES DEFINE TEMP. RISE OF EITHER JUNCTION ABOVE CASE TEMP FOR EQUAL AMPLITUDES SYMMETRICAL SINE WAVE CURRENT.
2. CURVES CONSIDER JUNCTION TEMP MEASURED IMMEDIATELY AFTER THE FINAL CYCLE OF CURRENT.
3. GATE WILL REGAIN CONTROL IF JUNCTION TEMP IS MAINTAINED BELOW RATED VALUE AND LOAD CURRENT IS REDUCED OR MAINTAINED AT RATED RMS VALUE.
4. FOR MORE THAN 100 CURRENT CYCLES THE DEVICE CASE TEMP RISE MUST BE OBSERVED AND USED IN CALCULATING THE TOTAL JUNCTION TEMPERATURE.
5. THE JUNCTION TEMP. RISE ABOVE CASE IS DEFINED AS THE APPARENT TRANSIENT THERMAL IMPEDANCE TIMES THE AVERAGE CONDUCTION POWER DISSIPATED DURING FULL-CYCLE CONDUCTION.

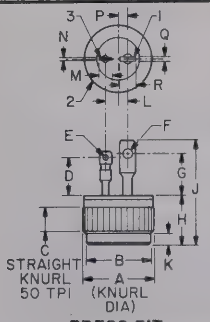
15. Maximum Apparent Transient Thermal Impedance



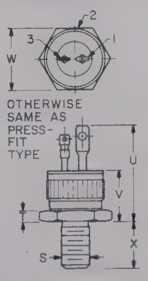
NOTES:
1. $T_C = 75°C$
2. FOR 360° CONDUCTION, $di/dt = \frac{I_{T(RMS)}\,\omega}{707}$ WHERE di/dt IS IN AMPERES/MILLISECOND AND $I_{T(RMS)}$ IS IN AMPERES

16. Typical Rate of Removal of Current (di/dt) Effect Upon Commutating dv/dt

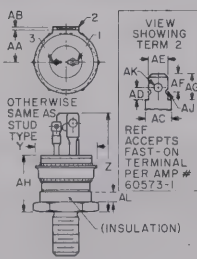
OUTLINE DRAWINGS



PRESS-FIT



STUD

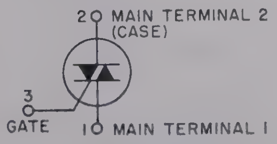

AB
2
3
1
AA
VIEW SHOWING TERM 2
AE
AK
AF
AG
AD
AJ
AC
REF ACCEPTS FAST-ON TERMINAL PER AMP # 60573-1
OTHERWISE SAME AS STUD TYPE
Y
Z
AH
AL
(INSULATION)

ISOLATED STUD

SYM	DECIMAL (INCHES) MIN.	DECIMAL (INCHES) MAX	METRIC (MM) MIN.	METRIC (MM) MAX.
A	.501	.505	12.73	12.83
B	.467	.475	11.86	12.07
C	.177 REF.		4.50 REF.	
D	.260	.301	6.60	7.65
E	.035	.045	.89	1.14
F	.065	.075	1.65	1.41
G		.350		8.89
H	.340	.376	8.64	9.55
J		.782		19.86
K	.083	.097	2.11	2.46
L	.130	.180	3.30	4.57
M	.085	.115	2.16	2.92

SYM	DECIMAL (INCHES) MIN.	DECIMAL (INCHES) MAX.	METRIC (MM) MIN.	METRIC (MM) MAX.
N	.016	.023	.41	.58
P	.065 REF.		1.65 REF.	
Q	.028	.035	.71	.89
R	.110	.135	2.79	3.43
S	1/4-28 UNF2A		1/4-28 UNF2A	
T	.086	.098	2.18	2.49
U		.865		21.79
V		.475		12.07
W	.552	.562	14.02	14.27
X	.432	.442	10.97	11.23
Y	.580	.610	14.73	15.49

SYM	DECIMAL (INCHES) MIN.	DECIMAL (INCHES) MAX.	METRIC (MM) MIN.	METRIC (MM) MAX.
Z		.975		24.77
AA	.290	.330	7.37	8.38
AB	.017	.024	.43	.61
AC	.235	.265	5.97	6.73
AD	.115	.121	2.29	3.07
AE	.186	.189	4.72	4.80
AF	.170 REF.		4.32 REF	
AG	.245	.255	6.22	6.48
AH		.585		14.86
AJ	.025	R-REF.	.64	R-REF.
AK	.065	.070	1.65	1.78
AL	.100	.110	2.54	2.79



TERMINAL ARRANGEMENT

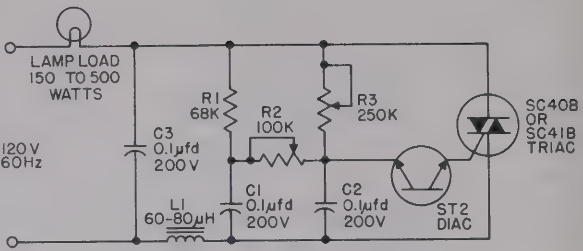
NOTES: (1)Case temperature is measured at the center of any hex flat or press-fit base.
(2)One ext. tooth lock washer and one nut (both steel, cad. plated) supplied with each stud and isolated stud unit.
(3)Insulation hardware for stud device consisting of terminal, 2 mica washers and one nylon bushing available at extra cost upon request.

TYPICAL CIRCUIT

Triacs are especially useful in lamp dimming because of their ability to conduct in both directions. The circuit shown here is one of the more popular circuits used. The R-C time constants provide a phase-shifted AC signal to the Diac. When the voltage on C2 exceeds the breakover voltage of the ST2 Diac, the Diac switches to the on-state and triggers the Triac. If R2 is adjusted so that the Diac is just below the triggering point when R3 is at the maximum setting, R3 will provide a smooth continuous control from 5% to over 95% of full power to the lamp load.

Capacitor C3 and inductor L1 form a low-pass filter to substantially reduce the radio frequency interference which can be generated in phase control circuits.

For further discussion of this circuit as well as many others, please refer to application notes listed below.



MOUNTING CONSIDERATIONS*

Installation of Press-Fit Device in Heat Sink

When press fitting a Triac into a heatsink, the following specifications and recommendations apply:

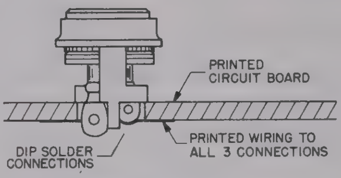
1. Heatsink materials may be copper, aluminum or steel. For maximum heat transfer and minimum corrosion problems, copper is recommended. The heatsink thickness, or amount of heatsink wall, in contact with the Triac should be ⅛ inch.
2. The hole diameter into which the Triac is pressed must be 0.4975 ± .001 inch. A slight chamfer on the hole should be used. This hole may be punched in a flat plate and reamed, or extruded and sized in sheet metal.
3. The entire knurled section of the Triac should be in contact with the heatsink to insure maximum heat transfer. The Triac must not be inserted into a heatsink deeper than the knurl height.
4. The Triac insertion force must not exceed 800 pounds. If the insertion force approaches this value before complete insertion, either the Triac is misaligned with the hole or the Triac-to-hole interference is excessive. The insertion force must be uniformly applied to the top face (terminal end) of the Triac within an annular ring which has an inside diameter of not less than 0.370 inch and not larger than 0.390 inch; the outside diameter of the insertion force must not be less than 0.500 inch.
5. The thermal resistance between the Triac case and a copper heatsink will not exceed 0.5°C/W, if the Triac is inserted in the manner described.

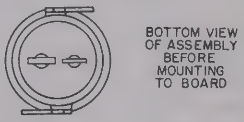
Soldering of Press-Fit Package to Heat Sink

The press-fit package may be soldered directly to a heat sink using 60/40 (Pb-Sn) solder at a temperature of about 200°C.

Attachment of Press Fit Device to Printed Circuit Board

For certain light load applications, the Triac can be inverted and, using a special brass bracket (A7149451), dip-soldered into a printed circuit board. The feet on the bracket act both as a mechanical support and Main Terminal 2 (case) electrical connection. For Triacs preassembled into the bracket, add —X24 to the type number, for example SC41BX24.





Attachment of the Stud & Isolated Stud Device To a Heat Sink

These devices require certain precautions in order to insure good thermal transfer. The chassis hole must be drilled and deburred, and should be between .005 and .015 inches larger than the stud outside diameter. The use of a Torque wrench is highly recommended and must be used within the torque limits indicated on page 2. A good grade of silicone grease will minimize contact thermal resistance.

---

*A more detailed discussion may be found in the General Electric SCR Manual, 4th Edition (1967), Chapter 17, "Cooling the Power Semiconductor.

OTHER TRIAC AND APPLICATION INFORMATION AVAILABLE FROM GENERAL ELECTRIC

Publication Number	*Specification Sheets*	
175.19	SC35/36	(3 Amp)
175.26	SC45/46	(10 Amp)
175.27	SC50/51	(15 Amp)
175.21	SC60/61	(25 Amp)
175.15	SC141/146	(6, 10 Amp in plastic package)

Publication Number	*Application Notes*
200.32	A Variety of Mounting Techniques for Press Fit Devices
200.35	Using the Triac for Control of AC Power
200.45	Temperature Controls Incorporating Zero Voltage Switching
200.51	Better Room Conditioning Via Solid State Controls
200.53	Solid State Incandescent Lighting Controls
201.12	500 Watt AC Line Voltage and Power Regulator
201.19	RF Filter Considerations for Triac & SCR Circuits
201.20	Proportional Zero Voltage Switching Temperature Control
201.21	On-Off Zero Voltage Switching Temperature Control
201.22	Low Power Zero Voltage Switching Using the PA424

Also, individual specifications are listed in publication number 450.52—Semiconductor Specifications Index. All of these referred to may be ordered by publication number from General Electric Company, Distribution Services, Bldg. 6-208, Schenectady, New York 12305.

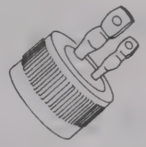
Bi-Directional Triode Thyristor

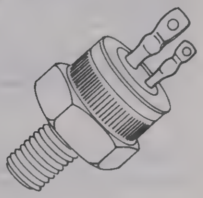
SC45,6

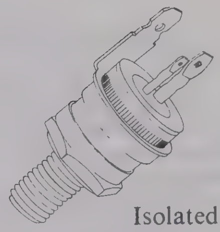
10A RMS Up to 500 Volts

Variations

Mechanical	Electrical
Press-Fit	Zero Voltage Switch Type
Stud	Selected Gate Type
Isolated Stud	400 Hertz Type







The Triac is a bi-directional triode thyristor which may be gate triggered from an OFF to an ON state for either polarity of applied voltage. This device will perform most of the functions of two SCR's connected in inverse parallel.

Features:

- 100A Peak One Full Cycle Surge Rating
- 1000 watt load (120V line)
- 2000 watt load (240V line)
- Inherent immunity from transient voltage damage (can be broken over safely in either direction)
- Press-Fit, Stud, and Isolated Stud Packages available
- Standard Electrical Variations available:

  (1) Selected for use with the General Electric PA424 Zero Voltage Switch

  (2) Selected for 25mA Maximum Gate Trigger Current in all four modes.

  (3) Selected for Operation at 400 Hz.

TYPICAL TRIAC APPLICATIONS

GENERAL FUNCTIONS

TYPES OF EQUIPMENT	Heat Control	Motor Speed Control	Light Control	Solid State Contactors and Relays	Power Regulation
Photographic Dev. Equip.	X		X		X
Process Control	X	X	X	X	X
Reproduction Equipment	X	X	X	X	X
Bio-Medical	X	X	X	X	X
Air Conditioners		X			
Blenders, Mixers		X			
Computer Tape Decks		X			
Fans		X			
Hand Tools		X			
Machine Tools/Misc. Mfg.		X		X	
Sewing Machines		X			
Laundry		X		X	
Farm Equipment	X	X	X	X	
Light Dimmers			X		
Photographic Equipment	X		X	X	
Outdoor Signs			X	X	
Clutches/Brakes				X	
Industrial Timers				X	
Traffic Signal Control			X	X	
Vending Machines	X			X	
Aircraft	X	X	X	X	X
Computer Power Supplies				X	X
Home Entertainment	X	X	X	X	X

FOR TRIAC TRIGGERS SEE PAGE 153

MAXIMUM ALLOWABLE RATINGS—ALL TYPES

PACKAGE	ELECTRICAL TYPE				Repetitive Peak Off-State Voltage V_{DRM}⁽¹⁾ $T_C = -40°C$ to $+100°C$
	Standard Type	Zero Voltage Switch	Selected Gate	400 Hz Operation	
PRESS-FIT	SC46B	SC46B12	SC46B13	SC46B14	200 Volts
STUD	SC45B	SC45B12	SC45B13	SC45B14	
ISOLATED STUD	SC45B2	SC45B22	SC45B23	SC45B24	
PRESS-FIT	SC46D	SC46D12	SC46D13	SC46B14	400 Volts
STUD	SC45D	SC45D12	SC45D13	SC45D14	
ISOLATED STUD	SC45D2	SC45D22	SC45D23	SC45D24	
PRESS-FIT	SC46E	SC46E12	SC46E13	SC46E14	500 Volts
STUD	SC45E	SC45E12	SC45E13	SC45E14	
ISOLATED STUD	SC45E2	SC45E22	SC45E23	SC45E24	

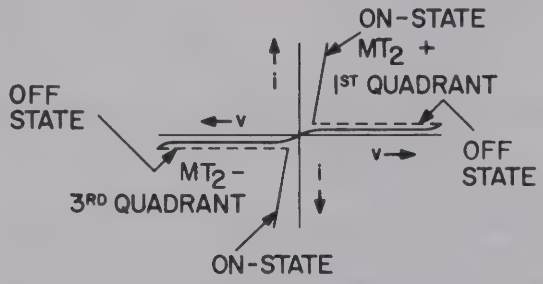
RMS On-State Current, $I_{T(RMS)}$		10 Amperes
Peak One Full Cycle Surge (non-rep) On-State Current, I_{TSM}	(50 Hz)	90 Amperes
	(60 Hz)	100 Amperes
	(400 Hz)	187 Amperes
I^2t (for fusing), for time at⁽²⁾	1.0 millisecond	20 Ampere² seconds
	8.3 millisecond	41.5 (See Chart 14)
Peak Gate Power Dissipation, P_{GM}⁽³⁾		10 Watts for 10 microseconds (See Chart 5)
Average Gate Power Dissipation, $P_{G(AV)}$		0.5 Watts
Peak Gate Current, I_{GM}⁽³⁾		See Chart 5
Peak Gate Voltage, V_{GM}⁽³⁾		See Chart 5
Critical Rate-of-Rise of On-State Current, di/dt⁽²⁾: Breakover voltage triggered operation		10 Amperes per microsecond
Storage Temperature, T_{STG}		—40°C to +125°C
Operating Temperature, T_J		—40°C to +100°C
Stud Torque—**(STUD & ISOLATED STUD TYPES)**		25 Lb-in (29 Kg-cm)
Insertion Pressure—**(PRESS-FIT TYPE)**		800 lbs (364 Kg)

NOTES

[1] Ratings apply for zero gate voltage only. Maximum case-to-ambient thermal resistance for which V_{DRM} ratings apply equals 18°C/watt. Ratings apply for either polarity of main terminal 2 voltage referenced to main treminal 1.

[2] Ratings apply for either polarity of main terminal 2 referenced to main terminal 1.

[3] Ratings apply for either polarity of gate terminal referenced to main terminal 1.



TYPICAL E-I CHARACTERISTICS

WARNING

Isolated stud products described in this specification sheet should be handled with care. The ceramic portion of these thyristors contains BERYLLIUM OXIDE as a major ingredient.

Do not crush, grind, or abrade these portions of the thyristors because the dust resulting from such action may be hazardous if inhaled.

TABLE I—STANDARD TYPE

CHARACTERISTICS										Reference Note
Type	Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions			
All types	Peak Off-state current	I_{DRM}				mA	V_{DRM} = Maximum Allowable Peak Off-State voltage Gate Open Circuited			1
			—	—	0.5		T_C = + 25°C			
			—	—	2.0		T_C = +100°C			
All types	Peak-On-State Voltage	V_{TM}	—	—	1.65	Volts	T_C = +25°C, I_{TM} = 14 A peak. 1 millisecond wide pulse, Duty cycle ≦ 2%			2
All types	Critical Rate of Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt	—	20	—	Volts/μsec	T_C = +100°C, Rated V_{DRM} Gate Open Circuited, Exponential Waveform			2
All except 400 Hertz Type (Refer to Table IV)	Critical Rate of Rise of Commutating Off-State Voltage (Commutating dv/dt)	dv/dt(c)	2.0	—	—	Volts/μsec	T_C = +75°C (+72°C for isolated stud type), $I_{T(RMS)}$ = Rated Max. Allowable RMS On-State Current, V_{DRM} = Rated Maximum Allowable Peak Off-State Voltage, Gate Open Circuited, Commutating di/dt = 5.4 A/msec			2
All except selected gate type (Refer to Table III)	D.C. Gate Trigger Current	I_{GT}				mAdc	V_D = 12 Vdc			3
							Trigger Mode	R_L	T_C	
			—	—	50		MT2+ Gate+	100 ohms	+25°C	
			—	—	50		MT2— Gate—	100 ohms		
			—	—	50		MT2+ Gate—	50 ohms		
			—	—	80		MT2+ Gate+	50 ohms	—40°C	
			—	—	80		MT2— Gate—	50 ohms		
			—	—	80		MT2+ Gate—	25 ohms		
All except selected gate type (Refer to Table III)	D.C. Gate Trigger Voltage	V_{GT}				Vdc	V_D = 12 Vdc			3
							Trigger Mode	R_L	T_C	
			—	—	2.5		MT2+ Gate+	100 ohms	+25°C	
			—	—	2.5		MT2— Gate—	100 ohms		
			—	—	2.5		MT2+ Gate—	50 ohms		
			—	—	3.5		MT2+ Gate+	50 ohms	—40°C	
			—	—	3.5		MT2— Gate—	50 ohms		
			—	—	3.5		MT2+ Gate—	25 ohms		
			0.20	—	—		MT2+ Gate+	1000 ohms	+100°C	3,4
							MT2— Gate—			
							MT2+ Gate—			
							MT2— Gate+			
All Types	Holding Current	I_H				mAdc	Main Terminal Source Voltage = 24 Vdc, Peak initiating on-state current = 0.5A, 0.1 milliseconds to 10 milliseconds wide pulse Gate trigger cource = 7 V, 20 Ohms			2
			—	—	50		T_C = +25°C			
			—	—	100		T_C = —40°C			
All Types	Latching Current	I_L				mAdc	Main Terminal Source Voltage = 24 Vdc, Gate trigger source = 15 V, 100 Ohms, 50 μsec pulse width, 5 μsec rise and fall times max			3
							Trigger Mode		T_C	
			—	—	100		MT2+ Gate+		+25°C	
			—	—	100		MT2— Gate—			
			—	—	200		MT2+ Gate—			
			—	—	200		MT2+ Gate+		—40°C	
			—	—	200		MT2— Gate—			
			—	—	400		MT2+ Gate—			
Press-fit & Stud type	Steady-State Thermal Resistance	$R_{\theta JC}$	—	—	2.0	°C/Watt	Junction to Case			2
Isolated stud type			—	—	2.3					

NOTES:

[1] Maximum case-to-ambient thermal resistance for which maximum V_{DRM} ratings apply equals 18°C per watt. Values apply for either polarity of main terminal 2 characteristic referenced to main terminal 1.

[2] Values apply for either polarity of main terminal 2 characteristics referenced to main terminal 1.

[3] Main terminal 1 is the reference terminal for main terminal 2 and gate terminal.

[4] With V_D equal to maximum allowable off-state voltage.

TABLE II—ZERO VOLTAGE SWITCH TYPE (FOR USE WITH PA424 ZERO VOLTAGE SWITCH)

NOTE: ALL STANDARD CHARACTERISTICS APPLY EXCEPT AS INDICATED

CHARACTERISTICS									Reference Note
Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions			
Pulse Gate Trigger Current	I_{GT}				mAdc	$V_D = 3$ Vdc, Gate Pulse width = 50 µsec			1
						Trigger Mode	R_L	T_C	
		—	—	30		MT2− Gate− MT2+ Gate−	20 ohms	+25°C	
		—	—	46		MT2− Gate− MT2+ Gate−	14 ohms	−20°C	
Pulse Gate Trigger Voltage	V_{GT}				Volts	$V_D = 3$ Vdc, Gate Pulse width = 50 µsec			1
						Trigger Mode	R_L	T_C	
		—	—	2.0		MT2− Gate− MT2+ Gate−	20 ohms	+25°C	
		—	—	2.75		MT2− Gate− MT2+ Gate−	14 ohms	−20°C	
Latching Current	I_L				mAdc	Main Terminal Source Voltage = 3 Vdc, Gate trigger source = PA424			1
						Trigger Mode		T_C	
		—	—	115		MT2− Gate− MT2+ Gate−		+25°C	
		—	120	—		MT2− Gate− MT2+ Gate−		−20°C	

TABLE III—SELECTED GATE TYPE

NOTE: ALL STANDARD CHARACTERISTICS APPLY EXCEPT AS INDICATED

CHARACTERISTICS									Reference Note
Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions			
D.C. Gate Trigger Current	I_{GT}				mAdc	$V_D = 12$ Vdc			1
						Trigger Mode	R_L	T_C	
		—	—	25		MT2+ Gate+	100 ohms	+25°C	
		—	—	25		MT2− Gate−	100 ohms		
		—	—	25		MT2+ Gate−	50 ohms		
		—	—	25		MT2− Gate+	50 ohms		
		—	—	50		MT2+ Gate+	50 ohms	−40°C	
		—	—	50		MT2− Gate−	50 ohms		
		—	—	50		MT2+ Gate−	25 ohms		
		—	—	50		MT2− Gate+	25 ohms		
D.C. Gate Trigger Voltage	V_{GT}				Vdc	$V_D = 12$ Vdc			1
						Trigger Mode	R_L	T_C	
		—	—	2.0		MT2+ Gate+	100 ohms	+25°C	
		—	—	2.0		MT2− Gate−	100 ohms		
		—	—	2.0		MT2+ Gate−	50 ohms		
		—	—	2.0		MT2− Gate+	50 ohms		
		—	—	3.0		MT2+ Gate+	50 ohms	−40°C	
		—	—	3.0		MT2− Gate−	50 ohms		
		—	—	3.0		MT2+ Gate−	25 ohms		
		—	—	3.0		MT2− Gate+	25 ohms		

TABLE IV—400 HZ OPERATION TYPE

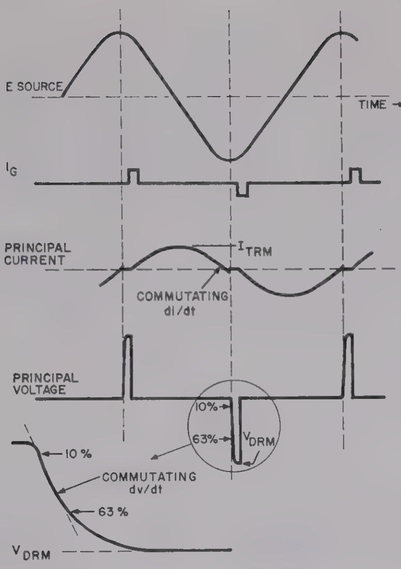
NOTE: ALL STANDARD CHARACTERISTICS APPLY EXCEPT AS INDICATED

CHARACTERISTICS							Reference Note
Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions	
Critical Rate of Rise of Commutating Off-State Voltage (Commutating dv/dt)	dv/dt(c)	2.0	—	—	Volts/µsec	$T_C = +75°C$ (+72°C for isolated stud type), $I_{T(RMS)}$ = Rated Max. Allowable RMS On-State Current V_{DRM} = Rated Maximum Allowable Peak Off-State Voltage Gate Open Circuited Commutating di/dt = 36 A/msec	2

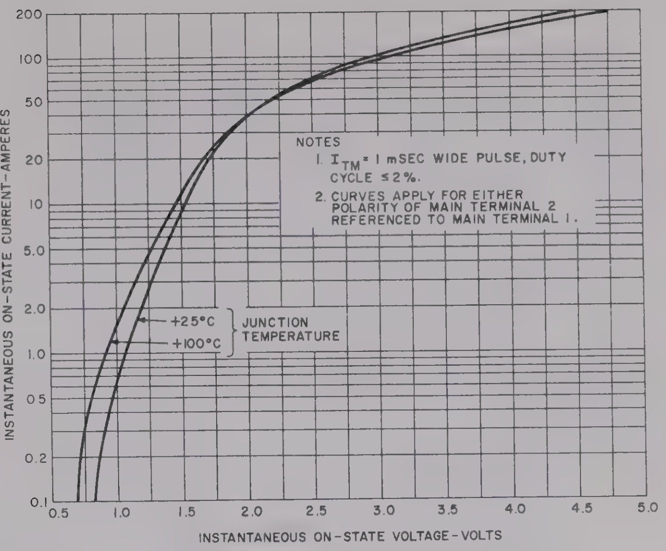
NOTES

[1] Main terminal 1 is the reference terminal for main terminal 2 and gate terminal.

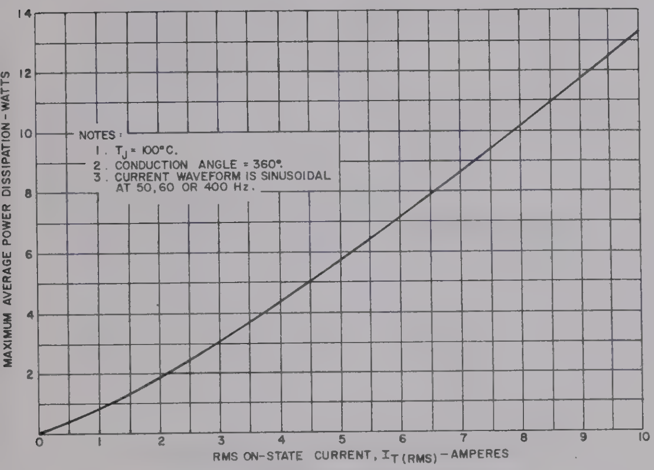
[2] Values apply for either polarity of main terminal 2 characteristic referenced to main terminal 1.


E SOURCE
TIME →
I_G
PRINCIPAL CURRENT
I_{TRM}
COMMUTATING dI/dt
PRINCIPAL VOLTAGE
10%
63%
V_{DRM}
10 %
COMMUTATING dv/dt
63 %
V_{DRM}

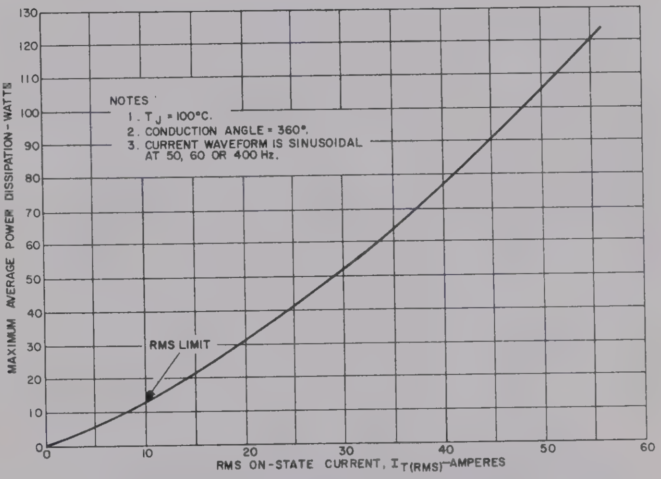
1. Waveform of Commutating dv/dt



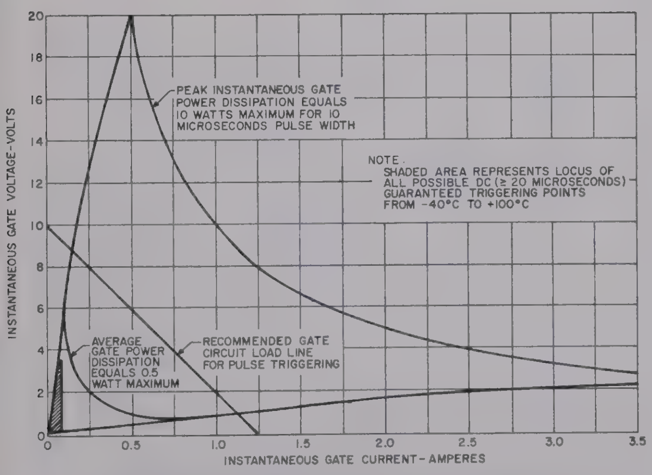
2. Maximum On-State Voltage vs. On-State Current



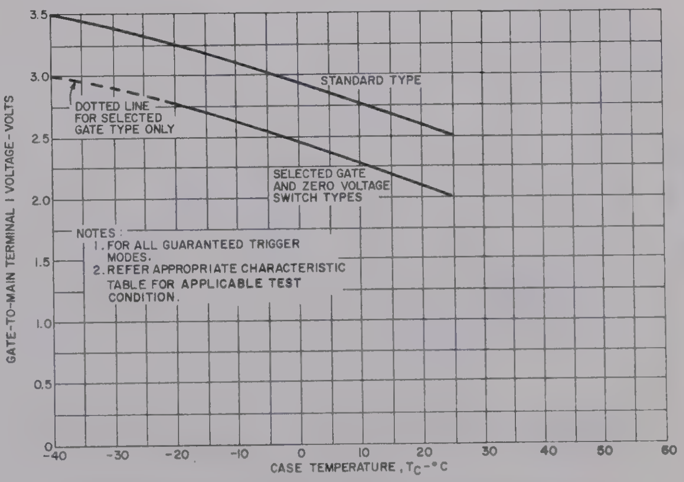
3. Maximum Average Power Dissipation vs. RMS On-State Current



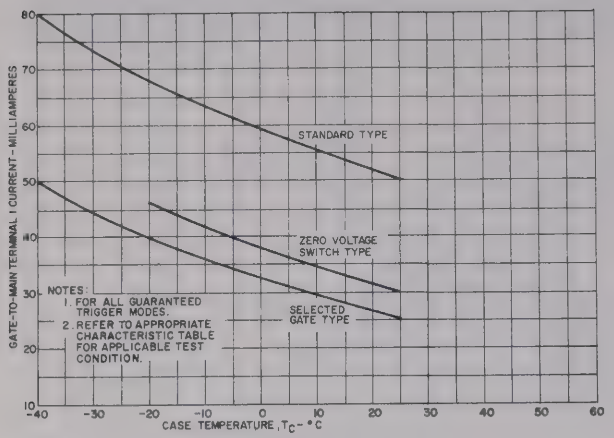
4. Maximum Average Power Dissipation vs. RMS On-State Current (High Level)



5. Gate Characteristics and Ratings

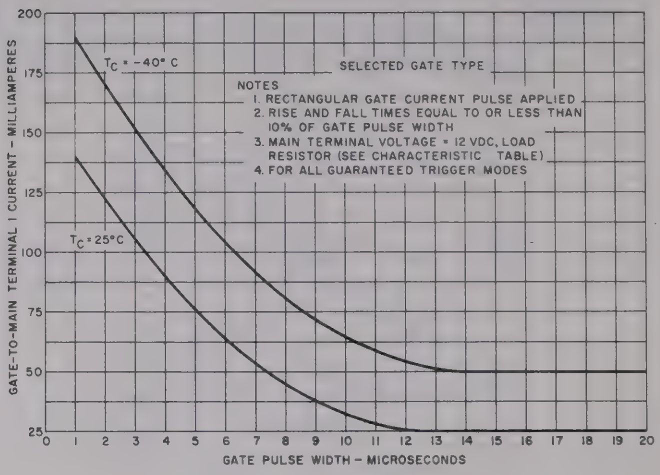


6. Maximum DC Gate Trigger Voltage vs. Case Temperature



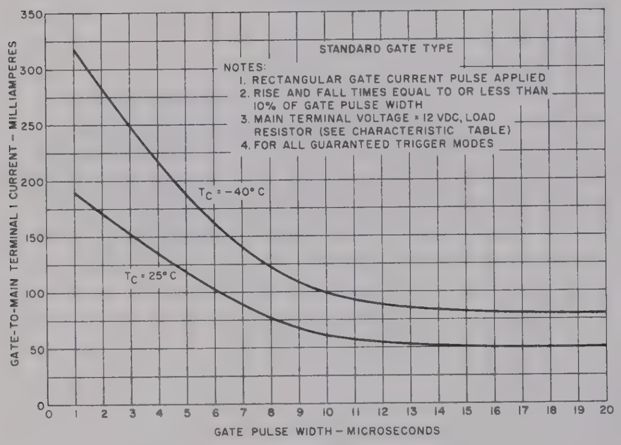
NOTES:
1. FOR ALL GUARANTEED TRIGGER MODES.
2. REFER TO APPROPRIATE CHARACTERISTIC TABLE FOR APPLICABLE TEST CONDITION.

7. Maximum DC Gate Trigger Current vs. Case Temperature



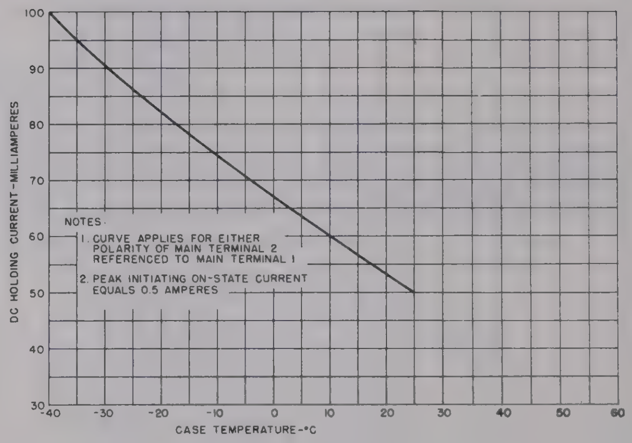
NOTES
1. RECTANGULAR GATE CURRENT PULSE APPLIED
2. RISE AND FALL TIMES EQUAL TO OR LESS THAN 10% OF GATE PULSE WIDTH
3. MAIN TERMINAL VOLTAGE = 12 VDC, LOAD RESISTOR (SEE CHARACTERISTIC TABLE)
4. FOR ALL GUARANTEED TRIGGER MODES

8. Maximum Gate Trigger Current vs. Gate Pulse Width (Selected Gate Type)



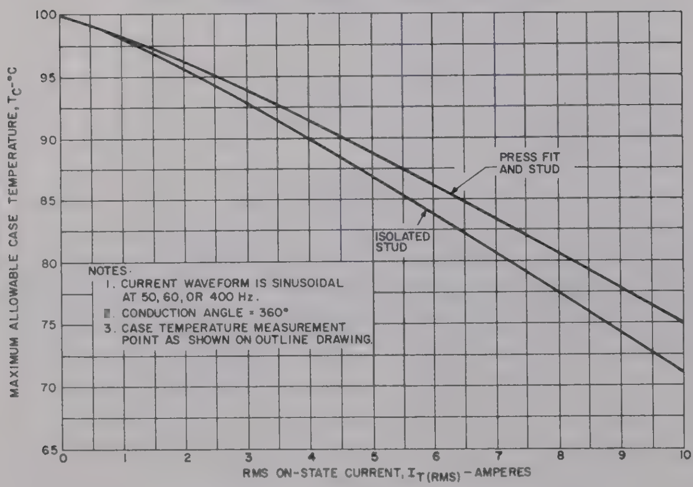
NOTES:
1. RECTANGULAR GATE CURRENT PULSE APPLIED
2. RISE AND FALL TIMES EQUAL TO OR LESS THAN 10% OF GATE PULSE WIDTH
3. MAIN TERMINAL VOLTAGE = 12 VDC, LOAD RESISTOR (SEE CHARACTERISTIC TABLE)
4. FOR ALL GUARANTEED TRIGGER MODES

9. Maximum Gate Trigger Current vs. Gate Pulse Width (Standard Gate Type)



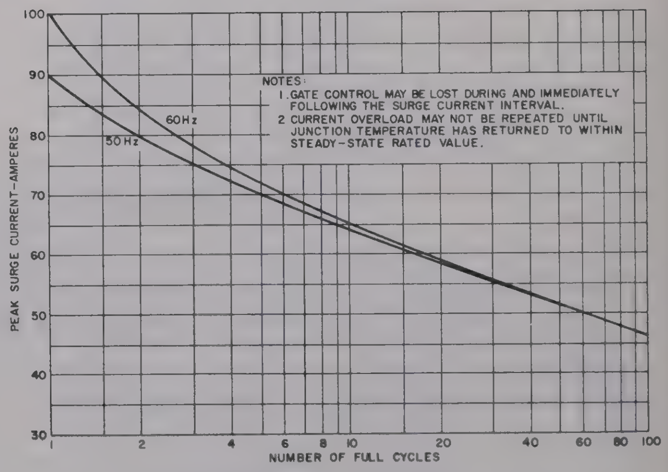
NOTES
1. CURVE APPLIES FOR EITHER POLARITY OF MAIN TERMINAL 2 REFERENCED TO MAIN TERMINAL 1
2. PEAK INITIATING ON-STATE CURRENT EQUALS 0.5 AMPERES

10. Maximum DC Holding Current vs. Case Temperature



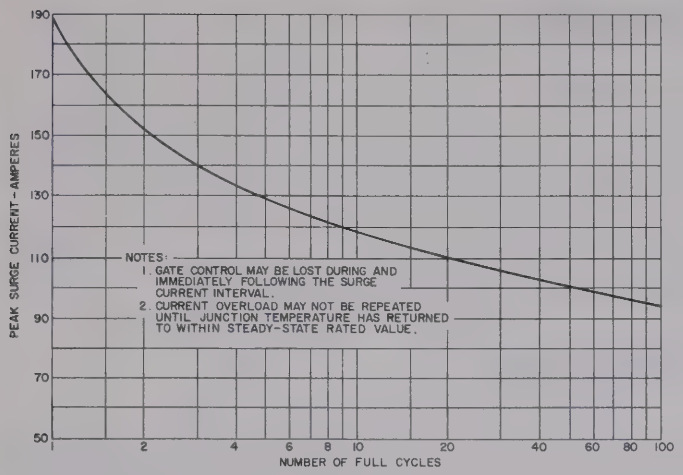
NOTES
1. CURRENT WAVEFORM IS SINUSOIDAL AT 50, 60, OR 400 Hz.
2. CONDUCTION ANGLE = 360°
3. CASE TEMPERATURE MEASUREMENT POINT AS SHOWN ON OUTLINE DRAWING.

11. Maximum Allowable Case Temperature vs. RMS On-State Current



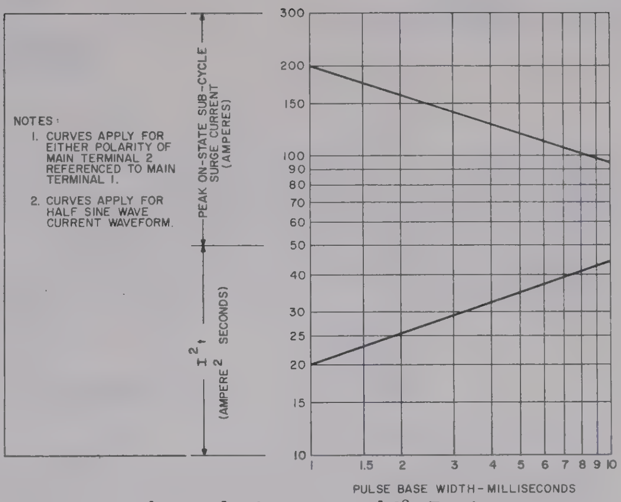
NOTES
1. GATE CONTROL MAY BE LOST DURING AND IMMEDIATELY FOLLOWING THE SURGE CURRENT INTERVAL.
2. CURRENT OVERLOAD MAY NOT BE REPEATED UNTIL JUNCTION TEMPERATURE HAS RETURNED TO WITHIN STEADY-STATE RATED VALUE.

12. Maximum Allowable Full Cycle Surge Current Following Rated Load Conditions



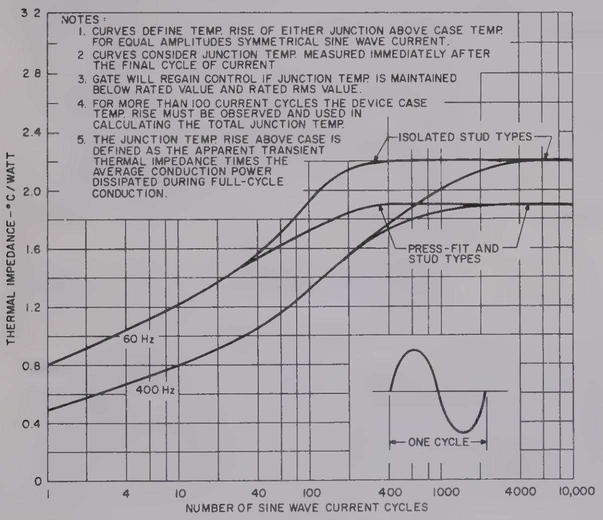
NOTES:
1. GATE CONTROL MAY BE LOST DURING AND IMMEDIATELY FOLLOWING THE SURGE CURRENT INTERVAL.
2. CURRENT OVERLOAD MAY NOT BE REPEATED UNTIL JUNCTION TEMPERATURE HAS RETURNED TO WITHIN STEADY-STATE RATED VALUE.

13. Maximum Allowable Full Cycle Surge Current Following Rated Load Conditions (400 Hz)



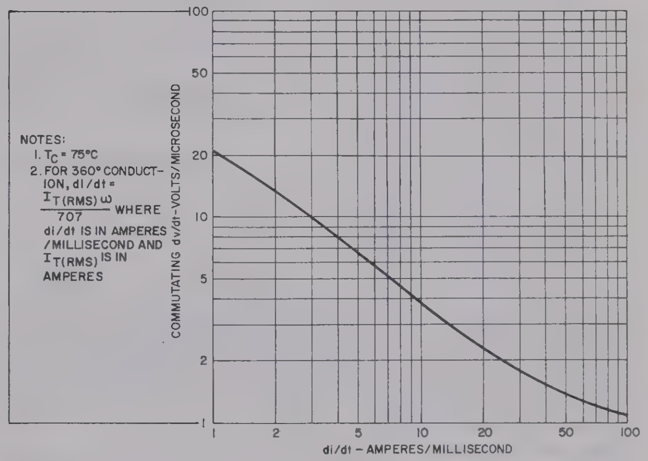
NOTES:
1. CURVES APPLY FOR EITHER POLARITY OF MAIN TERMINAL 2 REFERENCED TO MAIN TERMINAL 1.
2. CURVES APPLY FOR HALF SINE WAVE CURRENT WAVEFORM.

14. Sub-Cycle Surge and I²t Ratings Following Rated Load Conditions



NOTES:
1. CURVES DEFINE TEMP. RISE OF EITHER JUNCTION ABOVE CASE TEMP. FOR EQUAL AMPLITUDES SYMMETRICAL SINE WAVE CURRENT.
2. CURVES CONSIDER JUNCTION TEMP. MEASURED IMMEDIATELY AFTER THE FINAL CYCLE OF CURRENT.
3. GATE WILL REGAIN CONTROL IF JUNCTION TEMP. IS MAINTAINED BELOW RATED VALUE AND RATED RMS VALUE.
4. FOR MORE THAN 100 CURRENT CYCLES THE DEVICE CASE TEMP. RISE MUST BE OBSERVED AND USED IN CALCULATING THE TOTAL JUNCTION TEMP.
5. THE JUNCTION TEMP. RISE ABOVE CASE IS DEFINED AS THE APPARENT TRANSIENT THERMAL IMPEDANCE TIMES THE AVERAGE CONDUCTION POWER DISSIPATED DURING FULL-CYCLE CONDUCTION.

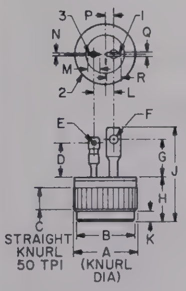
15. Maximum Apparent Transient Thermal Impedance



NOTES:
1. $T_C = 75°C$
2. FOR 360° CONDUCTION, $di/dt = \frac{I_{T(RMS)}\,\omega}{707}$ WHERE di/dt IS IN AMPERES/MILLISECOND AND $I_{T(RMS)}$ IS IN AMPERES

16. Typical Rate of Removal of Current (di/dt) Effect Upon Commutating dv/dt

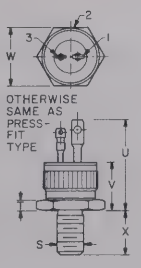
OUTLINE DRAWINGS



STRAIGHT KNURL 50 TPI

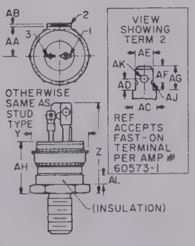
(KNURL DIA)

PRESS-FIT



OTHERWISE SAME AS PRESS-FIT TYPE

STUD



OTHERWISE SAME AS STUD TYPE

VIEW SHOWING TERM 2

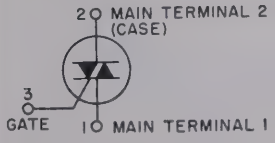
REF ACCEPTS FAST-ON TERMINAL PER AMP # 60573-1

ISOLATED STUD

SYM	DECIMAL (INCHES) MIN.	DECIMAL (INCHES) MAX	METRIC (MM) MIN.	METRIC (MM) MAX.
A	.501	.505	12.73	12.83
B	.467	.475	11.86	12.07
C	.177 REF.		4.50 REF.	
D	.260	.301	6.60	7.65
E	.035	.045	.89	1.14
F	.065	.075	1.65	1.41
G		.350		8.89
H	.340	.376	8.64	9.55
J		.782		19.86
K	.083	.097	2.11	2.46
L	.130	.180	3.30	4.57
M	.085	.115	2.16	2.92

SYM	DECIMAL (INCHES) MIN.	DECIMAL (INCHES) MAX.	METRIC (MM) MIN.	METRIC (MM) MAX.
N	.016	.023	.41	.58
P	.065 REF.		1.65 REF.	
Q	.028	.035	.71	.89
R	.110	.135	2.79	3.43
S	1/4-28 UNF2A		1/4-28 UNF2A	
T	.086	.098	2.18	2.49
U		.865		21.79
V		.475		12.07
W	.552	.562	14.02	14.27
X	.432	.442	10.97	11.23
Y	.580	.610	14.73	15.49

SYM	DECIMAL (INCHES) MIN.	DECIMAL (INCHES) MAX.	METRIC (MM) MIN.	METRIC (MM) MAX.
Z		.975		24.77
AA	.290	.330	7.37	8.38
AB	.017	.024	.43	.61
AC	.235	.265	5.97	6.73
AD	.115	.121	2.29	3.07
AE	.186	.189	4.72	4.80
AF	.170 REF.		4.32 REF	
AG	.245	.255	6.22	6.48
AH		.585		14.86
AJ	.025	R-REF.	.64	R-REF.
AK	.065	.070	1.65	1.78
AL	.100	.110	2.54	2.79

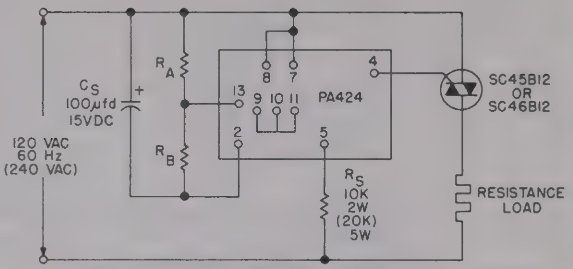


TERMINAL ARRANGEMENT

NOTES: (1)Case temperature is measured at the center of any hex flat or press-fit base.
(2)One ext. tooth lock washer and one nut (both steel, cad. plated) supplied with each stud and isolated stud unit.
(3)Insulation hardware for stud device consisting of terminal, 2 mica washers and one nlyon bushing available at extra cost upon request.

TYPICAL CIRCUIT

When the SC45 or SC46 is used with General Electric's PA424 zero voltage switch integrated circuit, an all solid-state electric temperature control results if a thermistor is used in the input of the PA424. With the proper thermistor, this circuit has the capability of controlling temperature to ±0.2°F. This application and many others, is covered in greater detail in the PA424 specification sheet (Pub. No. 85.21).



R_A = THERMISTOR FOR TEMPERATURE CONTROL APPLICATIONS

MOUNTING CONSIDERATIONS*

Installation of Press-Fit Device in Heat Sink

When press fitting a Triac into a heatsink, the following specifications and recommendations apply:

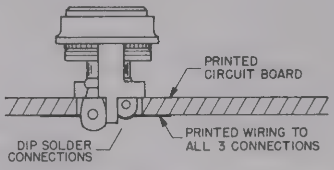
1. Heatsink materials may be copper, aluminum or steel. For maximum heat transfer and minimum corrosion problems, copper is recommended. The heatsink thickness, or amount of heatsink wall, in contact with the Triac should be ⅛ inch.
2. The hole diameter into which the Triac is pressed must be 0.4975 ± .001 inch. A slight chamfer on the hole should be used. This hole may be punched in a flat plate and reamed, or extruded and sized in sheet metal.
3. The entire knurled section of the Triac should be in contact with the heatsink to insure maximum heat transfer. The Triac must not be inserted into a heatsink deeper than the knurl height.
4. The Triac insertion force must not exceed 800 pounds. If the insertion force approaches this value before complete insertion, either the Triac is misaligned with the hole or the Triac-to-hole interference is excessive. The insertion force must be uniformly applied to the top face (terminal end) of the Triac within an annular ring which has an inside diameter of not less than 0.370 inch and not larger than 0.390 inch; the outside diameter of the insertion force must not be less than 0.500 inch.
5. The thermal resistance between the Triac case and a copper heatsink will not exceed 0.5°C/W, if the Triac is inserted in the manner described.

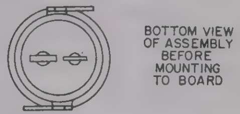
Soldering of Press-Fit Package to Heat Sink

The press-fit package may be soldered directly to a heat sink using 60/40 (Pb-Sn) solder at a temperature of about 200°C.

Attachment of Press Fit Device to Printed Circuit Board

For certain light load applications, the Triac can be inverted and, using a special brass bracket (A7149451), dip-soldered into a printed circuit board. The feet on the bracket act both as a mechanical support and Main Terminal 2 (case) electrical connection. For Triacs preassembled into the bracket, add —X24 to the type number, for example SC46BX24.





Attachment of the Stud & Isolated Stud Device To a Heat Sink

These devices require certain precautions in order to insure good thermal transfer. The chassis hole must be drilled and deburred, and should be between .005 and .015 inches larger than the stud outside diameter. The use of a Torque wrench is highly recommended and must be used within the torque limits indicated on page 2. A good grade of silicone grease will minimize contact thermal resistance.

---

*A more detailed discussion may be found in the General Electric SCR Manual, 4th Edition (1967), Chapter 17, "Cooling the Power Semiconductor.

OTHER TRIAC AND APPLICATION INFORMATION AVAILABLE FROM GENERAL ELECTRIC

Publication Number	Specification Sheets	
85.21	PA424	(Zero Voltage Switch)
175.19	SC35/36	(3 Amp)
175.25	SC40/41	(6 Amp)
175.27	SC50/51	(15 Amp)
175.21	SC60/61	(25 Amp)
175.15	SC141/146	(6, 10 Amp in plastic package)

Publication Number	Application Notes
200.32	A Variety of Mounting Techniques for Press Fit Devices
200.35	Using the Triac for Control of AC Power
200.45	Temperature Controls Incorporating Zero Voltage Switching
200.51	Better Room Conditioning Via Solid State Controls
200.53	Solid State Incandescent Lighting Controls
201.12	500 Watt AC Line Voltage and Power Regulator
201.19	RF Filter Considerations for Triac & SCR Circuits
201.20	Proportional Zero Voltage Switching Temperature Control
201.21	On-Off Zero Voltage Switching Temperature Control
201.22	Low Power Zero Voltage Switching Using the PA424

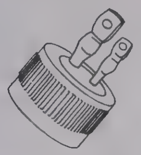
Also, individual specifications are listed in publication number 450.52 —Semiconductor Specifications Index. All of these referred to may be ordered by publication number from General Electric Company, Distribution Services, Bldg. 6-208, Schenectady, New York 12305.

Bi-Directional Triode Thyristor

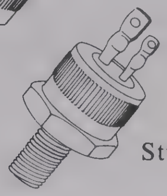
15A RMS Up to 500 Volts

Variations

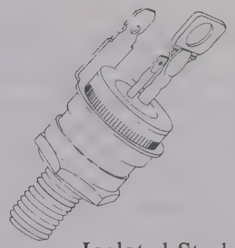
Mechanical	Electrical
Press-Fit Stud Isolated Stud	Zero Voltage Switch Type Selected Gate Type 400 Hertz Type



Press - Fit



Stud



Isolated Stud

The Triac is a bi-directional triode thyristor which may be gate triggered from an OFF to an ON state for either polarity of applied voltage. This device will perform most of the functions of two SCR's connected in inverse parallel.

Features:

- 100A Peak One Full Cycle Surge Rating
- 1200 watt load (120V line)
- 2400 watt load (240V line)
- Inherent immunity from transient voltage damage (can be broken over safely in either direction)
- Press-Fit, Stud, and Isolated Stud Packages available
- Standard Electrical Variations available:
  - (1) Selected for use with the General Electric PA424 Zero Voltage Switch
  - (2) Selected for 25mA Maximum Gate Trigger Current in all four modes.
  - (3) Selected for Operation at 400 Hz.

TYPICAL TRIAC APPLICATIONS

GENERAL FUNCTIONS

TYPES OF EQUIPMENT	Heat Control	Motor Speed Control	Light Control	Solid State Contactors and Relays	Power Regulation
Photographic Dev. Equip.	X		X		X
Process Control	X	X	X	X	X
Reproduction Equipment	X	X	X	X	X
Bio-Medical	X	X	X	X	X
Air Conditioners		X		X	
Blenders, Mixers		X			
Computer Tape Decks		X			
Fans		X			
Hand Tools		X			
Machine Tools/Misc. Mfg.		X		X	
Sewing Machines		X			
Laundry	X	X		X	
Farm Equipment	X	X	X	X	
Light Dimmers			X		
Photographic Equipment	X		X	X	
Outdoor Signs			X	X	
Clutches/Brakes				X	
Industrial Timers				X	
Traffic Signal Control			X	X	
Vending Machines	X			X	
Aircraft	X	X	X	X	X
Computer Power Supplies				X	X
Home Entertainment	X	X	X	X	X

FOR TRIAC TRIGGERS SEE PAGE 153

MAXIMUM ALLOWABLE RATINGS—ALL TYPES

PACKAGE	ELECTRICAL TYPE				Repetitive Peak Off-State Voltage V_{DRM} (1) $T_C = -40°C$ to $+115°C$
	Standard Type	Zero Voltage Switch	Selected Gate	400 Hz Operation	
PRESS-FIT	SC51B	SC51B12	SC51B13	SC51B14	200 Volts
STUD	SC50B	SC50B12	SC50B13	SC50B14	
ISOLATED STUD	SC50B2	SC50B22	SC50B23	SC50B24	
PRESS-FIT	SC51D	SC51D12	SC51D13	SC51D14	400 Volts
STUD	SC50D	SC50D12	SC50D13	SC50D14	
ISOLATED STUD	SC50D2	SC50D22	SC50D23	SC50D24	
PRESS-FIT	SC51E	SC51E12	SC51E13	SC51E14	500 Volts
STUD	SC50E	SC50E12	SC50E13	SC50E14	
ISOLATED STUD	SC50E2	SC50E22	SC50E23	SC50E24	

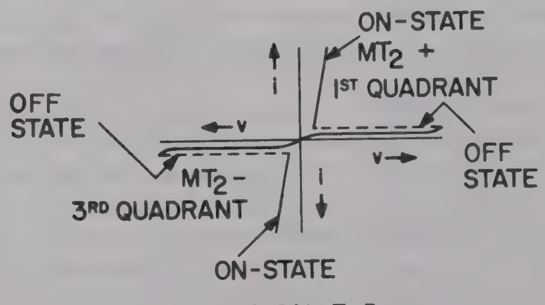
RMS On-State Current, $I_{T(RMS)}$	15 Amperes
Peak One Full Cycle Surge (non-rep) On-State Current, I_{TSM} (50 Hz)	90 Amperes
(60 Hz)	100 Amperes
(400 Hz)	187 Amperes
I^2t (for fusing), for time at$^{(2)}$ 1.0 millisecond	20 Ampere^2 seconds (See Chart 14)
8.3 millisecond	41.5
Peak Gate Power Dissipation, $P_{GM}$$^{(3)}$	10 Watts for 10 microseconds (See Chart 5)
Average Gate Power Dissipation, $P_{G(AV)}$	0.5 Watts
Peak Gate Current, $I_{GM}$$^{(3)}$	See Chart 5
Peak Gate Voltage, $V_{GM}$$^{(3)}$	See Chart 5
Critical Rate-of-Rise of On-State Current, di/dt$^{(2)}$: Breakover voltage triggered operation	10 Amperes per microsecond
Storage Temperature, T_{STG}	−40°C to +125°C
Operating Temperature, T_J	−40°C to +115°C
Stud Torque—**(STUD & ISOLATED STUD TYPES)**	25 Lb-in (29 Kg-cm)
Insertion Pressure—**(PRESS-FIT TYPE)**	800 lbs (364 Kg)

NOTES

[1] Ratings apply for zero gate voltage only. Maximum case-to-ambient thermal resistance for which V_{DRM} ratings apply equals 18°C/watt. Ratings apply for either polarity of main terminal 2 voltage referenced to main treminal 1.

[2] Ratings apply for either polarity of main terminal 2 referenced to main terminal 1.

[3] Ratings apply for either polarity of gate terminal referenced to main terminal 1.



TYPICAL E-I CHARACTERISTICS

WARNING

Isolated stud products described in this specification sheet should be handled with care. The ceramic portion of these thyristors contains BERYLLIUM OXIDE as a major ingredient.

Do not crush, grind, or abrade these portions of the thyristors because the dust resulting from such action may be hazardous if inhaled.

TABLE I—STANDARD TYPE

CHARACTERISTICS										Reference Note
Type	Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions			
All types	Peak Off-State current	I_{DRM}				mA	V_{DRM} = Maximum Allowable Peak Off-State voltage Gate Open Circuited			1
			—	—	0.5		T_C = + 25°C			
			—	—	2.0		T_C = +115°C			
All types	Peak On-State Voltage	V_{TM}	—	—	1.65	Volts	T_C = +25°C, I_{TM} = 21 A peak. 1 millisecond wide pulse, Duty cycle ≦ 2%			2
All types	Critical Rate of Rise of Off-State Voltage (Higher values may cause device switching	dv/dt	—	20	—	Volts/μsec	T_C = +115°C, Rated V_{DRM} Gate Open Circuited, Exponential Waveform			2
All except 400 Hertz Type (Refer to Table IV)	Critical Rate of Rise of Commutating Off-State Voltage (Commutating dv/dt)	dv/dt(c)	2.0	—	—	Volts/μsec	T_C = +80°C (+74°C for isolated stud type), $I_{T(RMS)}$ = Rated Max. Allowable RMS On-State Current, V_{DRM} = Rated Maximum Allowable Peak Off-State Voltage, Gate Open Circuited, Commutating di/dt = 8 A/msec			2
All except selected gate type (Refer to table III)	D.C. Gate Trigger Current	I_{GT}				mAdc	V_D = 12 Vdc			3
							Trigger Mode	R_L	T_C	
			—	—	50		MT2+ Gate+	100 ohms	+25°C	
			—	—	50		MT2− Gate−	100 ohms		
			—	—	50		MT2+ Gate−	50 ohms		
			—	—	80		MT2+ Gate+	50 ohms	−40°C	
			—	—	80		MT2− Gate−	50 ohms		
			—	—	80		MT2+ Gate−	25 ohms		
All except selected gate type (Refer to Table III)	D.C. Gate Trigger Voltage	V_{GT}				Vdc	V_D = 12 Vdc			3
							Trigger Mode	R_L	T_C	
			—	—	2.5		MT2+ Gate+	100 ohms	+25°C	
			—	—	2.5		MT2− Gate−	100 ohms		
			—	—	2.5		MT2+ Gate−	50 ohms		
			—	—	3.5		MT2+ Gate+	50 ohms	−40°C	
			—	—	3.5		MT2− Gate−	50 ohms		
			—	—	3.5		MT2+ Gate−	25 ohms		
			0.20	—	—		MT2+ Gate+ MT2− Gate− MT2+ Gate− MT2− Gate+	1000 ohms	+115°C	3,4
All Types	Holding Current	I_H				mAdc	Main Terminal Source Voltage = 24 Vdc, Peak initiating on-state current = 0.5A, 0.1 milliseconds to 10 milliseconds wide pulse Gate trigger cource = 7 V, 20 Ohms			2
			—	—	50		T_C = +25°C			
			—	—	100		T_C = −40°C			
All Types	Latching Current	I_L				mAdc	Main Terminal Source Voltage = 24 Vdc, Gate trigger source = 15 V, 100 Ohms, 50 μsec pulse width, 5 μsec rise and fall times max			3
							Trigger Mode		T_C	
			—	—	100		MT2+ Gate+		+25°C	
			—	—	100		MT2− Gate−			
			—	—	200		MT2+ Gate−			
			—	—	200		MT2+ Gate+		−40°C	
			—	—	200		MT2− Gate−			
			—	—	400		MT2+ Gate−			
Press-fit & stud type	Steady-State Thermal Resistance	$R_{\theta JC}$	—	—	2.0	°C/Watt	Junction to Case			2
Isolated stud type			—	—	2.3					

NOTES:

[1] Maximum case-to-ambient thermal resistance for which maximum V_{DRM} ratings apply equals 18°C per watt. Values apply for either polarity of main terminal 2 characteristic referenced to main terminal 1.

[2] Values apply for either polarity of main terminal 2 characteristics referenced to main terminal 1.

[3] Main terminal 1 is the reference terminal for main terminal 2 and gate terminal.

[4] With V_D equal to maximum allowable off-state voltage.

TABLE II—ZERO VOLTAGE SWITCH TYPE (FOR USE WITH PA424 ZERO VOLTAGE SWITCH)

NOTE: ALL STANDARD CHARACTERISTICS APPLY EXCEPT AS INDICATED

CHARACTERISTICS									Reference Note
Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions			
Pulse Gate Trigger Current	I_{GT}				mAdc	$V_D = 3$ Vdc, Gate Pulse width = 50 μsec			1
						Trigger Mode	R_L	T_C	
		—	—	30		MT2− Gate− MT2+ Gate−	20 ohms	+25°C	
		—	—	46		MT2− Gate− MT2+ Gate−	14 ohms	−20°C	
Pulse Gate Trigger Voltage	V_{GT}				Volts	$V_D = 3$ Vdc, Gate Pulse width = 50 μsec			1
						Trigger Mode	R_L	T_C	
		—	—	2.0		MT2− Gate− MT2+ Gate−	20 ohms	+25°C	
		—	—	2.75		MT2− Gate− MT2+ Gate−	14 ohms	−20°C	
Latching Current	I_L				mAdc	Main Terminal Source Voltage = 3 Vdc, Gate trigger source = PA424			1
						Trigger Mode		T_C	
		—	—	115		MT2− Gate− MT2+ Gate−		+25°C	
		—	120	—		MT2− Gate− MT2+ Gate−		−20°C	

TABLE III—SELECTED GATE TYPE

NOTE: ALL STANDARD CHARACTERISTICS APPLY EXCEPT AS INDICATED

CHARACTERISTICS									Reference Note
Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions			
D.C. Gate Trigger Current	I_{GT}				mAdc	$V_D = 12$ Vdc			1
						Trigger Mode	R_L	T_C	
		—	—	25		MT2+ Gate+	100 ohms	+25°C	
		—	—	25		MT2− Gate−	100 ohms		
		—	—	25		MT2+ Gate−	50 ohms		
		—	—	25		MT2− Gate+	50 ohms		
		—	—	50		MT2+ Gate+	50 ohms	−40°C	
		—	—	50		MT2− Gate−	50 ohms		
		—	—	50		MT2+ Gate−	25 ohms		
		—	—	50		MT2− Gate+	25 ohms		
D.C. Gate Trigger Voltage	V_{GT}				Vdc	$V_D = 12$ Vdc			1
						Trigger Mode	R_L	T_C	
		—	—	2.0		MT2+ Gate+	100 ohms	+25°C	
		—	—	2.0		MT2− Gate−	100 ohms		
		—	—	2.0		MT2+ Gate−	50 ohms		
		—	—	2.0		MT2− Gate+	50 ohms		
		—	—	3.0		MT2+ Gate+	50 ohms	−40°C	
		—	—	3.0		MT2− Gate−	50 ohms		
		—	—	3.0		MT2+ Gate−	25 ohms		
		—	—	3.0		MT2− Gate+	25 ohms		

TABLE IV—400 HZ OPERATION TYPE

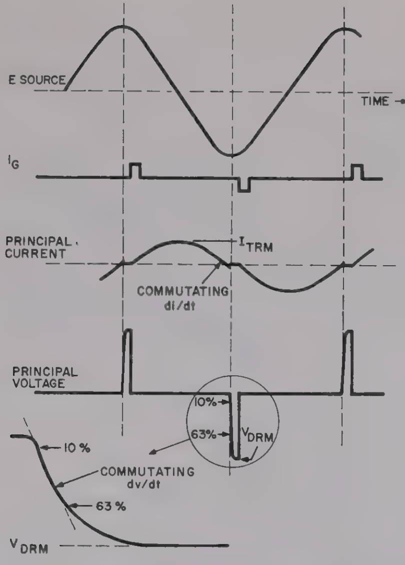
NOTE: ALL STANDARD CHARACTERISTICS APPLY EXCEPT AS INDICATED

CHARACTERISTICS							Reference Note
Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions	
Critical Rate of Rise of Commutating Off-State Voltage (Commutating dv/dt)	dv/dt(c)	2.0	—	—	Volts/μsec	$T_C = +80°C$ (+74°C for isolated stud type), $I_{T(RMS)}$ = Rated Max. Allowable RMS On-State Current V_{DRM} = Rated Maximum Allowable Peak Off-State Voltage Gate Open Circuited Commutating di/dt = 54 A/msec	2

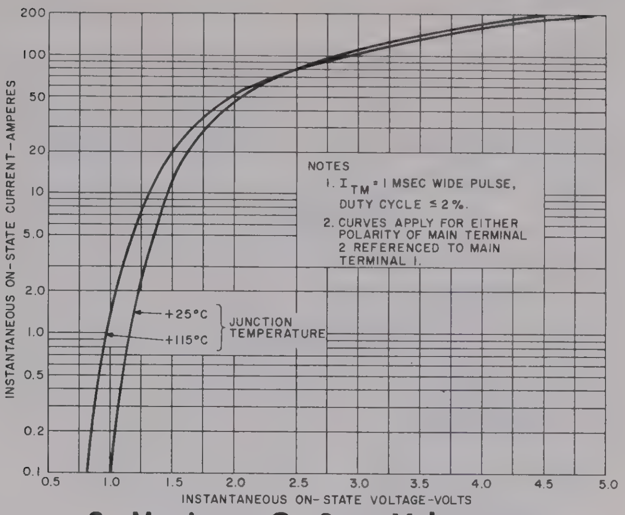
NOTES

[1] Main terminal 1 is the reference terminal for main terminal 2 and gate terminal.

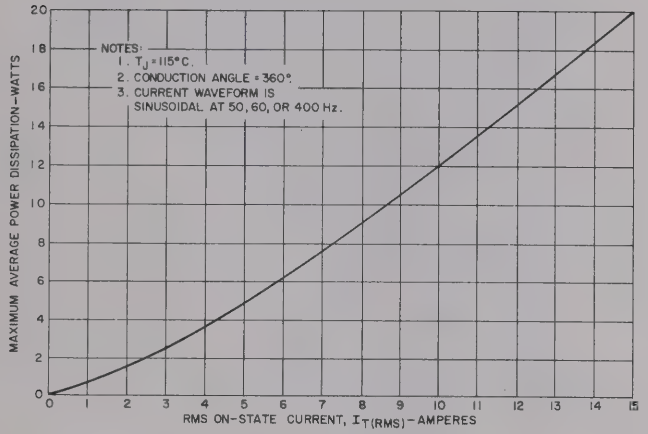
[2] Values apply for either polarity of main terminal 2 characteristic referenced to main terminal 1.


E SOURCE
TIME →
I_G
PRINCIPAL CURRENT
I_{TRM}
COMMUTATING di/dt
PRINCIPAL VOLTAGE
10%
63%
V_{DRM}
10 %
COMMUTATING dv/dt
63 %
V_{DRM}

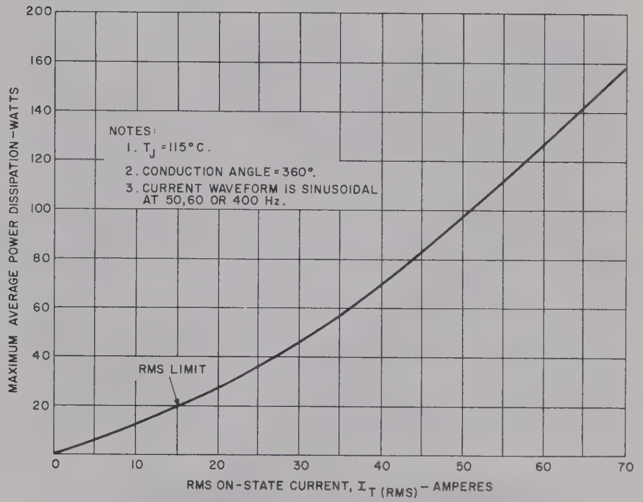
1. Waveform of Commutating dv/dt



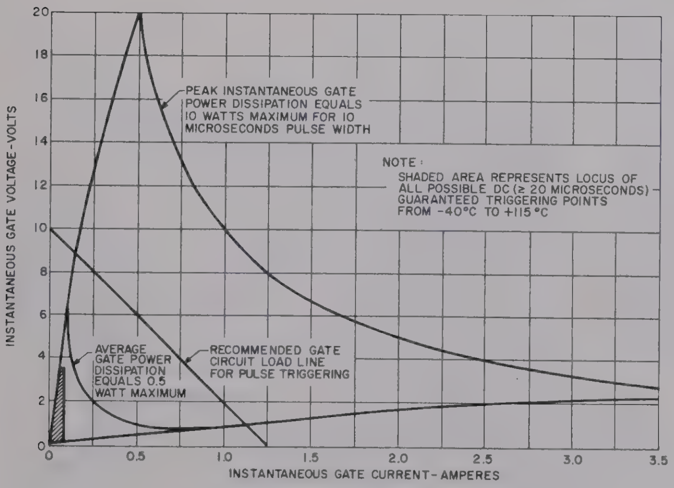
2. Maximum On-State Voltage vs. On-State Current



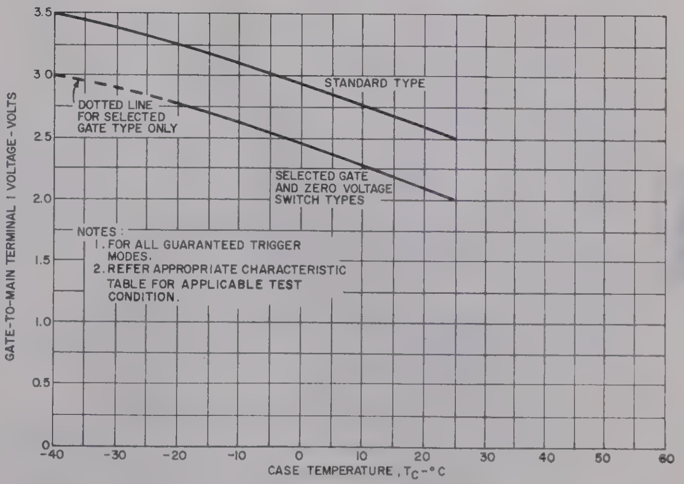
3. Maximum Average Power Dissipation vs. RMS On-State Current



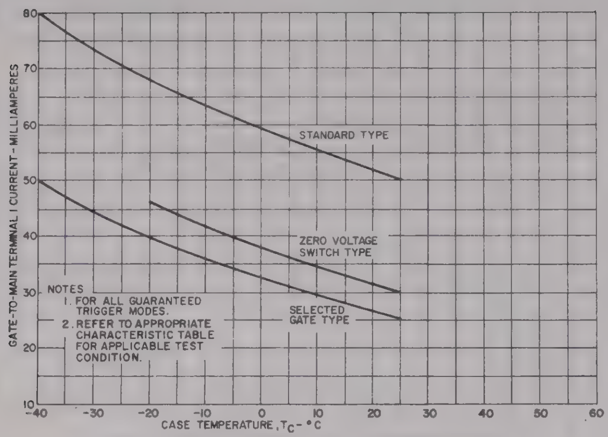
4. Maximum Average Power Dissipation vs. RMS On-State Current (High Level)



5. Gate Characteristics and Ratings

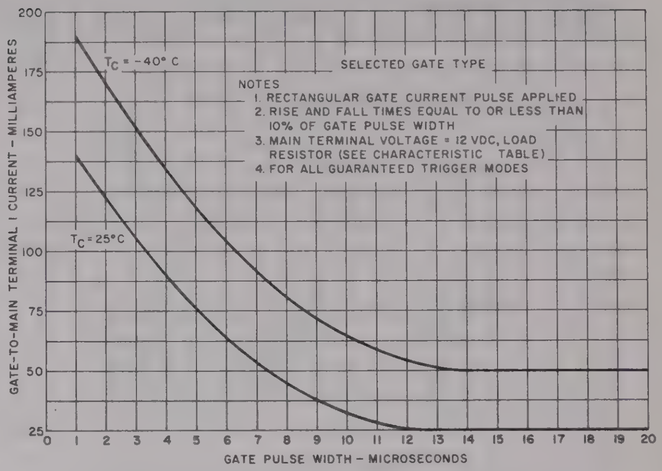


6. Maximum DC Gate Trigger Voltage vs. Case Temperature



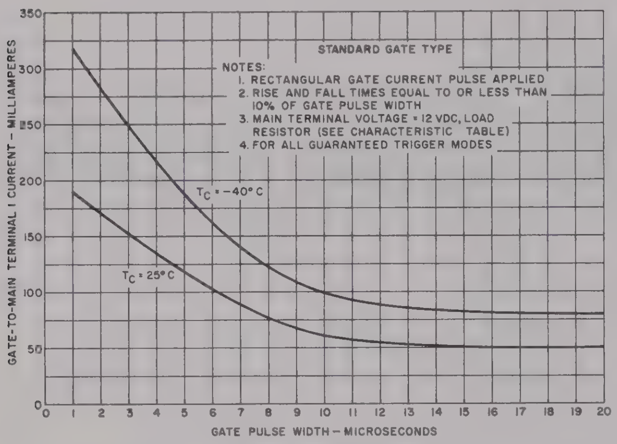
NOTES
1. FOR ALL GUARANTEED TRIGGER MODES.
2. REFER TO APPROPRIATE CHARACTERISTIC TABLE FOR APPLICABLE TEST CONDITION.

7. Maximum DC Gate Trigger Current vs. Case Temperature



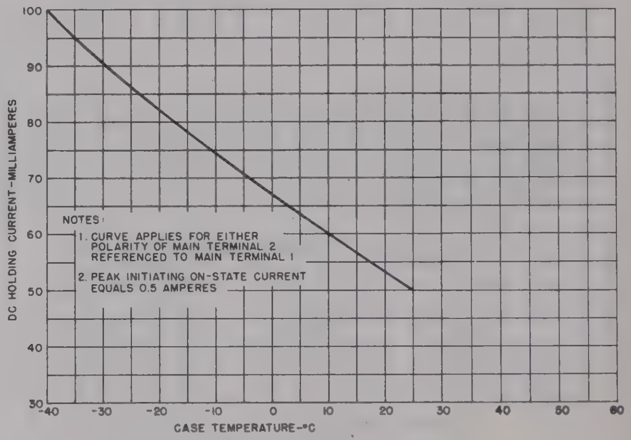
NOTES
1. RECTANGULAR GATE CURRENT PULSE APPLIED
2. RISE AND FALL TIMES EQUAL TO OR LESS THAN 10% OF GATE PULSE WIDTH
3. MAIN TERMINAL VOLTAGE = 12 VDC, LOAD RESISTOR (SEE CHARACTERISTIC TABLE)
4. FOR ALL GUARANTEED TRIGGER MODES

8. Maximum Gate Trigger Current vs. Gate Pulse Width (Selected Gate Type)



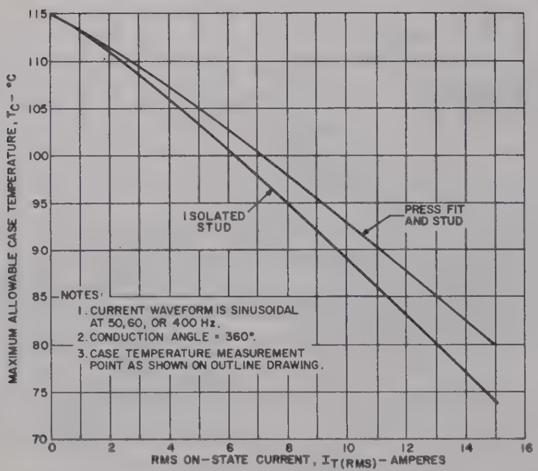
NOTES:
1. RECTANGULAR GATE CURRENT PULSE APPLIED
2. RISE AND FALL TIMES EQUAL TO OR LESS THAN 10% OF GATE PULSE WIDTH
3. MAIN TERMINAL VOLTAGE = 12 VDC, LOAD RESISTOR (SEE CHARACTERISTIC TABLE)
4. FOR ALL GUARANTEED TRIGGER MODES

9. Maximum Gate Trigger Current vs. Gate Pulse Width (Standard Gate Type)



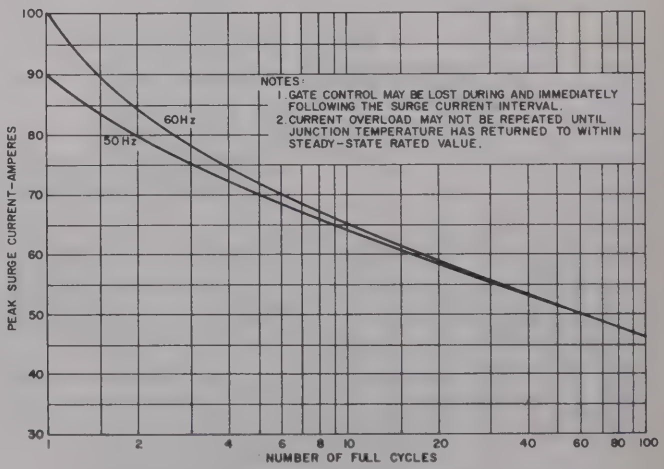
NOTES:
1. CURVE APPLIES FOR EITHER POLARITY OF MAIN TERMINAL 2 REFERENCED TO MAIN TERMINAL 1
2. PEAK INITIATING ON-STATE CURRENT EQUALS 0.5 AMPERES

10. Maximum DC Holding Current vs. Case Temperature



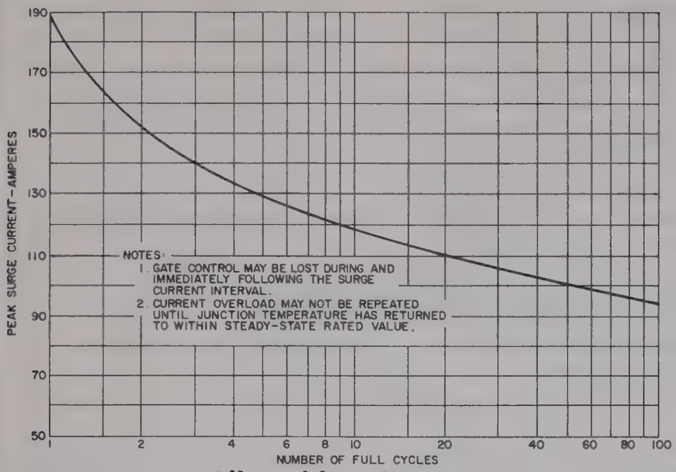
NOTES:
1. CURRENT WAVEFORM IS SINUSOIDAL AT 50, 60, OR 400 Hz.
2. CONDUCTION ANGLE = 360°.
3. CASE TEMPERATURE MEASUREMENT POINT AS SHOWN ON OUTLINE DRAWING.

11. Maximum Allowable Case Temperature vs. RMS On-State Current



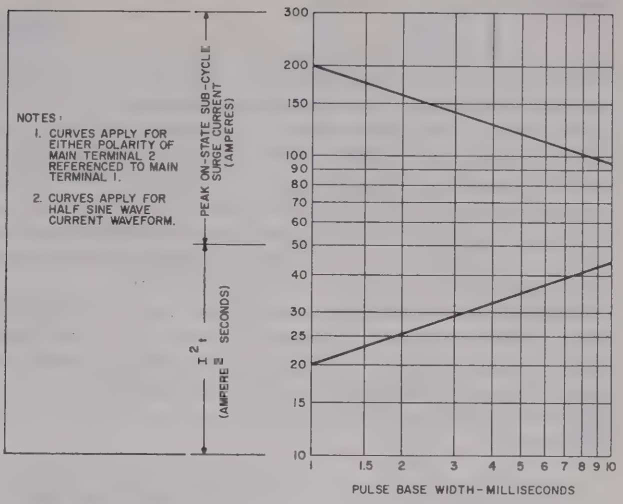
NOTES:
1. GATE CONTROL MAY BE LOST DURING AND IMMEDIATELY FOLLOWING THE SURGE CURRENT INTERVAL.
2. CURRENT OVERLOAD MAY NOT BE REPEATED UNTIL JUNCTION TEMPERATURE HAS RETURNED TO WITHIN STEADY-STATE RATED VALUE.

12. Maximum Allowable Full Cycle Surge Current Following Rated Load Conditions



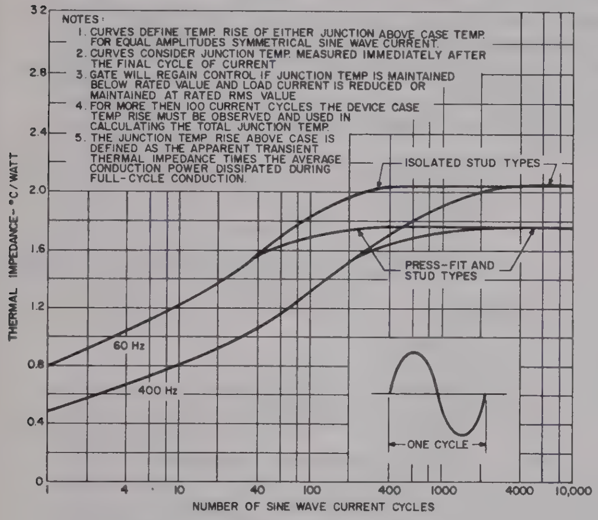
NOTES:
1. GATE CONTROL MAY BE LOST DURING AND IMMEDIATELY FOLLOWING THE SURGE CURRENT INTERVAL.
2. CURRENT OVERLOAD MAY NOT BE REPEATED UNTIL JUNCTION TEMPERATURE HAS RETURNED TO WITHIN STEADY-STATE RATED VALUE.

13. Maximum Allowable Full Cycle Surge Current Following Rated Load Conditions (400 Hz)



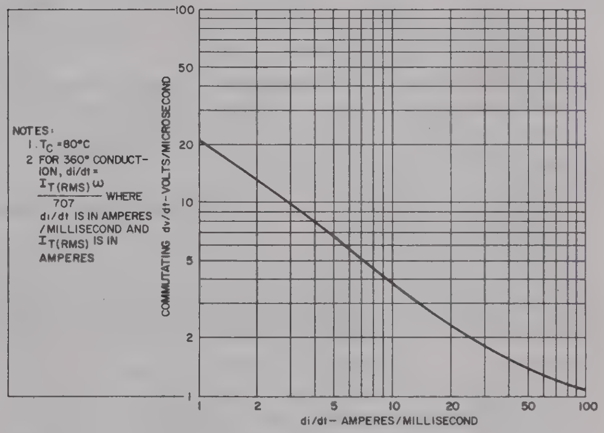
NOTES:
1. CURVES APPLY FOR EITHER POLARITY OF MAIN TERMINAL 2 REFERENCED TO MAIN TERMINAL 1.
2. CURVES APPLY FOR HALF SINE WAVE CURRENT WAVEFORM.

14. Sub-Cycle Surge and I^2t Ratings Following Rated Load Conditions



NOTES:
1. CURVES DEFINE TEMP. RISE OF EITHER JUNCTION ABOVE CASE TEMP. FOR EQUAL AMPLITUDES SYMMETRICAL SINE WAVE CURRENT.
2. CURVES CONSIDER JUNCTION TEMP. MEASURED IMMEDIATELY AFTER THE FINAL CYCLE OF CURRENT.
3. GATE WILL REGAIN CONTROL IF JUNCTION TEMP. IS MAINTAINED BELOW RATED VALUE AND LOAD CURRENT IS REDUCED OR MAINTAINED AT RATED RMS VALUE.
4. FOR MORE THEN 100 CURRENT CYCLES THE DEVICE CASE TEMP RISE MUST BE OBSERVED AND USED IN CALCULATING THE TOTAL JUNCTION TEMP.
5. THE JUNCTION TEMP. RISE ABOVE CASE IS DEFINED AS THE APPARENT TRANSIENT THERMAL IMPEDANCE TIMES THE AVERAGE CONDUCTION POWER DISSIPATED DURING FULL-CYCLE CONDUCTION.

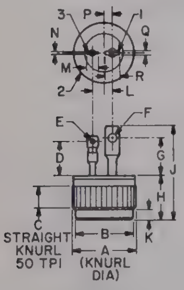
15. Maximum Apparent Transient Thermal Impedance



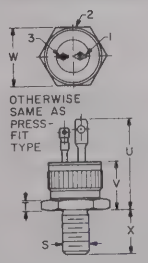
NOTES:
1. $T_C = 80°C$
2. FOR 360° CONDUCTION, $di/dt = \frac{I_{T(RMS)}\,\omega}{707}$ WHERE di/dt IS IN AMPERES/MILLISECOND AND $I_{T(RMS)}$ IS IN AMPERES

16. Typical Rate of Removal of Current (di/dt) Effect Upon Commutating dv/dt

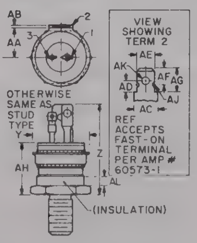
OUTLINE DRAWINGS



PRESS-FIT



STUD

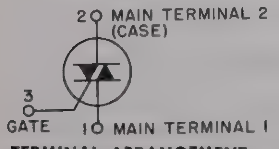

AB
2
AA
3
1
VIEW SHOWING TERM 2
AE
AK
AF
AG
AD
AJ
AC
REF ACCEPTS FAST-ON TERMINAL PER AMP # 60573-1
OTHERWISE SAME AS STUD TYPE
Y
Z
AH
AL
(INSULATION)

ISOLATED STUD

SYM	DECIMAL (INCHES) MIN.	DECIMAL (INCHES) MAX.	METRIC (MM) MIN.	METRIC (MM) MAX.
A	.501	.505	12.73	12.83
B	.467	.475	11.86	12.07
C	.177 REF.		4.50 REF.	
D	.260	.301	6.60	7.65
E	.035	.045	.89	1.14
F	.065	.075	1.65	1.41
G		.350		8.89
H	.340	.376	8.64	9.55
J		.782		19.86
K	.083	.097	2.11	2.46
L	.130	.180	3.30	4.57
M	.085	.115	2.16	2.92

SYM	DECIMAL (INCHES) MIN.	DECIMAL (INCHES) MAX.	METRIC (MM) MIN.	METRIC (MM) MAX.
N	.016	.023	.41	.58
P	.065 REF.		1.65 REF.	
Q	.028	.035	.71	.89
R	.110	.135	2.79	3.43
S	1/4-28 UNF2A		1/4-28 UNF2A	
T	.086	.098	2.18	2.49
U		.865		21.79
V		.475		12.07
W	.552	.562	14.02	14.27
X	.432	.442	10.97	11.23
Y	.580	.610	14.73	15.49

SYM	DECIMAL (INCHES) MIN.	DECIMAL (INCHES) MAX.	METRIC (MM) MIN.	METRIC (MM) MAX.
Z		.975		24.77
AA	.290	.330	7.37	8.38
AB	.017	.024	.43	.61
AC	.235	.265	5.97	6.73
AD	.115	.121	2.29	3.07
AE	.186	.189	4.72	4.80
AF	.170 REF.		4.32 REF	
AG	.245	.255	6.22	6.48
AH		.585		14.86
AJ	.025	R-REF.	.64	R-REF.
AK	.065	.070	1.65	1.78
AL	.100	.110	2.54	2.79



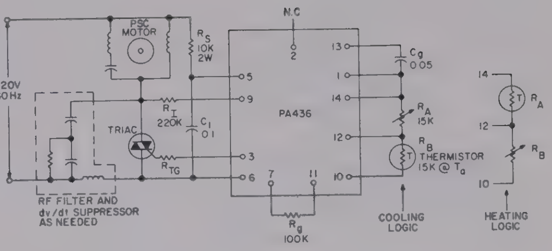
TERMINAL ARRANGEMENT

NOTES: (1)Case temperature is measured at the center of any hex flat or press-fit base.
(2)One ext. tooth lock washer and one nut (both steel, cad. plated) supplied with each stud and isolated stud unit.
(3)Insulation hardware for stud device consisting of terminal, 2 mica washers and one nlyon bushing available at extra cost upon request.

TYPICAL CIRCUIT

The circuit shown here is for controlling speed of a permanent-split capacitor fan motor in response to temperature. For a cooling fan application, R_B is a thermistor having about 5000 ohms resistance at the desired operating temperature. R_A is made variable in order to select the temperature set-point for the control. When temperature increases, fan speed will increase to provide a greater cooling effect. In a heating application, such as a fan-and-coil room heater, the functions of R_A and R_B are reversed so that an increase in temperature will decrease fan speed to provide less heating effect.

This circuit will control the motor over the full range from zero to 100% speed; and usually requires a motor with ball bearings. When sleeve bearings are used, it is generally desirable to limit the minimum speed in order to properly maintain bearing lubrication. A low-speed limit may also be wanted in order to maintain a minimum level of air circulation.



MOUNTING CONSIDERATIONS*

Installation of Press-Fit Device in Heat Sink

When press fitting a Triac into a heatsink, the following specifications and recommendations apply:

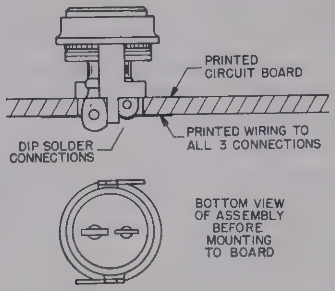
1. Heatsink materials may be copper, aluminum or steel. For maximum heat transfer and minimum corrosion problems, copper is recommended. The heatsink thickness, or amount of heatsink wall, in contact with the Triac should be ⅛ inch.
2. The hole diameter into which the Triac is pressed must be 0.4975 ± .001 inch. A slight chamfer on the hole should be used. This hole may be punched in a flat plate and reamed, or extruded and sized in sheet metal.
3. The entire knurled section of the Triac should be in contact with the heatsink to insure maximum heat transfer. The Triac must not be inserted into a heatsink deeper than the knurl height.
4. The Triac insertion force must not exceed 800 pounds. If the insertion force approaches this value before complete insertion, either the Triac is misaligned with the hole or the Triac-to-hole interference is excessive. The insertion force must be uniformly applied to the top face (terminal end) of the Triac within an annular ring which has an inside diameter of not less than 0.370 inch and not larger than 0.390 inch; the outside diameter of the insertion force must not be less than 0.500 inch.
5. The thermal resistance between the Triac case and a copper heatsink will not exceed 0.5°C/W, if the Triac is inserted in the manner described.

Soldering of Press-Fit Package to Heat Sink

The press-fit package may be soldered directly to a heat sink using 60/40 (Pb-Sn) solder at a temperature of about 200°C.

Attachment of Press Fit Device to Printed Circuit Board

For certain light load applications, the Triac can be inverted and, using a special brass bracket (A7149451), dip-soldered into a printed circuit board. The feet on the bracket act both as a mechanical support and Main Terminal 2 (case) electrical connection. For Triacs preassembled into the bracket, add —X24 to the type number, for example SC51BX24.



Attachment of the Stud & Isolated Stud Device To a Heat Sink

These devices require certain precautions in order to insure good thermal transfer. The chassis hole must be drilled and deburred, and should be between .005 and .015 inches larger than the stud outside diameter. The use of a Torque wrench is highly recommended and must be used within the torque limits indicated on page 2. A good grade of silicone grease will minimize contact thermal resistance.

---

*A more detailed discussion may be found in the General Electric SCR Manual, 4th Edition (1967), Chapter 17, "Cooling the Power Semiconductor.

OTHER TRIAC AND APPLICATION INFORMATION AVAILABLE FROM GENERAL ELECTRIC

Publication Number	Specification Sheets	
85.31	PA436	(Phase Control Integrated Circuit)
175.19	SC35/36	(3 Amp)
175.25	SC40/41	(6 Amp)
175.26	SC45/46	(10 Amp)
175.21	SC60/61	(25 Amp)
175.15	SC141/146	(6, 10 Amp in plastic package)

Publication Number	Application Notes
200.32	A Variety of Mounting Techniques for Press Fit Devices
200.35	Using the Triac for Control of AC Power
200.45	Temperature Controls Incorporating Zero Voltage Switching
200.51	Better Room Conditioning Via Solid State Controls
200.53	Solid State Incandescent Lighting Controls
201.12	500 Watt AC Line Voltage and Power Regulator
201.19	RF Filter Considerations for Triac & SCR Circuits
201.20	Proportional Zero Voltage Switching Temperature Control
201.21	On-Off Zero Voltage Switching Temperature Control
201.22	Low Power Zero Voltage Switching Using the PA424

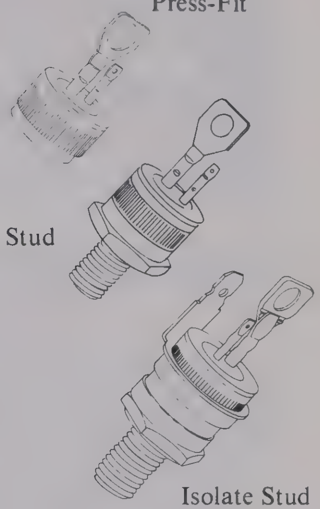
Also, individual specifications are listed in publication number 450.52—Semiconductor Specifications Index. All of these referred to may be ordered by publication number from General Electric Company, Distribution Services, Bldg. 6-208, Schenectady, New York 12305.

Bi-Directional Triode Thyristor

25A RMS Up to 500 Volts

Variations

Mechanical	Electrical
Press-Fit	Zero Voltage Switch Type
Stud	Selected Gate Type
Isolated Stud	400 Hertz Type



The Triac is a bi-directional triode thyristor which may be gate triggered from an OFF to an ON state for either polarity of applied voltage. This device will perform most of the functions of two SCR's connected in inverse parallel.

Features:

- 250A Peak One Full Cycle Surge Rating
- 3000 watt resistive (2000 watt lamp) load—120V line
- 6000 watt resistive (4000 watt lamp) load—240V line
- Inherent immunity from transient voltage damage (can be broken over safely in either direction)
- Press-Fit, Stud, and Isolated Stud Packages available
- Standard Electrical Variations available:
  (1) Selected for use with the General Electric PA424 Zero Voltage Switch
  (2) Selected for 50mA Maximum Gate Trigger Current in all four modes.
  (3) Selected for Operation at 400 Hz.

TYPICAL TRIAC APPLICATIONS

GENERAL FUNCTIONS

TYPES OF EQUIPMENT	Heat Control	Motor Speed Control	Light Control	Solid State Contactors and Relays	Power Regulation
Photographic Dev. Equip.	X		X		X
Process Control	X	X	X	X	X
Reproduction Equipment	X	X	X	X	X
Bio-Medical	X	X	X	X	X
Air Conditioners		X		X	X
Computer Tape Decks		X			
Fans		X		X	
Machine Tools/Misc. Mfg.		X		X	X
Sewing Machines		X			
Laundry	X	X		X	
Farm Equipment	X	X	X	X	
Light Dimmers			X		
Photographic Equipment	X		X	X	X
Outdoor Signs		X	X	X	
Clutches/Brakes				X	
Industrial Timers				X	
Traffic Signal Control			X	X	
Vending Machines	X			X	
Aircraft	X	X	X	X	X
Computer Power Supplies				X	X
Household Misc.	X	X	X	X	X

FOR TRIAC TRIGGERS SEE PAGE 153

MAXIMUM ALLOWABLE RATINGS—ALL TYPES

PACKAGE	ELECTRICAL TYPE				Repetitive Peak Off-State Voltage V_{DRM} (1) $T_C = -40°C$ to $+115°C$
	Standard Type	Zero Voltage Switch	Selected Gate	400 Hz Operation	
PRESS-FIT	SC61B	SC61B12	SC61B13	SC61B14	200 Volts
STUD	SC60B	SC60B12	SC60B13	SC60B14	
ISOLATED STUD	SC60B2	SC60B22	SC60B23	SC60B24	
PRESS-FIT	SC61D	SC61D12	SC61D13	SC61D14	400 Volts
STUD	SC60D	SC60D12	SC60D13	SC60D14	
ISOLATED STUD	SC60D2	SC60D22	SC60D23	SC60D24	
PRESS-FIT	SC61E	SC61E12	SC61E13	SC61E14	500 Volts
STUD	SC60E	SC60E12	SC60E13	SC60E14	
ISOLATED STUD	SC60E2	SC60E22	SC60E23	SC60E24	

RMS On-State Current, $I_{T(RMS)}$		25 Amperes
Peak One Full Cycle Surge (non-rep) On-State Current, I_{TSM}	(50 Hz)	230 Amperes
	(60 Hz)	250 Amperes
	(400 Hz)	510 Amperes
I^2t (for fusing), for time at (2)	1.0 millisecond	150 Ampere² seconds (See Chart 14)
	8.3 millisecond	250 Ampere² seconds (See Chart 14)
Peak Gate Power Dissipation, P_{GM} (3)		10 Watts for 10 microseconds (See Chart 5)
Average Gate Power Dissipation, $P_{G(AV)}$		0.5 Watts
Peak Gate Current, I_{GM} (3)		See Chart 5
Peak Gate Voltage, V_{GM} (3)		See Chart 5
Critical Rate-of-Rise of On-State Current, di/dt (2): Breakover voltage triggered operation		10 Amperes per microsecond
Storage Temperature, T_{STG}		−40°C to +125°C
Operating Temperature, T_J		−40°C to +115°C
Stud Torque — (STUD & ISOLATED STUD TYPES)		25 Lb-in (29 Kg-cm)
Insertion Pressure — (PRESS-FIT TYPE)		800 lbs (364 Kg)
Isolation Breakdown Voltage Between Any Terminal and Stud (ISOLATED STUD TYPE) (4)		1800 Volts RMS

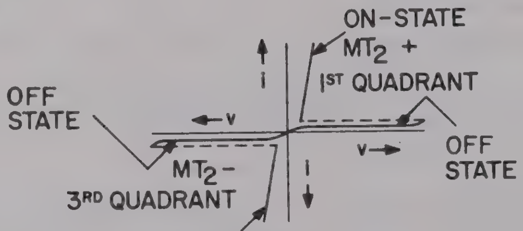
NOTES:

[1] Ratings apply for zero gate voltage only. Maximum case-to-ambient thermal resistance for which V_{DRM} ratings apply equals 18°C/watt. Ratings apply for either polarity of main terminal 2 voltage referenced to main terminal 1.

[2] Ratings apply for either polarity of main terminal 2 referenced to main terminal 1.

[3] Ratings apply for either polarity of gate terminal referenced to main terminal 1.

[4] Rating applies for 50, 60 and 400 Hz sinusoidal voltage waveform.



TYPICAL E-I CHARACTERISTICS

WARNING

Isolated stud products described in this specification sheet should be handled with care. The ceramic portion of these thyristors contains BERYLLIUM OXIDE as a major ingredient.

Do not crush, grind, or abrade these portions of the thyristors because the dust resulting from such action may be hazardous if inhaled.

TABLE I—STANDARD TYPE

CHARACTERISTICS										Reference Note
Type	Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions			
All types	Peak Off-State current	I_{DRM}				mA	V_{DRM} = Maximum Allowable Peak Off-State voltage Gate Open Circuited			1
			—	—	0.5		T_C = + 25°C			
			—	—	2.0		T_C = +115°C			
All types	Peak On-State Voltage	V_{TM}	—	—	1.50	Volts	T_C = +25°C, I_{TM} = 35A peak. 1 millisecond wide pulse, Duty cycle ≦ 2%			2
All types	Critical Rate of Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt	—	100	—	Volts/μsec	T_C = +115°C, Rated V_{DRM} Gate Open Circuited Exponential Waveform			2
All except 400 Hertz Type (Refer to Table IV)	Critical Rate of Rise of Commutating Off-State Voltage (Commutating dv/dt)	dv/dt(c)	5.0	—	—	Volts/μsec	T_C = +80°C (+71.5°C for isolated stud type), $I_{T(RMS)}$ = Rated Max. Allowable RMS On-State Current V_{DRM} = Rated Maximum Allowable Peak Off-State Voltage, Gate Open Circuited, Commutating di/dt = 13.5A/msec			2
All except selected gate type (Refer to table III)	D.C. Gate Trigger Current	I_{GT}				mAdc	V_D = 12 Vdc			3
							Trigger Mode	R_L	T_C	
			—	—	50		MT2+ Gate+	100 ohms	+25°C	
			—	—	50		MT2− Gate−	100 ohms		
			—	—	50		MT2+ Gate−	50 ohms		
			—	—	80		MT2+ Gate+	50 ohms	−40°C	
			—	—	80		MT2− Gate−	50 ohms		
			—	—	80		MT2+ Gate−	25 ohms		
All except selected gate type (Refer to Table III)	D.C. Gate Trigger Voltage	V_{GT}				Vdc	V_D = 12 Vdc			3
							Trigger Mode	R_L	T_C	
			—	—	2.5		MT2+ Gate+	100 ohms	+25°C	
			—	—	2.5		MT2− Gate−	100 ohms		
			—	—	2.5		MT2+ Gate−	50 ohms		
			—	—	3.5		MT2+ Gate+	50 ohms	−40°C	
			—	—	3.5		MT2− Gate−	50 ohms		
			—	—	3.5		MT2+ Gate−	25 ohms		
			.25	—	—		MT2+ Gate+ MT2− Gate− MT2+ Gate− MT2− Gate+	1000 ohms	+115°C	3,4
All Types	Holding Current	I_H				mAdc	Main Terminal Source Voltage = 24 Vdc, Peak initiating on-state current = 0.5A, 0.1 milliseconds to 10 milliseconds wide pulse Gate trigger source = 7 V, 20 Ohms			2
			—	—	75		T_C = +25°C			
			—	—	150		T_C = −40°C			
All Types	Latching Current	I_L				mAdc	Main Terminal Source Voltage = 24 Vdc, Gate trigger source = 15 V, 100 Ohms, 50 μsec pulse width, 5 μsec rise and fall times max			3
							Trigger Mode		Tc	
			—	—	100		MT2+ Gate+		+25°C	
			—	—	100		MT2− Gate−			
			—	—	200		MT2+ Gate−			
			—	—	200		MT2+ Gate+		−40°C	
			—	—	200		MT2− Gate−			
			—	—	400		MT2+ Gate−			
Press-fit & stud type	Steady-State Thermal Resistance	$R_{\theta JC}$	—	—	1.7	°C/Watt	Junction to Case			2
Isolated stud type			—	—	2.0					

NOTES

[1] Maximum case-to-ambient thermal resistance for which maximum V_{DRM} ratings apply equals 18°C per watt. Values apply for either polarity of main terminal 2 characteristic referenced to main terminal 1.

[2] Values apply for either polarity of main terminal 2 characteristics referenced to main terminal 1.

[3] Main terminal 1 is the reference terminal for main terminal 2 and gate terminal.

[4] With V_D equal to maximum allowable off-state voltage.

TABLE II—ZERO VOLTAGE SWITCH TYPE (FOR USE WITH PA424 ZERO VOLTAGE SWITCH)

NOTE: ALL STANDARD CHARACTERISTICS APPLY EXCEPT AS INDICATED

CHARACTERISTICS									Reference Note
Test	**Symbol**	**Min.**	**Typ.**	**Max.**	**Units**	**Test Conditions**			
Pulse Gate Trigger Current	I_{GT}				mAdc	V_D = 3 Vdc, Gate Pulse width = 50 μsec			1
						Trigger Mode	R_L	T_C	
		—	—	30		MT2− Gate− MT2+ Gate−	15 ohms	+25°C	
		—	—	46		MT2− Gate− MT2+ Gate−	9 ohms	−20°C	
Pulse Gate Trigger Voltage	V_{GT}				Volts	V_D = 3 Vdc, Gate Pulse width = 50 μsec			1
						Trigger Mode	R_L	T_C	
		—	—	2.0		MT2− Gate− MT2+ Gate−	15 ohms	+25°C	
		—	—	2.75		MT2− Gate− MT2+ Gate−	9 ohms	−20°C	
Latching Current	I_L				mAdc	Main Terminal Source Voltage = 3 Vdc, Gate trigger source = PA424			1
						Trigger Mode	T_C		
		—	—	150		MT2− Gate− MT2+ Gate−	+25°C		
		—	—	250		MT2− Gate− MT2+ Gate−	−20°C		

TABLE III—SELECTED GATE TYPE

NOTE: ALL STANDARD CHARACTERISTICS APPLY EXCEPT AS INDICATED

CHARACTERISTICS									Reference Note
Test	**Symbol**	**Min.**	**Typ.**	**Max.**	**Units**	**Test Conditions**			
D.C. Gate Trigger Current	I_{GT}				mAdc	V_D = 12 Vdc			1
						Trigger Mode	R_L	T_C	
		—	—	50		MT2+ Gate+	100 ohms	+25°C	
		—	—	50		MT2− Gate−	100 ohms		
		—	—	50		MT2+ Gate−	50 ohms		
		—	—	50		MT2− Gate+	50 ohms		
		—	—	80		MT2+ Gate+	50 ohms	−40°C	
		—	—	80		MT2− Gate−	50 ohms		
		—	—	80		MT2+ Gate−	25 ohms		
		—	—	80		MT2− Gate+	25 ohms		
D.C. Gate Trigger Voltage	V_{GT}				Vdc	V_D = 12 Vdc			1
						Trigger Mode	R_L	T_C	
		—	—	2.5		MT2+ Gate+	100 ohms	+25°C	
		—	—	2.5		MT2− Gate−	100 ohms		
		—	—	2.5		MT2+ Gate−	50 ohms		
		—	—	2.5		MT2− Gate+	50 ohms		
		—	—	3.5		MT2+ Gate+	50 ohms	−40°C	
		—	—	3.5		MT2− Gate−	50 ohms		
		—	—	3.5		MT2+ Gate−	25 ohms		
		—	—	3.5		MT2− Gate+	25 ohms		

TABLE IV—400 HZ OPERATION TYPE

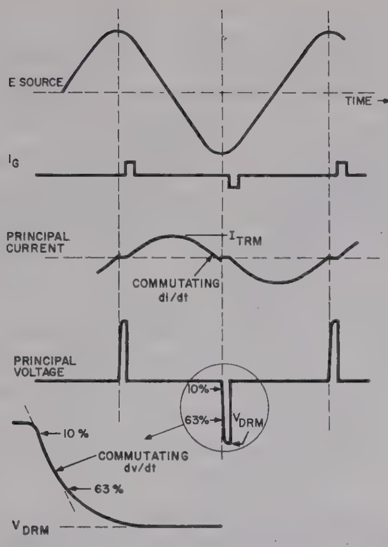
NOTE: ALL STANDARD CHARACTERISTICS APPLY EXCEPT AS INDICATED

CHARACTERISTICS							Reference Note
Test	**Symbol**	**Min.**	**Typ.**	**Max.**	**Units**	**Test Conditions**	
Critical Rate of Rise of Commutating Off-State Voltage (Commutating dv/dt)	dv/dt(c)	5	—	—	Volts/μsec	T_C = +80°C (+71.5°C for isolated stud type), $I_{T(RMS)}$ = Rated Max. Allowable RMS On-State Current V_{DRM} = Rated Maximum Allowable Peak Off-State Voltage Gate Open Circuited Commutating di/dt = 89 A/msec	2

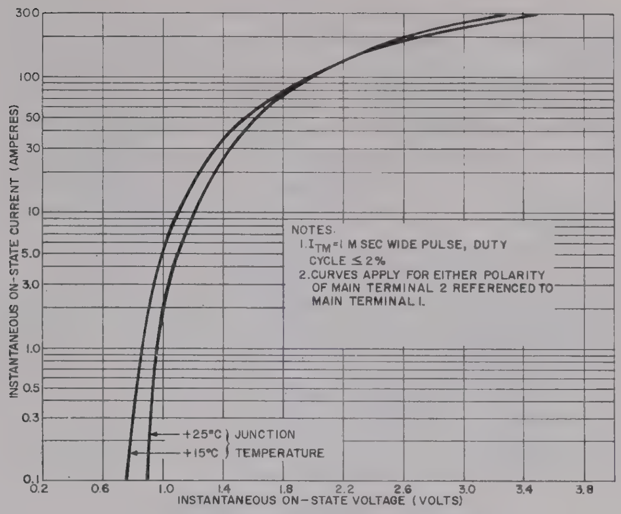
NOTES

[1] Main terminal 1 is the reference terminal for main terminal 2 and gate terminal.

[2] Values apply for either polarity of main terminal 2 characteristic referenced to main terminal 1.

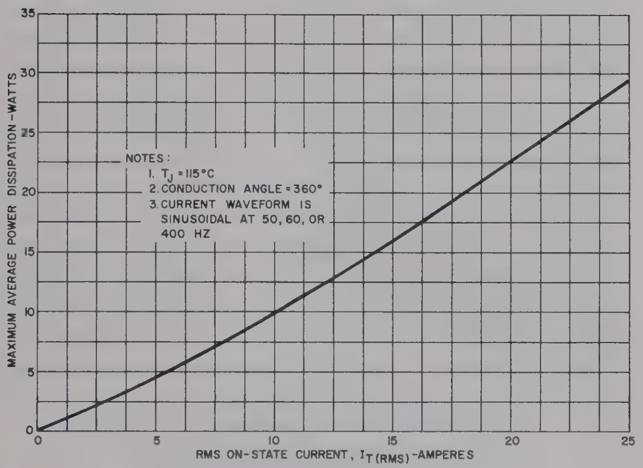

E SOURCE
TIME →
I_G
PRINCIPAL CURRENT
I_{TRM}
COMMUTATING di/dt
PRINCIPAL VOLTAGE
10%
63%
V_{DRM}
10 %
COMMUTATING dv/dt
63 %
V_{DRM}

1. Waveform of Commutating dv/dt



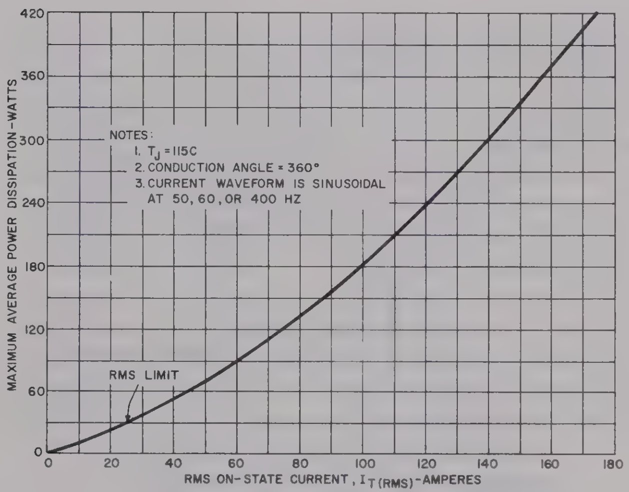
NOTES:
1. I_{TM}=1 M SEC WIDE PULSE, DUTY CYCLE ≤ 2%
2. CURVES APPLY FOR EITHER POLARITY OF MAIN TERMINAL 2 REFERENCED TO MAIN TERMINAL 1.

2. Maximum On-State Voltage vs. On-State Current



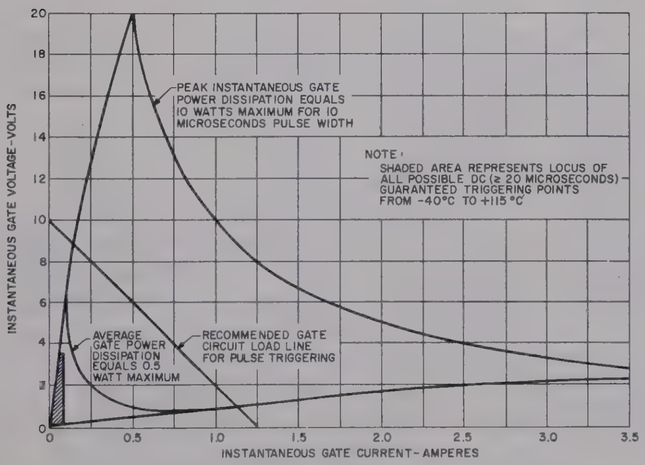
NOTES:
1. T_J = 115°C
2. CONDUCTION ANGLE = 360°
3. CURRENT WAVEFORM IS SINUSOIDAL AT 50, 60, OR 400 HZ

3. Maximum Average Power Dissipation vs. RMS On-State Current



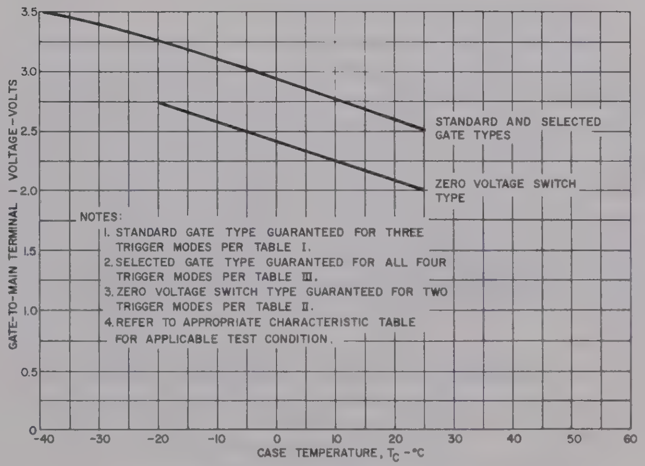
NOTES:
1. T_J = 115C
2. CONDUCTION ANGLE = 360°
3. CURRENT WAVEFORM IS SINUSOIDAL AT 50, 60, OR 400 HZ

4. Maximum Average Power Dissipation vs. RMS On-State Current (High Level)



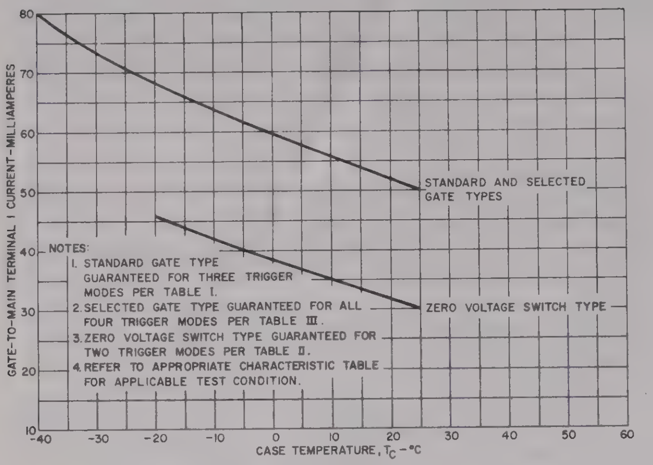
NOTE:
SHADED AREA REPRESENTS LOCUS OF ALL POSSIBLE DC (≥ 20 MICROSECONDS) GUARANTEED TRIGGERING POINTS FROM -40°C TO +115°C

5. Gate Characteristics and Ratings

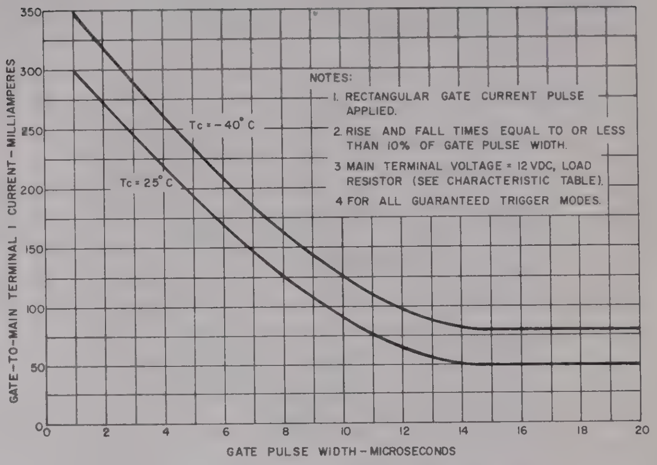


NOTES:
1. STANDARD GATE TYPE GUARANTEED FOR THREE TRIGGER MODES PER TABLE I.
2. SELECTED GATE TYPE GUARANTEED FOR ALL FOUR TRIGGER MODES PER TABLE III.
3. ZERO VOLTAGE SWITCH TYPE GUARANTEED FOR TWO TRIGGER MODES PER TABLE II.
4. REFER TO APPROPRIATE CHARACTERISTIC TABLE FOR APPLICABLE TEST CONDITION.

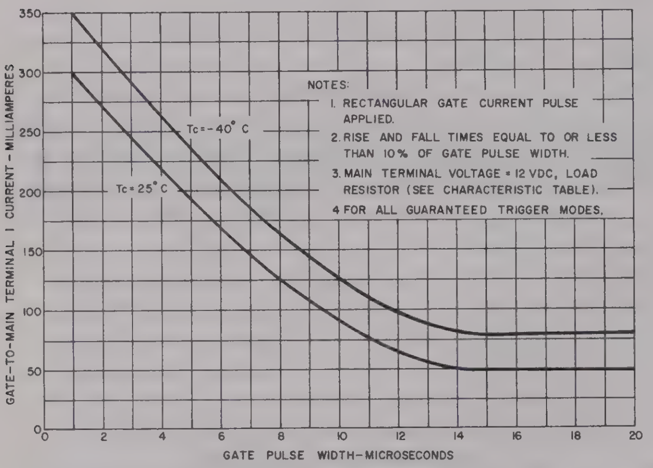
6. Maximum DC Gate Trigger Voltage vs. Case Temperature



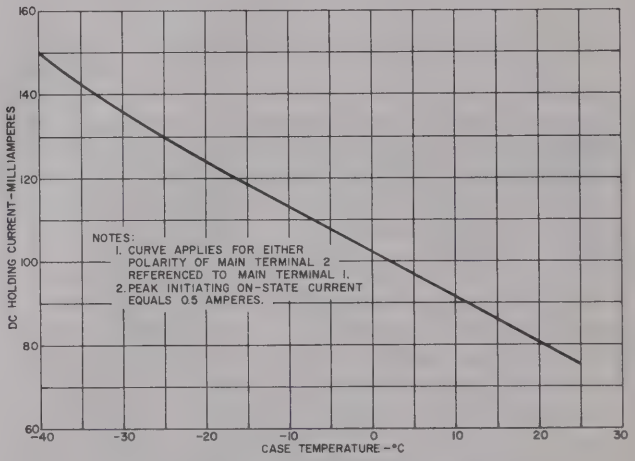
7. Maximum DC Gate Trigger Current vs. Case Temperature



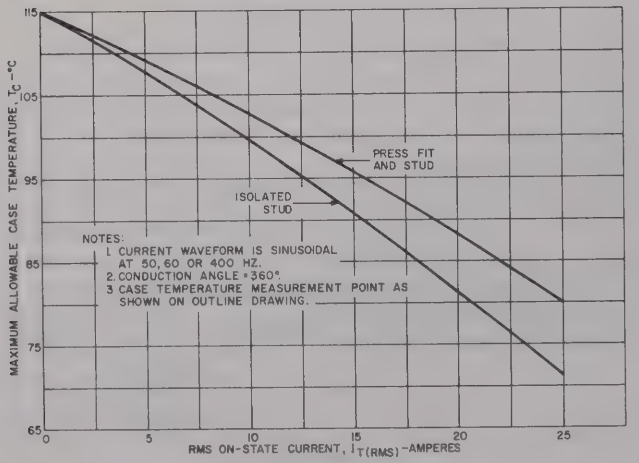
8. Maximum Gate Trigger Current vs. Gate Pulse Width (Selected Gate Type)



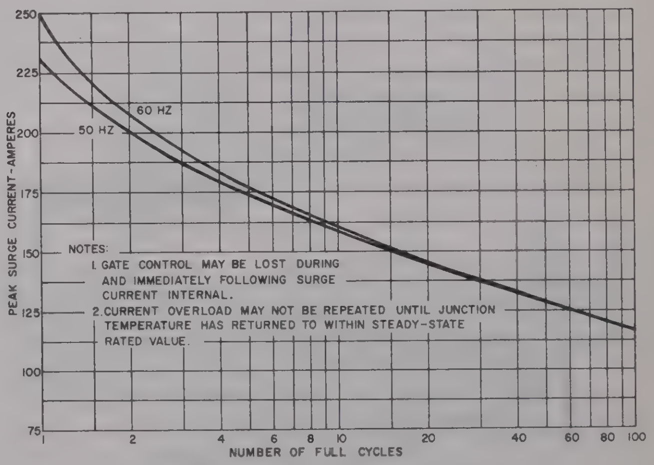
9. Maximum Gate Trigger Current vs. Gate Pulse Width (Standard Gate Type)



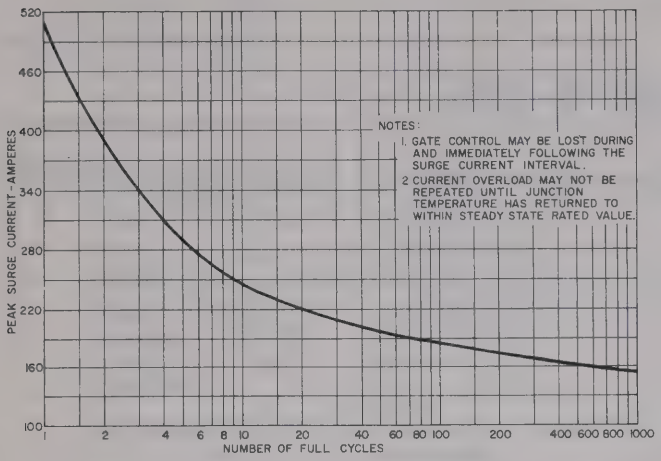
10. Maximum DC Holding Current vs. Case Temperature



11. Maximum Allowable Case Temperature vs. RMS On-State Current

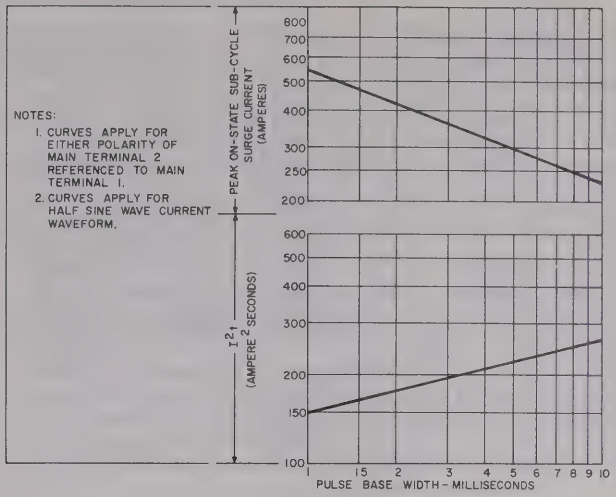


12. Maximum Allowable Full Cycle Surge Current Following Rated Load Conditions



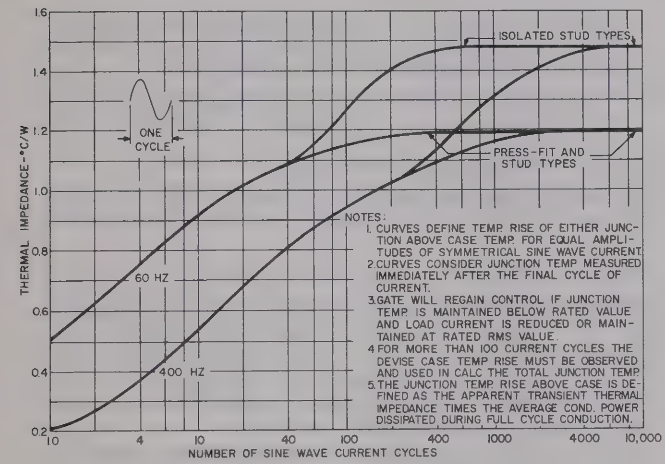
NOTES:
1. GATE CONTROL MAY BE LOST DURING AND IMMEDIATELY FOLLOWING THE SURGE CURRENT INTERVAL.
2 CURRENT OVERLOAD MAY NOT BE REPEATED UNTIL JUNCTION TEMPERATURE HAS RETURNED TO WITHIN STEADY STATE RATED VALUE.

13. Maximum Allowable Full Cycle Surge Current Following Rated Load Conditions (400 Hz)



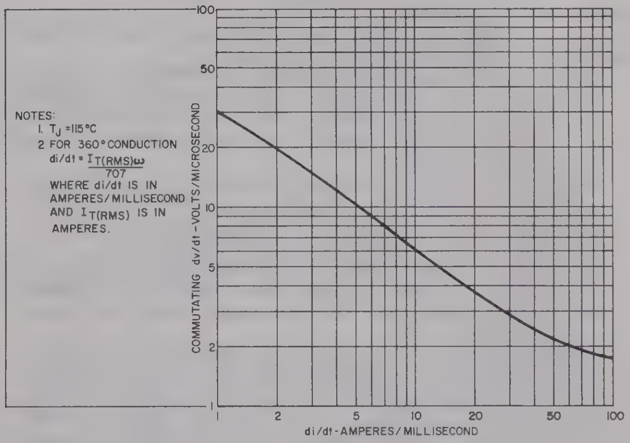
NOTES:
1. CURVES APPLY FOR EITHER POLARITY OF MAIN TERMINAL 2 REFERENCED TO MAIN TERMINAL 1.
2. CURVES APPLY FOR HALF SINE WAVE CURRENT WAVEFORM.

14. Sub-Cycle Surge and I^2t Ratings Following Rated Load Conditions



NOTES:
1. CURVES DEFINE TEMP. RISE OF EITHER JUNCTION ABOVE CASE TEMP. FOR EQUAL AMPLITUDES OF SYMMETRICAL SINE WAVE CURRENT.
2. CURVES CONSIDER JUNCTION TEMP MEASURED IMMEDIATELY AFTER THE FINAL CYCLE OF CURRENT.
3. GATE WILL REGAIN CONTROL IF JUNCTION TEMP. IS MAINTAINED BELOW RATED VALUE AND LOAD CURRENT IS REDUCED OR MAINTAINED AT RATED RMS VALUE.
4 FOR MORE THAN 100 CURRENT CYCLES THE DEVISE CASE TEMP RISE MUST BE OBSERVED AND USED IN CALC THE TOTAL JUNCTION TEMP.
5. THE JUNCTION TEMP. RISE ABOVE CASE IS DEFINED AS THE APPARENT TRANSIENT THERMAL IMPEDANCE TIMES THE AVERAGE COND. POWER DISSIPATED DURING FULL CYCLE CONDUCTION.

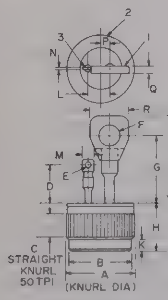
15. Maximum Apparent Transient Thermal Impedance



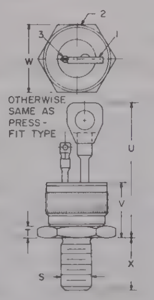
NOTES:
1. T_J = 115°C
2 FOR 360° CONDUCTION $di/dt = \frac{I_{T(RMS)}\omega}{707}$ WHERE di/dt IS IN AMPERES/MILLISECOND AND $I_{T(RMS)}$ IS IN AMPERES.

16. Typical Rate of Removal of Current (di/dt) Effect Upon Commutating dv/dt

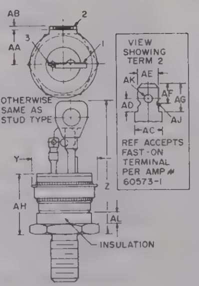
OUTLINE DRAWINGS



PRESS-FIT



STUD

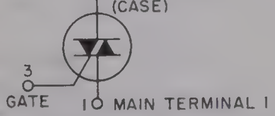

AB
2
3
AA
1
OTHERWISE SAME AS STUD TYPE
VIEW SHOWING TERM 2
AK
AE
AF
AG
AD
AJ
AC
REF ACCEPTS FAST-ON TERMINAL PER AMP # 60573-1
Y
Z
AH
AL
INSULATION

ISOLATED STUD

SYM	DECIMAL (INCHES) MIN.	DECIMAL (INCHES) MAX.	METRIC (MM) MIN.	METRIC (MM) MAX.
A	.501	.505	12.73	12 83
B	.467	475	11.86	12.07
C	.177 REF		4.50 REF	
D	.260	301	6 60	7.65
E	.035	.045	89	1.14
F	145	160	3 683	4.064
G	.480 – REF		12 19 – REF	
H	340	376	8 64	9 55
J		1.064		27025
K	.083	097	2.11	2 46
L	130	180	3 30	4 57
M	.085	.115	2.16	2 92

SYM	DECIMAL (INCHES) MIN.	DECIMAL (INCHES) MAX.	METRIC (MM) MIN	METRIC (MM) MAX
N	.016	023	41	58
P	.065 REF		1.65 REF	
Q	.044	062	1.117	1.575
R	284	302	7 213	7 671
S	1/4-28 UNF2A		1/4-28 UNF2A	
T	.086	.098	2 18	2 49
U		1.150		29 210
V		475		12 07
W	552	562	14 02	14 27
X	432	442	10 97	11 23
Y	580	610	14 73	15 49

SYM	DECIMAL (INCHES) MIN.	DECIMAL (INCHES) MAX	METRIC (MM) MIN	METRIC (MM) MAX.
Z		1 260		32 00
AA	290	330	7 37	8 38
AB	.017	024	.43	61
AC	235	265	5 97	6 73
AD	.115	121	2 29	3 07
AE	186	189	4 72	4 80
AF	170 REF		4 32 REF	
AG	.245	255	6 22	6 48
AH		585		14 86
AJ	.025 R-REF		64 R-REF	
AK	065	070	1 65	1 78
AL	100	110	2 54	2.79



TERMINAL ARRANGEMENT

NOTES: (1) Case temperature is measured at the center of any hex flat or press-fit base.
(2) One ext. tooth lock washer and one nut (both steel, cad. plated) supplied with each stud and isolated stud unit.
(3) Insulation hardware for stud device consisting of terminal, 2 mica washers and one nylon bushing available at extra cost upon request.

TYPICAL CIRCUIT

In temperature control of large loads, the thermal time constants of the system often cause large overshoots in temperature if off-on controllers are used. A smaller temperature variation will occur if proportional control is used. Figure 1 shows the relative difference. In off-on control, power is applied to the load until the set point (SP) is reached; at this time the power is turned off, but because of the thermal time lag, the temperature overshoots. In proportional control, however, the controller provides less power as the set point is approached; this causes slower heating and reduces the overshoot. The system then controls the power on a proportional basis while the temperature remains within the proportional band. As the temperature increases, less and less power is delivered to the load. This concept is graphically shown for a steady state condition in Figure 2.

Figure 3 shows a proportional control designed for use with baseboard electric heating. The period, proportional band, and sensor were designed to give optimum performance in this application. For other applications these parameters can be changed to provide even higher performance systems.

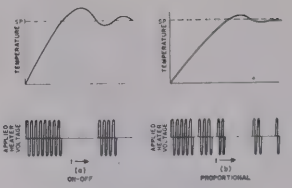


Figure 1: Modes of Control

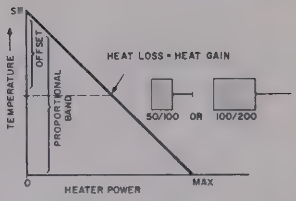


Figure 2: Proportional Control

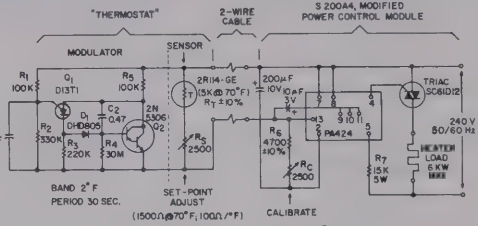


Figure 3: Proportional Control Temperature Regulator

MOUNTING CONSIDERATIONS*

Installation of Press-Fit Device in Heat Sink

When press fitting a Triac into a heatsink, the following specifications and recommendations apply.

1. Heatsink materials may be copper, aluminum or steel. For maximum heat transfer and minimum corrosion problems, copper is recommended. The heatsink thickness, or amount of heatsink wall, in contact with the Triac should be ⅛ inch.
2. The hole diameter into which the Triac is pressed must be 0.4975 ± .001 inch. A slight chamfer on the hole should be used. This hole may be punched in a flat plate and reamed, or extruded and sized in sheet metal.
3. The entire knurled section of the Triac should be in contact with the heatsink to insure maximum heat transfer. The Triac must not be inserted into a heatsink deeper than the knurl height.
4. The Triac insertion force must not exceed 800 pounds. If the insertion force approaches this value before complete insertion, either the Triac is misaligned with the hole or the Triac-to-hole interference is excessive. The insertion force must be uniformly applied to the top face (terminal end) of the Triac within an annular ring which has an inside diameter of not less than 0.370 inch and not larger than 0.390 inch; the outside diameter of the insertion force must not be less than 0.500 inch.
5. The thermal resistance between the Triac case and a copper heatsink will not exceed 0.5°C/W, if the Triac is inserted in the manner described.

Soldering of Press-Fit Package to Heat Sink

The press-fit package may be soldered directly to a heat sink using 60/40 (Pb-Sn) solder at a temperature of about 200°C.

Attachment of the Stud & Isolated Stud Device To a Heat Sink

These devices require certain precautions in order to insure good thermal transfer. The chassis hole must be drilled and deburred, and should be between .005 and .015 inches larger than the stud outside diameter. The use of a Torque wrench is highly recommended and must be used within the torque limits indicated on page 2. A good grade of silicone grease will minimize contact thermal resistance.

*A more detailed discussion may be found in the General Electric SCR Manual, 4th Edition (1967), Chapter 17, "Cooling the Power Semiconductor.

OTHER TRIAC AND APPLICATION INFORMATION AVAILABLE FROM GENERAL ELECTRIC

Publication Number	Specification Sheets	
85.21	PA424	(Zero Voltage IC Switch)
85.31	PA436	(Phase Control Integrated Circuit)
175.15	SC141/146	(6, 10 Amp in plastic package)
175.19	SC35/36	(3 Amp)
175.25	SC40/41	(6 Amp)
175.26	SC45/46	(10 Amp)
175.27	SC50/51	(15 Amp)

Publication Number	Application Notes
200.32	A Variety of Mounting Techniques for Press Fit Devices.
200.35	Using the Triac for Control of AC Power
200.45	Temperature Controls Incorporating Zero Voltage Switching
200.51	Better Room Conditioning Via Solid State Controls
200.53	Solid State Incandescent Lighting Controls
201.12	500 Watt AC Line Voltage and Power Regulator
201.19	RF Filter Considerations for Triac & SCR Circuits
201.20	Proportional Zero Voltage Switching Temperature Control
201.21	On-off Zero Voltage Switching Temperature Control
201.22	Low Power Zero Voltage Switching Using the PA424
201.24	Thyristor Selection for Incandescent Lamp Loads

Also, individual specifications are listed in publication number 450.52 —Semiconductor Specifications Index. All of these referred to may be ordered by publication number from General Electric Company, Distribution Services, Bldg. 6-208, Schenectady, New York 12305.

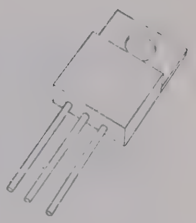
Triac
Bi-Directional Triode Thyristor

SC141
SC146

6A and 10A RMS **Up to 500 Volts**

The triac is a silicon AC switch which may be gate triggered from an OFF-state to an ON-state for either polarity of applied voltage.

The SC141 and SC146 are molded silicon plastic triacs which incorporate General Electric's new POWER-GLAS glassivation process. This process provides for an intimate void-free bond between the silicon chip and the glass coating significantly improving performance and reliability.



JEDEC TO-220-AB

Features:

- Glassivated silicon chip for maximum reliability
- Inherent immunity from transient voltage damage (can be broken over safely in either direction)
- Improved commutating dv/dt (4V/μs min)
- No maximum torque limit on mounting screw
- Round leads – greatly simplifies customer assembly
- Six standard lead forming configurations available from factory (including TO-66 compatability)
- Special selections for non-standard gate requirements available upon request
- Zero voltage switch selections available upon request

TYPICAL TRIAC APPLICATIONS

	GENERAL FUNCTIONS				
TYPES OF EQUIPMENT	Heat Control	Motor Speed Control	Light Control	Solid State Contactors and Relays	Power Regulation
Photographic Dev. Equip.	X	X	X		
Process Control	X	X	X	X	X
Reproduction Equipment	X	X	X	X	
Air Conditioners		X			
Blenders, Mixers		X			
Computer Tape Decks		X			
Fans		X			
Hand Tools		X			
Machine Tools/Misc. Mfg.		X		X	
Sewing Machines		X			
Laundry				X	
Farm Equipment	X	X	X	X	
Light Dimmers			X		
Photographic Equipment	X		X	X	
Outdoor Signs			X	X	
Clutches/Brakes				X	
Industrial Timers				X	
Traffic Signal Control			X	X	
Vending Machines	X	X		X	
Computer Power Supplies					X
Home Entertainment	X	X	X	X	X

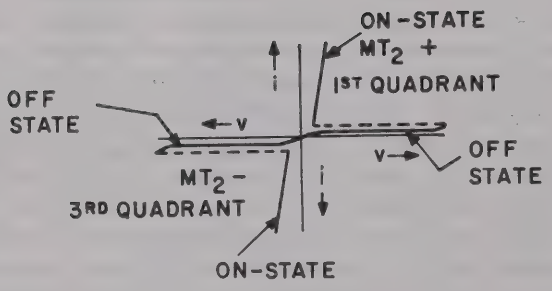
MAXIMUM ALLOWABLE RATINGS

	RMS On-State Current, I_T(1) (RMS)	Repetitive Peak Off-State Voltage, V_{DRM}(2)			Peak One Full Cycle Surge (Non-Rep) On-State Current, I_{TSM} Amperes		I^2t For Fusing in Ampere² Seconds For Times At(3)	
Type	Amperes	B Volts	D Volts	E Volts	50Hz	60 Hz	1 Millisecond	8.3 Milliseconds
SC141B,D,E	6	200	400	500	74	80	18	26.5
SC146B,D,E	10	200	400	500	90	100	20	41.5

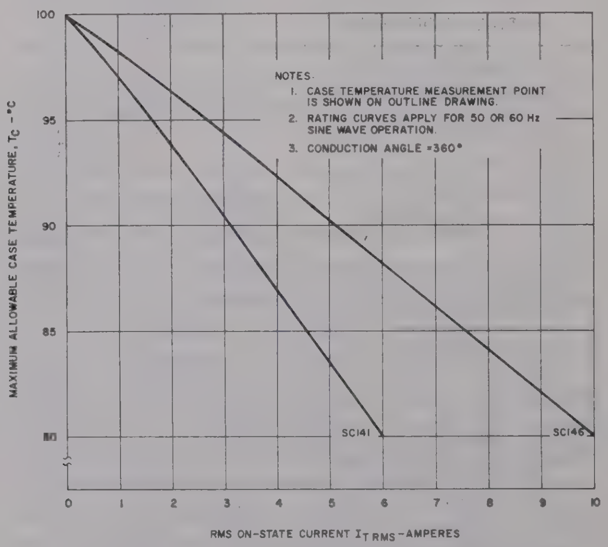
Critical Rate-Of-Rise of On-State Current, di/dt: (3)(5)
Breakover voltage triggered operation. . . . . 10 Amperes per microsecond
Peak Gate Power Dissipation, P_{GM}(4). . . . . .10 Watts for 10 microseconds (see Chart 9)
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 0.5 Watts
Peak Gate Current, I_{GM}(4). . . . . see Chart 9
Peak Gate Voltage, V_{GM}(4) . . . . see Chart 9
Storage Temperature, T_{stg} . . . . -40°C to +125°C
Operating Temperature, T_J . . . . -40°C to +100°C

NOTES:

1. At main terminal 2 lead reference point temperature of 80°C maximum and 360° conduction.
2. Ratings apply for zero gate voltage only. Ratings apply for either polarity of main terminal 2 voltage referenced to main terminal 1.
3. Ratings apply for either polarity of main terminal 2 referenced to main terminal 1.
4. Ratings apply for either polarity of gate terminal referenced to main terminal 1.
5. di/dt rating is established in accordance with JEDEC Suggested Standard No. 7, Section 5.1.2.4. Off-state (blocking) voltage capability may be temporarily lost immediately after each current pulse for duration less than the period of the applied pulse repetition rate. The pulse repetition rate for this test is 400 Hz. The duration of the JEDEC di/dt test condition is 5.0 seconds (minimum).



1. Typical E-I Characteristics



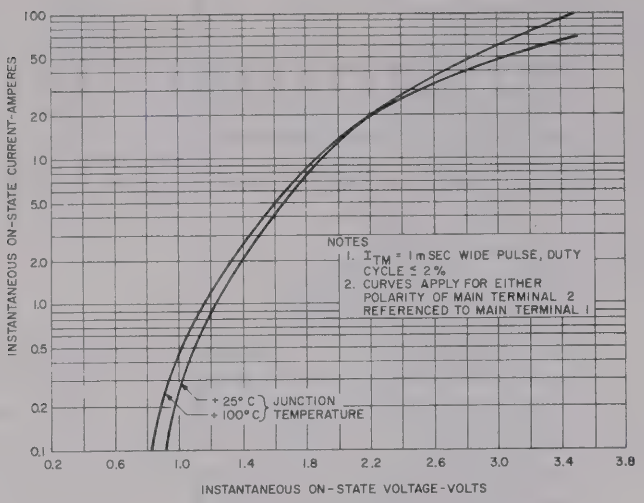
2. Maximum Allowable Case Temperature vs. RMS On-State Current

CHARACTERISTICS

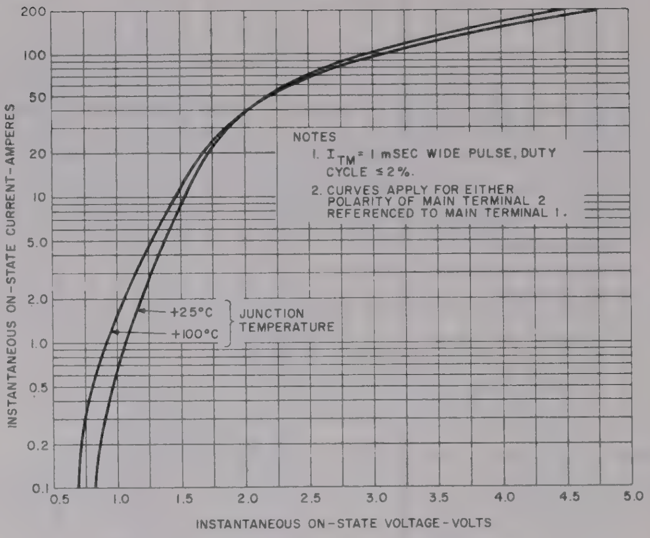
Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions			Reference Note
Peak Off-State Current	I_{DRM}				mA	V_{DRM} = Maximum Allowable Peak Off-State Voltage Gate Open Circuited			1
		–	–	0.1		$T_c = +25^\circ C$			
		–	–	0.5		$T_c = +100^\circ C$			
Peak On-State Voltage	V_{TM}				Volts	$T_c = +25^\circ C$, I_{TM} = 1 msec Wide pulse, duty cycle ≤ 2%			
SC141		–	–	1.83		I_{TM} = 8.5A peak			1
SC146		–	–	1.65		I_{TM} = 14A peak			
Critical Rate of Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt	–	50	–	Volts/μsec	$T_c = +100^\circ C$, Rated V_{DRM} Gate Open Circuited, Exponential Waveform			1
Critical Rate of Rise of Commutating Off-State Voltage (Commutating dv/dt)	$dv/dt_{(c)}$				Volts/μsec	$T_c = +80^\circ C$, $I_{T(RMS)}$ = Rated Max. Allowable RMS On-State Current. V_{DRM} = Rated Max. Allowable Peak Off-State Voltage. Gate Open Circuited			1
SC141		4	–	–		Commutating di/dt = 3.2A/msec			
SC146		4	–	–		Commutating di/dt = 5.4A/msec			
D.C. Gate Trigger Current	I_{GT}				mAdc	V_D = 12 Vdc			2
						Trigger Mode	R_L	T_c	
		–	–	50		MT2+ Gate +	100 ohms	+25°C	
		–	–	50		MT2– Gate–	100 ohms		
		–	–	50		MT2+ Gate –	50 ohms		
		–	–	80		MT2+ Gate+	50 ohms	-40°C	
		–	–	80		MT2– Gate–	50 ohms		
		–	–	80		MT2+ Gate–	25 ohms		
D.C. Gate Trigger Voltage	V_{GT}				Vdc	V_D = 12 Vdc			2
						Trigger Mode	R_L	T_c	
		–	–	2.5		MT2+ Gate+	100 ohms	+25°C	
		–	–	2.5		MT2– Gate–	100 ohms		
		–	–	2.5		MT2+ Gate–	50 ohms		
		–	–	3.5		MT2+ Gate+	50 ohms	–40°C	
		–	–	3.5		MT2– Gate–	50 ohms		
		–	–	3.5		MT2+ Gate–	25 ohms		
		0.20	–	–		MT2+ Gate+	1000 ohms	+100°C	2,3
						MT2– Gate–			
						MT2+ Gate–			
						MT2– Gate+			
Holding Current	I_H				mAdc	Main Terminal Source Voltage = 24 Vdc, Peak initiating on-state current = 0.5A, 0.1 milliseconds to 10 milliseconds wide pulse, Gate trigger source = 7 V, 20 ohms			1
		–	–	50		$T_c = +25^\circ C$			
		–	–	100		$T_c = -40^\circ C$			
Latching Current	I_L				mAdc	Main Terminal Source Voltage @ 24 Vdc, Gate trigger source @ 15 V, 100 ohms, 50 μsec rise and fall times max.			2
						Trigger Mode		T_c	
		–	–	100		MT2+ Gate+		+25°C	
		–	–	100		MT2– Gate–			
		–	–	200		MT2+ Gate–			
		–	–	200		MT2+ Gate+		–40°C	
		–	–	200		MT2– Gate–			
		–	–	400		MT2– Gate–			
Steady-State Thermal Resistance	$R\theta JA$	–	–	75	°C/Watt	Junction to Ambient			
SC141	$R\theta JC$	–	–	3.0		Junction to Case			
SC146		–	–	2.2					

NOTES:

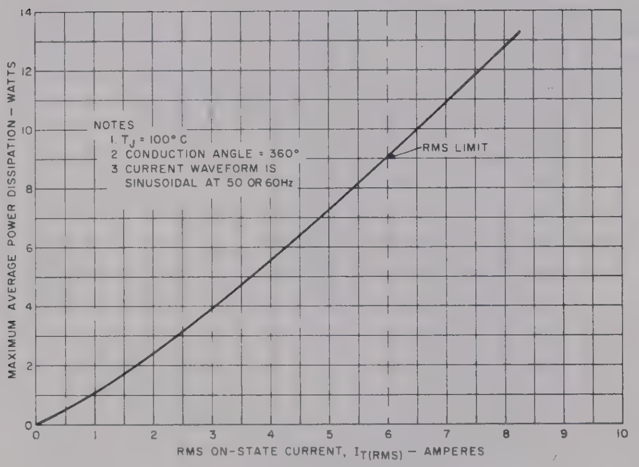
1. Values apply for either polarity of main terminal 2 characteristics referenced to main terminal 1.
2. Main terminal 1 is the reference terminal for main terminal 2 and gate terminal.
3. With V_D equal to maximum allowable off-state voltage.
4. Junction to case values tested in accordance with JEDEC Semiconductor device registration #JC-22 (RDF-2), VA, Note 6, which states, "Thermal characteristics are to be measured with the device operating in only one direction. The values registered are to be the limiting value for either direction." T_L is approximately equal to T_C, see outline drawing. The junction to ambient value is under worst case conditions, i.e., with #22 copper wire used for electrical contact to the terminals and natural convection.



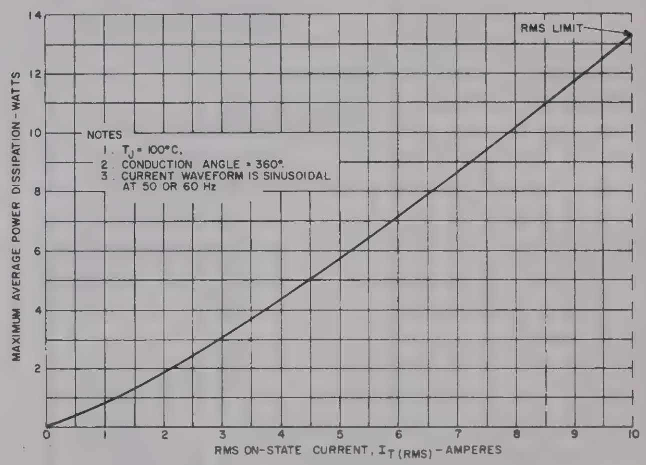
3. SC141 Maximum On-State Voltage vs. On-State Current



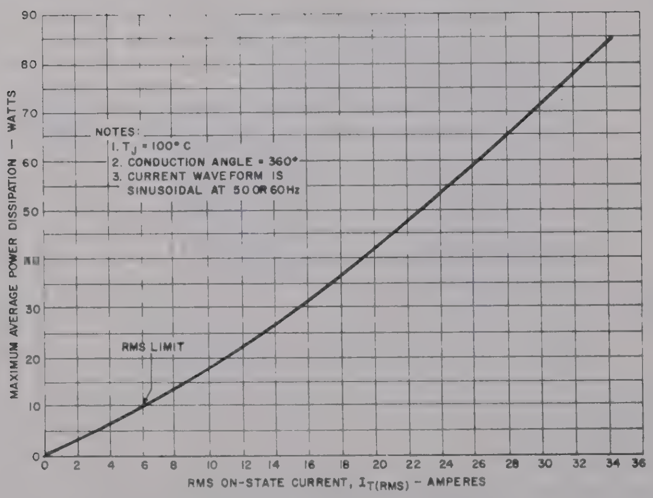
4. SC146 Maximum On-State Voltage vs. On-State Current



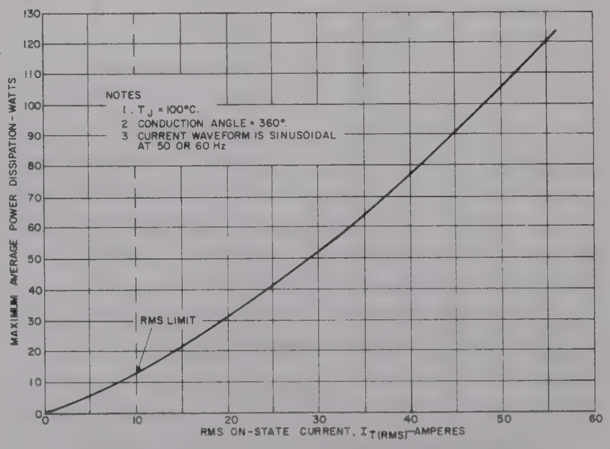
5. SC141 Maximum Average Power Dissipation vs. RMS On-State Current



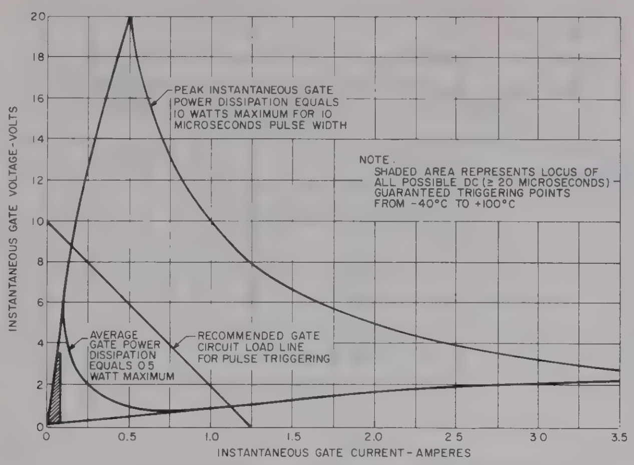
6. SC146 Maximum Average Power Dissipation vs. RMS On-State Current



7. SC141 Maximum Average Power Dissipation vs. RMS On-State Current (High Level)

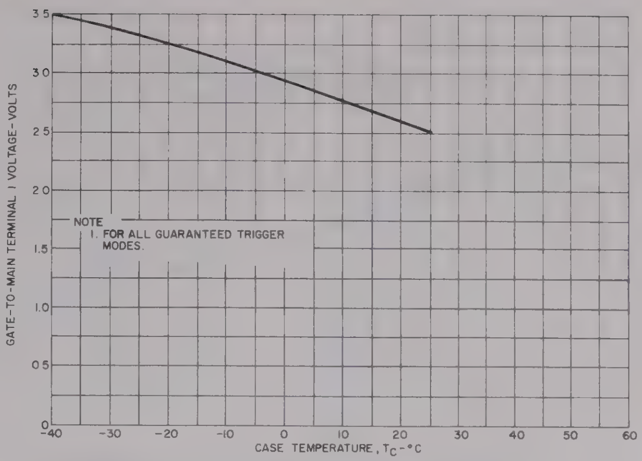


8. SC146 Maximum Average Power Dissipation vs. RMS On-State Current (High Level)



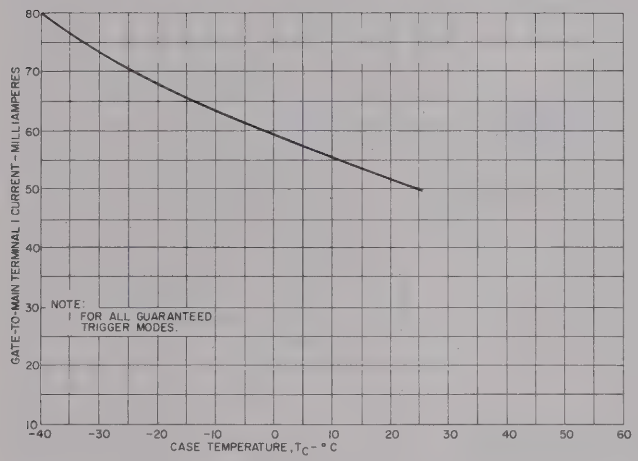
NOTE.
SHADED AREA REPRESENTS LOCUS OF ALL POSSIBLE DC (≥ 20 MICROSECONDS) GUARANTEED TRIGGERING POINTS FROM −40°C TO +100°C

9. Gate Characteristics and Ratings



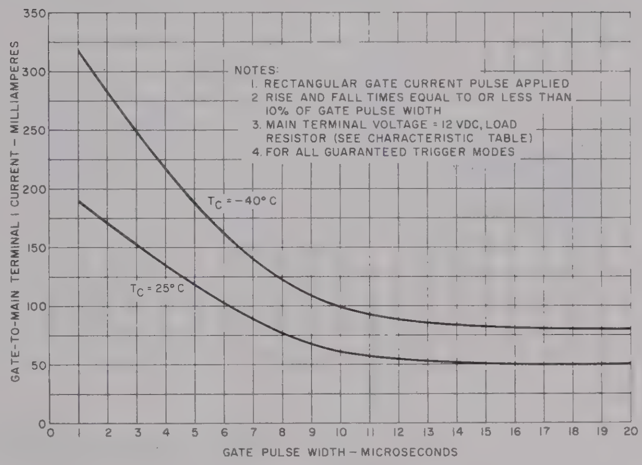
NOTE
1. FOR ALL GUARANTEED TRIGGER MODES.

10. Maximum DC Gate Voltage to Trigger vs. Case Temperature



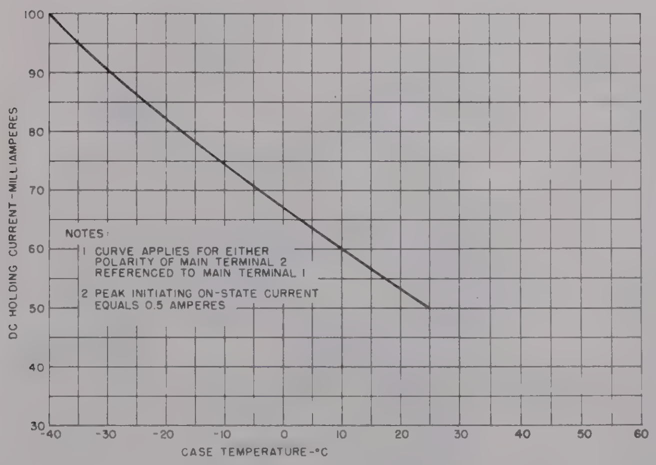
NOTE:
1 FOR ALL GUARANTEED TRIGGER MODES.

11. Maximum DC Gate Current to Trigger vs. Case Temperature



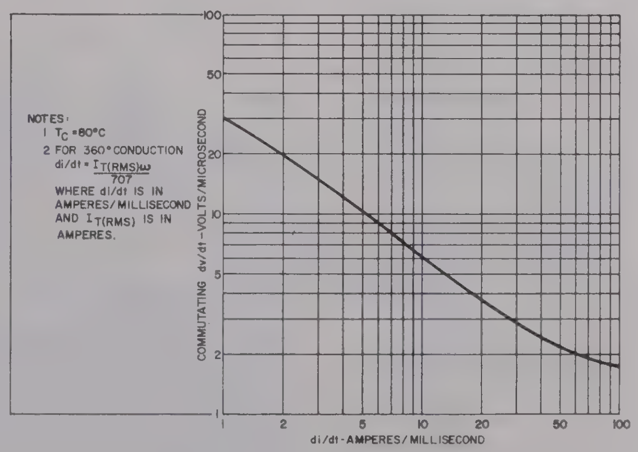
NOTES:
1. RECTANGULAR GATE CURRENT PULSE APPLIED
2. RISE AND FALL TIMES EQUAL TO OR LESS THAN 10% OF GATE PULSE WIDTH
3. MAIN TERMINAL VOLTAGE = 12 VDC, LOAD RESISTOR (SEE CHARACTERISTIC TABLE)
4. FOR ALL GUARANTEED TRIGGER MODES

12. Maximum Gate Current to Trigger vs. Gate Pulse Width



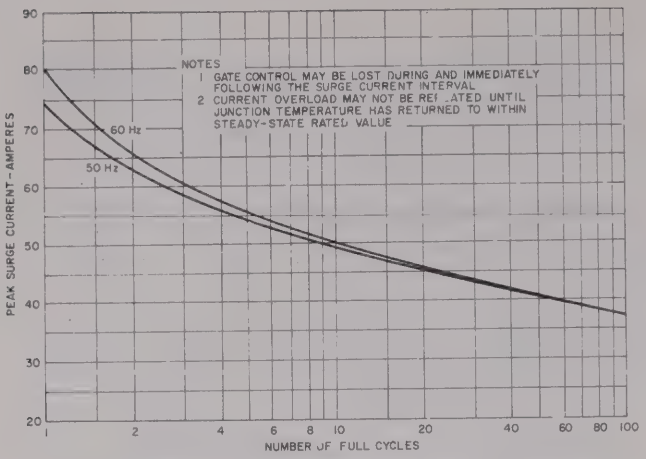
NOTES:
1 CURVE APPLIES FOR EITHER POLARITY OF MAIN TERMINAL 2 REFERENCED TO MAIN TERMINAL 1
2 PEAK INITIATING ON-STATE CURRENT EQUALS 0.5 AMPERES

13. Maximum DC Holding Current vs. Case Temperature

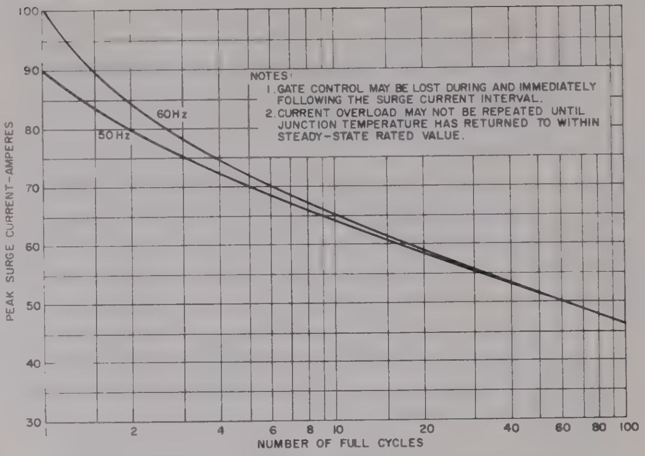


NOTES:
1 T_C = 80°C
2 FOR 360° CONDUCTION $di/dt = \frac{I_{T(RMS)}\omega}{707}$ WHERE di/dt IS IN AMPERES/MILLISECOND AND $I_{T(RMS)}$ IS IN AMPERES.

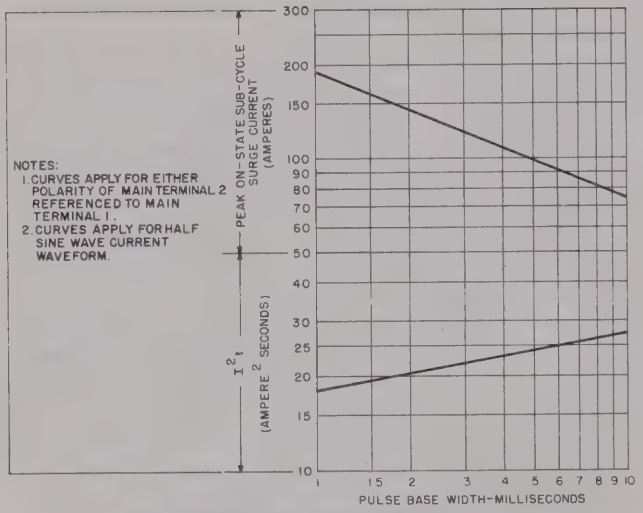
14. Typical Rate of Removal of Current (di/dt) Effect Upon Commutating (dv/dt)



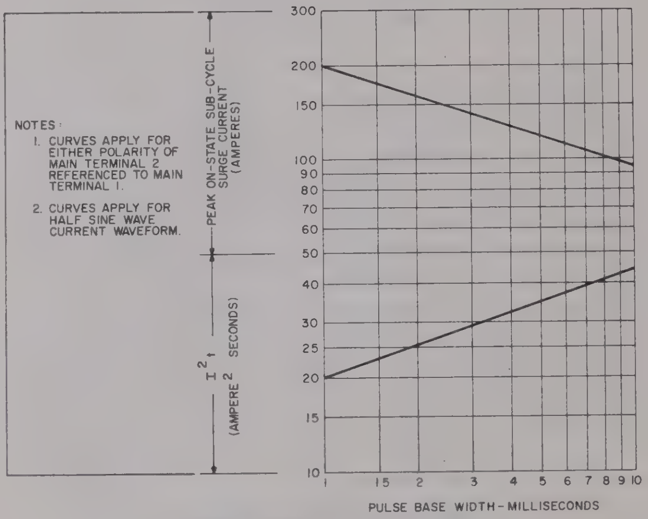
15. SC141 Maximum Allowable Full Cycle Surge Current Following Rated Load Conditions



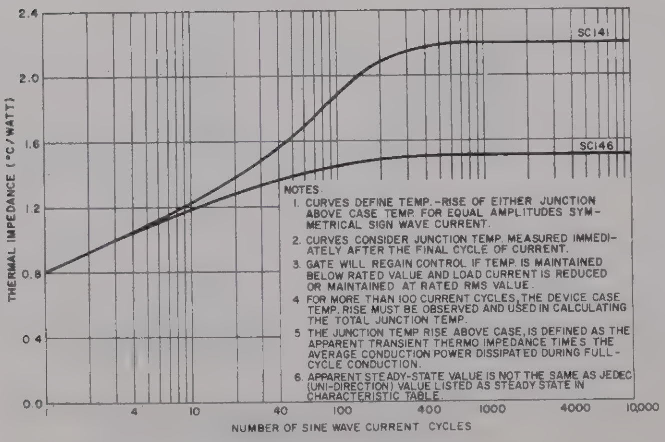
16. SC146 Maximum Allowable Full Cycle Surge Current Following Rated Load Conditions



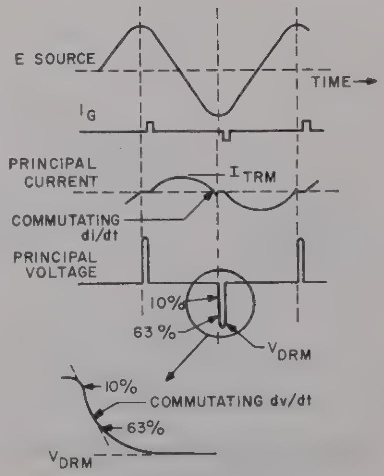
17. SC141 Subcycle Surge And I^2t Ratings Following Rated Load Conditions



18. SC146 Subcycle Surge And I^2t Ratings Following Rated Load Conditions

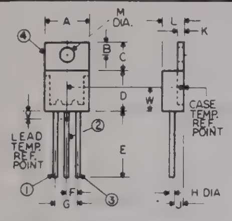
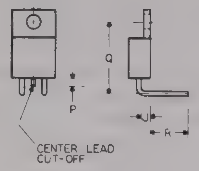
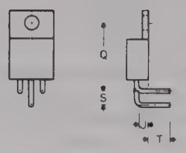
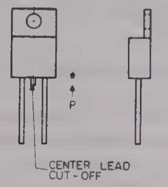
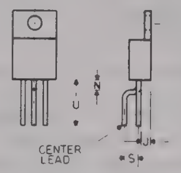
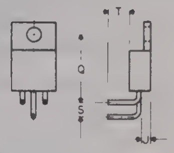


19. Maximum Apparent Transient Thermal Impedance


E SOURCE
TIME
I_G
PRINCIPAL CURRENT
I_{TRM}
COMMUTATING di/dt
PRINCIPAL VOLTAGE
10%
63%
V_{DRM}
10%
COMMUTATING dv/dt
63%
V_{DRM}

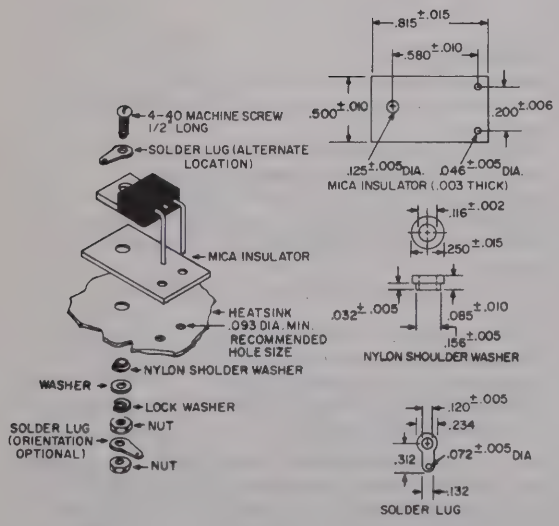
20. Waveform of Commutating dv/dt

OUTLINE DRAWINGS

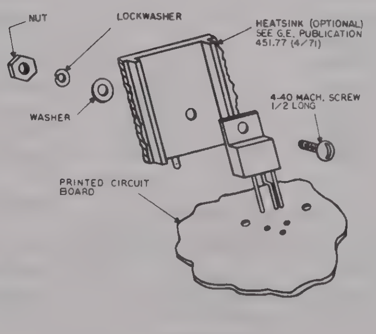
STANDARD TYPE	FORMED LEAD TYPES				
	TO-66 EQUIVALENT	FLAT MOUNTING CHASIS HEATSINK	CENTER LEAD CUT	UPRIGHT MOUNTING	FLAT MOUNTING RADIATOR HEATSINK
 A M DIA. L K ④ B C D W CASE TEMP. REF. POINT ② LEAD TEMP. REF. POINT E ① F G ③ H DIA J 1. MAIN TERMINAL 1 (MT1). 2. MAIN TERMINAL 2 (MT2). 3. GATE. 4. MOUNTING TAB (ELECTRICALLY COMMON TO MT2).	 Q P J R CENTER LEAD CUT-OFF		 P CENTER LEAD CUT-OFF	 N U J CENTER LEAD S	
TYPE 1	TYPE 2	TYPE 3	TYPE 4	TYPE 5	TYPE 6

SYM.	DEC. IN.		METRIC MM		SYM.	DEC. IN.		METRIC MM	
	MIN.	MAX.	MIN.	MAX.		MIN.	MAX.	MIN.	MAX.
A	.390	.420	9.906	10.668	L	.160	.190	4.064	4.826
B	.110	.120	2.794	3.048	M	.141	.145	3.581	3.683
C	.240	.260	6.096	6.604	N	.065	.095	1.651	2.413
D	.325	.355	8.255	9.017	P	.035	.065	.889	1.651
E	.500	———	12.700	———	Q	.570	.590	14.478	14.986
F	.095	.105	2.413	2.667	R	.360	———	9.144	———
G	.190	.210	4.826	5.334	S	.120	.130	3.048	3.302
H	.029	.035	.737	.889	T	.172	.202	4.369	5.131
J	.085	.115	2.159	2.921	U	.353	.433	8.966	10.998
K	.040	.060	1.016	1.524	V	———	.065	———	1.651
					W	———	.220	———	5.588

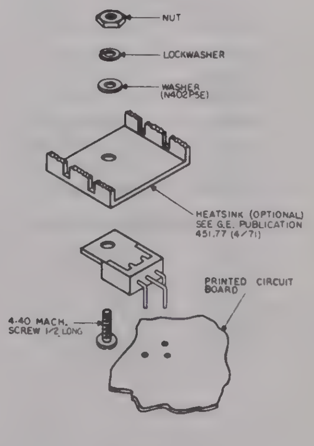
SUGGESTED MOUNTING METHODS


4-40 MACHINE SCREW 1/2" LONG
SOLDER LUG (ALTERNATE LOCATION)
MICA INSULATOR
HEATSINK .093 DIA. MIN. RECOMMENDED HOLE SIZE
NYLON SHOLDER WASHER
WASHER
LOCK WASHER
NUT
SOLDER LUG (ORIENTATION OPTIONAL)
NUT
.815±.015
.580±.010
.500±.010
.200±.006
.125±.005 DIA.
.046±.005 DIA.
MICA INSULATOR (.003 THICK)
.116±.002
.250±.015
.032±.005
.085±.010
.156±.005
NYLON SHOULDER WASHER
.120±.005
.234
.312
.072±.005 DIA
.132
SOLDER LUG

TYPES 2,3


NUT
LOCKWASHER
HEATSINK (OPTIONAL) SEE G.E. PUBLICATION 451.77 (4/71)
WASHER
4-40 MACH. SCREW 1/2 LONG
PRINTED CIRCUIT BOARD

TYPES 4,5

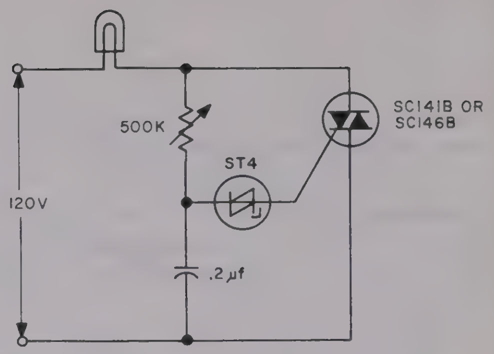

NUT
LOCKWASHER
WASHER (N402PSE)
HEATSINK (OPTIONAL) SEE G.E. PUBLICATION 451.77 (4/71)
PRINTED CIRCUIT BOARD
4-40 MACH. SCREW 1/2 LONG

TYPE 6

TYPICAL CIRCUITS

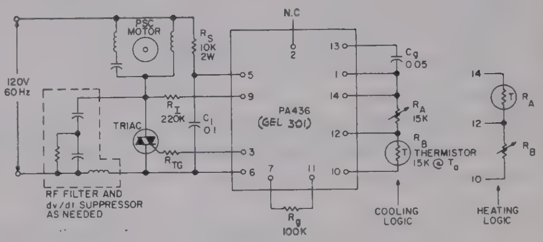
Triacs are especially useful in lamp dimming because of their ability to conduct in both directions.

The circuit shown here incorporates General Electric's new ST4 asymmetrical AC trigger integrated circuit. This device greatly reduces the snap-on effects that are present in symmetrical trigger circuits and minimizes control circuit hysteresis. This performance is possible with a single RC time constant, whereas a symmetrical circuit of comparable performance would require at least three additional passive components.



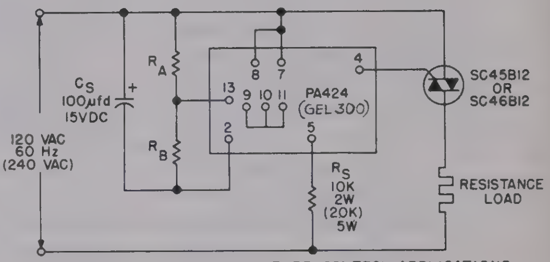
The circuit shown here is for controlling speed of a permanent-split capacitor fan motor in response to temperature. For a cooling fan application, R_B is a thermistor having about 5000 ohms resistance at the desired operating temperature. R_A is made variable in order to select the temperature set-point for the control. When temperature increases, fan speed will increase to provide a greater cooling effect. In a heating application, such as a fan-and-coil room heater, the functions of R_A and R_B are reversed so that an increase in temperature will decrease fan speed to provide less heating effect.

This circuit will control the motor over the full range from zero to 100% speed; and usually requires a motor with ball bearings. When sleeve bearings are used, it is generally desirable to limit the minimum speed in order to properly maintain bearing lubrication. A low-speed limit may also be wanted in order to maintain a minimum level of air circulation.



When the SC141 or SC146 is used with General Electric's PA424 (GEL300) zero voltage switch integrated circuit, an all solid-state electric temperature control results if a thermistor is used in the input of the PA424. With the proper thermistor, this circuit has the capability of controlling temperature to ± 0.2°F.

For further discussion of these circuits as well as many others, please refer to application notes listed below.



R_A = THERMISTOR FOR TEMPERATURE CONTROL APPLICATIONS

OTHER TRIAC, TRIGGER, AND APPLICATION INFORMATION AVAILABLE FROM GENERAL ELECTRIC

Publication Number		
Triac Specification Sheets		
175.19	SC35/36	(3 Amp)
175.25	SC40/41	(6 Amp)
175.26	SC45/46	(10 Amp)
175.27	SC50/51	(15 Amp)
175.16	SC240/241	(6 Amp)
175.17	SC245/246	(10 Amp)
175.18	SC250/251	(15 Amp)
175.28	SC60/61	(25 Amp)
Trigger Specification Sheets		
85.21	PA424	(Zero Voltage IC Switch)
85.31	PA436	(Phase Control Integrated Circuit)
175.30	ST2	(Diac)
175.32	ST4	(Asymmetrical AC Trigger)
65.32	2N4992	(Silicon Bilateral Switch)

Publication Number	Application Notes
200.35	Using the Triac for Control of AC Power
200.45	Temperature Controls Incorporating Zero Voltage Switching
200.51	Better Room Conditioning Via Solid State Controls
200.53	Solid State Incandescent Lighting Controls
201.12	500 Watt AC Line Voltage and Power Regulator
201.19	RF Filter Considerations for Triac & SCR Circuits
201.20	Proportional Zero Voltage Switching Temperature Control
201.21	On-off Zero Voltage Switching Temperature Control
201.22	Low Power Zero Voltage Switching Using the PA424
201.24	Thyristor Selection for Incandescent Lamp Loads
200.48	Solid State Electric Heating Controls
200.55	Thermal Mounting Considerations for Plastic Power Semiconductor Packages

Also, individual specifications are listed in publication number 450.52 —Semiconductor Specifications Index. All of these referred to may be ordered by publication number from General Electric Company, Distribution Services, Bldg. 6-208, Schenectady, New York 12305.

TRIAC

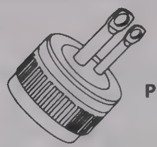
Silicon AC Switch

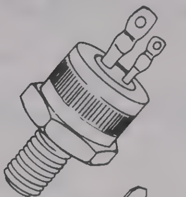
SC240
SC241

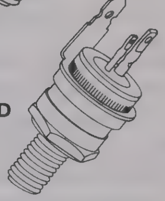
6A RMS **Up to 500 Volts**

Variations

Mechanical	Electrical
Press-Fit	Zero Voltage Switch Type
Stud	Selected Gate Type
Isolated Stud	400 Hertz Type







The triac is a silicon AC switch which may be gate triggered from an OFF state to an ON state for either polarity of applied voltage.

The SC240 series of glassivated triacs incorporates General Electric's new POWER–GLAS process that improves upon normal passivation techniques. It provides for an intimate void-free bond between the silicon chip and the stress-matched glass coating. The resulting stable low level leakage current significantly improves performance and reliability.

Features:

- Glassivated silicon chip for maximum reliability.
- Improved commutating dv/dt (4V/vs. min.)
- 80A Peak One Full Cycle Surge Rating (60 Hz)
- 600 watt load (120V line)
- 1200 watt load (240V line)
- Inherent immunity from transient voltage damage (can be broken over safely in either direction).
- Press-Fit, Stud, and Isolated Stud Packages available.
- Standard Electrical Variations available:

  (1) Selected for use with the General Electric PA424 Zero Voltage Switch

  (2) Selected for 25mA Maximum Gate Trigger Current in all four modes

  (3) Selected for Operation at 400 Hz.

TYPICAL TRIAC APPLICATIONS

GENERAL FUNCTIONS

TYPES OF EQUIPMENT	Heat Control	Motor Speed Control	Light Control	Solid State Contactors and Relays	Power Regulation
Photographic Dev. Equip.	X		X		
Process Control	X	X	X	X	X
Reproduction Equipment	X	X	X	X	
Bio-Medical	X	X	X	X	X
Air Conditioners		X			
Blenders, Mixers		X			
Computer Tape Decks		X			
Fans		X			
Hand Tools		X			
Machine Tools/Misc. Mfg.		X		X	
Sewing Machines		X			
Laundry				X	
Farm Equipment	X	X	X	X	
Light Dimmers			X		
Photographic Equipment	X		X	X	
Outdoor Signs			X	X	
Clutches/Brakes				X	
Industrial Timers				X	
Traffic Signal Control			X	X	
Vending Machines	X			X	
Aircraft	X	X	X	X	
Computer Power Supplies					X
Home Entertainment	X	X	X	X	X

FOR TRIAC TRIGGERS SEE PAGE 153

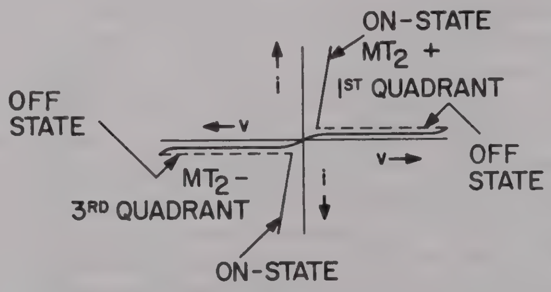
MAXIMUM ALLOWABLE RATINGS—ALL TYPES

PACKAGE	ELECTRICAL TYPE				Repetitive Peak Off-State Voltage V_{DRM}(1) T_C = −40°C to +100°C
	Standard Type	Zero Voltage Switch	Selected Gate	400 Hz Operation	
PRESS-FIT	SC241B	SC241B12	SC241B13	SC241B14	200 Volts
STUD	SC240B	SC240B12	SC240B13	SC240B14	
ISOLATED STUD	SC240B2	SC240B22	SC240B23	SC240B24	
PRESS-FIT	SC241D	SC241D12	SC241D13	SC241D14	400 Volts
STUD	SC240D	SC240D12	SC240D13	SC240D14	
ISOLATED STUD	SC240D2	SC240D22	SC240D23	SC240D24	
PRESS-FIT	SC241E	SC241E12	SC241E13	SC241E14	500 Volts
STUD	SC240E	SC240E12	SC240E13	SC240E14	
ISOLATED STUD	SC240E2	SC240E22	SC240E23	SC240E24	

RMS On-State Current, $I_{T(RMS)}$(4)	6 Amperes
Peak One Full Cycle Surge (non-rep) On-State Current, I_{TSM} (50 Hz)	74 Amperes
(60 Hz)	80 Amperes
(400 Hz)	173 Amperes
I^2t (for fusing), for time at(2) 1.0 millisecond	18 Ampere² seconds (See Chart 14)
8.3 millisecond	26.5
Peak Gate Power Dissipation, P_{GM}(3)	10 Watts for 10 microseconds (See Chart 5)
Average Gate Power Dissipation, $P_{G(AV)}$	0.5 Watts
Peak Gate Current, I_{GM}(3)	See Chart 5
Peak Gate Voltage, V_{GM}(3)	See Chart 5
Critical Rate-of-Rise of On-State Current, di/dt(2)(5) Breakover voltage triggered operation	10 Amperes per microsecond
Storage Temperature, T_{STG}	−40°C to +125°C
Operating Temperature, T_J	−40°C to +100°C
Stud Torque—(STUD & ISOLATED STUD TYPES)	25 Lb-in (29 Kg-cm)
Insertion Pressure—(PRESS-FIT TYPE)	800 lbs (364 Kg)
Isolation Breakdown Voltage Between Any Terminal and Stud (ISOLATED STUD TYPE)(6)	1800 Volts RMS

NOTES:

1. Ratings apply for zero gate voltage only. Ratings apply for either polarity of main terminal 2 voltage referenced to main terminal 1.
2. Ratings apply for either polarity of main terminal 2 referenced to main terminal 1.
3. Ratings apply for either polarity of gate terminal referenced to main terminal 1.
4. At case reference point temperature of 80°C (77.5°C isolated stud type) maximum and 360° conduction.
5. di/dt rating is established in accordance with JEDEC suggested standard No. 7, Section 5.1.2.4. off-state (blocking) voltage capability may be temporarily lost immediately after each current pulse for duration less than the period of the applied repetition rate. The pulse repetition rate for this test is 400 Hz. The duration of the JEDEC di/dt test condition is 5.0 seconds (minimum).
6. Rating applies for 50, 60 and 400 Hz sinusoidal waveform.



TYPICAL E-I CHARACTERISTICS

WARNING

Isolated stud products described in this specification sheet should be handled with care. The ceramic portion of these thyristors contains BERYLLIUM OXIDE as a major ingredient.

Do not crush, grind, or abrade these portions of the thyristors because the dust resulting from such action may be hazardous if inhaled.

TABLE I—STANDARD TYPE CHARACTERISTICS

Type	Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions			Reference Note
All types	Peak Off-State current	I_{DRM}				mA	V_{DRM} = Maximum Allowable Peak Off-State Voltage Gate Open Circuited			1
			–	–	0.1		T_C = +25°C			
			–	–	0.5		T_C = +100°C			
All types	Peak-On-State Voltage	V_{TM}	–	–	1.83	Volts	T_C = +25°C, I_{TM} = 8.5 A peak 1 millisecond wide pulse, Duty cycle ≦ 2%			1
All types	Critical Rate of Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt	–	50	–	Volts/μsec	T_C = +100°C, Rated V_{DRM} Gate Open Circuited, Exponential Waveform			1
All except 400 Hertz Type (Refer to Table IV)	Critical Rate of Rise of Commutating Off-State Voltage (Commutating dv/dt)	dv/dt(c)	4.0	–	–	Volts/μsec	T_C = +80°C (+77.5°C for isolated stud type), $I_{T(RMS)}$ = Rated Max. Allowable RMS On-State Current, V_{DRM} = Rated Maximum Allowable Peak Off-State Voltage, Gate Open Circuited, Commutating di/dt =3.2 A/msec			1
All except selected gate type (Refer to Table III)	D.C. Gate Trigger Current	I_{GT}				mAdc	V_D = 12 Vdc			2
							Trigger Mode	R_L	T_C	
			–	–	50		MT2+ Gate+	100 ohms	+25°C	
			–	–	50		MT2– Gate–	100 ohms		
			–	–	50		MT2+ Gate–	50 ohms		
			–	–	80		MT2+ Gate+	50 ohms	–40°C	
			–	–	80		MT2– Gate–	50 ohms		
			–	–	80		MT2+ Gate–	25 ohms		
All except selected gate type (Refer to Table III)	D.C. Gate Trigger Voltage	V_{GT}				Vdc	V_D = 12 Vdc			2
							Trigger Mode	R_L	T_C	
			–	–	2.5		MT2+ Gate+	100 ohms	+25°C	
			–	–	2.5		MT2– Gate–	100 ohms		
			–	–	2.5		MT2+ Gate–	50 ohms		
			–	–	3.5		MT2+ Gate+	50 ohms	–40°C	
			–	–	3.5		MT2– Gate–	50 ohms		
			–	–	3.5		MT2+ Gate–	25 ohms		
			0.20	–	–		MT2+ Gate+ MT2– Gate– MT2+ Gate– MT2– Gate+	1000 ohms	+100°C	2, 3
All types	Holding Current	I_H				mAdc	Main Terminal Source Voltage = 24 Vdc, Peak initiating on-state current = 0.5A, 0.1 milliseconds to 10 milliseconds wide pulse Gate trigger source = 7 V, 20 ohms			1
			–	–	50		T_C = +25°C			
			–	–	100		T_C = –40°C			
All types	Latching Current	I_L				mAdc	Main Terminal Source Voltage = 24 Vdc, Gate trigger source = 15 V, 100 ohms, 50 μsec pulse width, 5 μsec rise and fall times max			2
							Trigger Mode		T_C	
			–	–	100		MT2+ Gate+		+25°C	
			–	–	100		MT2– Gate–			
			–	–	200		MT2+ Gate–			
			–	–	200		MT2+ Gate+		–40°C	
			–	–	200		MT2– Gate–			
			–	–	400		MT2+ Gate–			
All types	Steady-State Thermal Resistance	$R_{\theta JA}$	–	–	45	°C/Watt	Junction to Ambient			4
Press-fit & Stud type		$R_{\theta JC}$	–	–	2.8		Junction to Case			
Isolated stud type			–	–	3.1					

NOTES:

1. Values apply for either polarity of main terminal 2 characteristics referenced to main terminal 1.
2. Main terminal 1 is the reference terminal for main terminal 2 and gate terminal.
3. With V_D equal to maximum allowable off-state voltage.
4. Junction to case values tested in accordance with JEDEC Semi-conductor device registration #JC-22 (RDF-2), VA, Note 6, which states, "Thermal characteristics are to be measured with the device operating in only one direction. The values registered are to be the limiting value for either direction." The junction to ambient value is under worst case conditions, i.e., with # 22 copper wire used for electrical contact to the terminals and natural convection.

TABLE II–ZERO VOLTAGE SWITCH TYPE (FOR USE WITH PA424 ZERO VOLTAGE SWITCH)

NOTE: ALL STANDARD CHARACTERISTICS APPLY EXCEPT AS INDICATED

CHARACTERISTICS									Reference Note
Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions			
Pulse Gate Trigger Current	I_{GT}				mAdc	V_D = 3 Vdc, Gate Pulse width = 50 μsec			1
						Trigger Mode	R_L	T_C	
		–	–	30		MT2– Gate– MT2+ Gate–	20 ohms	25°C	
		–	–	46		MT2– Gate– MT2+ Gate–	14 ohms	–20°C	
Pulse Gate Trigger Voltage	V_{GT}				Volts	V_D = 3 Vdc, Gate Pulse width = 50 μsec			1
						Trigger Mode	R_L	T_C	
		–	–	2.0		MT2– Gate– MT2+ Gate–	20 ohms	25°C	
		–	–	2.75		MT2– Gate– MT2+ Gate–	14 ohms	–20°C	
Latching Current	I_L				mAdc	Main Terminal Source Voltage = 3 Vdc, Gate trigger source = PA424			1
						Trigger Mode		T_C	
		–	–	115		MT2– Gate– MT2+ Gate–		25°C	
		–	120	–		MT2– Gate– MT2+ Gate–		–20°C	

TABLE III–SELECTED GATE TYPE

NOTE: ALL STANDARD CHARACTERISTICS APPLY EXCEPT AS INDICATED

CHARACTERISTICS									Reference Note
Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions			
D.C. Gate Trigger Current	I_{GT}				mAdc	V_D = 12 Vdc			1
						Trigger Mode	R_L	T_C	
		–	–	25		MT2+ Gate+	100 ohms	25°C	
		–	–	25		MT2– Gate–	100 ohms		
		–	–	25		MT2+ Gate–	50 ohms		
		–	–	25		MT2– Gate+	50 ohms		
		–	–	50		MT2+ Gate+	50 ohms	–40°C	
		–	–	50		MT2– Gate–	50 ohms		
		–	–	50		MT2+ Gate–	25 ohms		
		–	–	50		MT2– Gate+	25 ohms		
D.C. Gate Trigger Voltage	V_{GT}				Vdc	V_D = 12 Vdc			1
						Trigger Mode	R_L	T_C	
		–	–	2.0		MT2+ Gate+	100 ohms	25°C	
		–	–	2.0		MT2– Gate–	100 ohms		
		–	–	2.0		MT2+ Gate–	50 ohms		
		–	–	2.0		MT2– Gate+	50 ohms		
		–	–	3.0		MT2+ Gate+	50 ohms	–40°C	
		–	–	3.0		MT2– Gate–	50 ohms		
		–	–	3.0		MT2+ Gate–	25 ohms		
		–	–	3.0		MT2– Gate+	25 ohms		

TABLE IV–400 HZ OPERATION TYPE

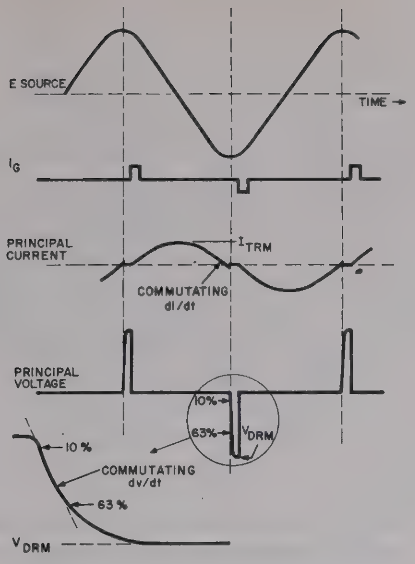
NOTE: ALL STANDARD CHARACTERISTICS APPLY EXCEPT AS INDICATED

CHARACTERISTICS							Reference Note
Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions	
Critical Rate of Rise of Commutating Off-State Voltage (Commutating dv/dt)	dv/dt(c)	4.0	–	–	Volts/μsec	T_C = +80°C (+77.5°C for isolated stud type), $I_{T(RMS)}$ = Rated Max. Allowable RMS On-State Current V_{DRM} = Rated Maximum Allowable Peak off-state Voltage Gate Open Circuited Commutating di/dt =21.5A/msec	2

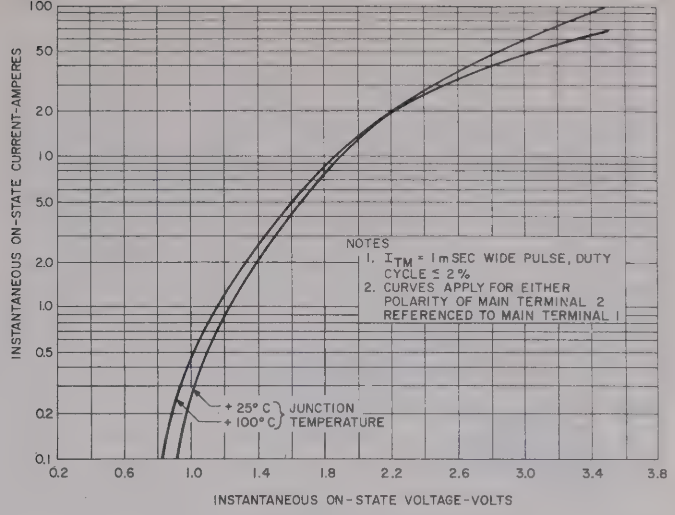
NOTES

1 Main terminal 1 is the reference terminal for main terminal 2 and gate terminal.

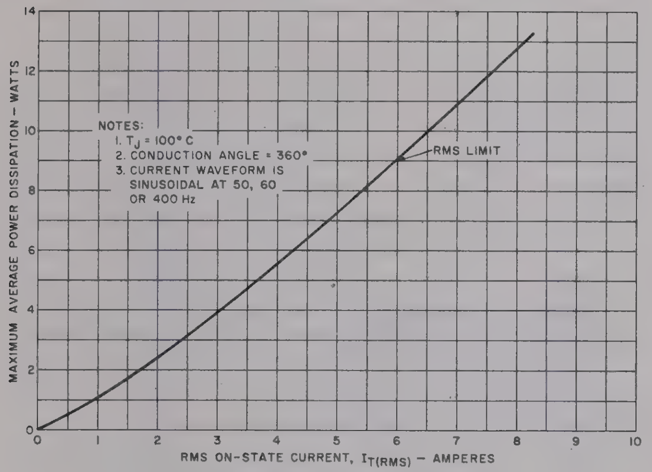
2 Values apply for either polarity of main terminal 2 characteristic referenced to main terminal 1.


E SOURCE
TIME →
I_G
PRINCIPAL CURRENT
I_{TRM}
COMMUTATING dI/dt
PRINCIPAL VOLTAGE
10%
63%
V_{DRM}
10 %
COMMUTATING dv/dt
63 %
V_{DRM}

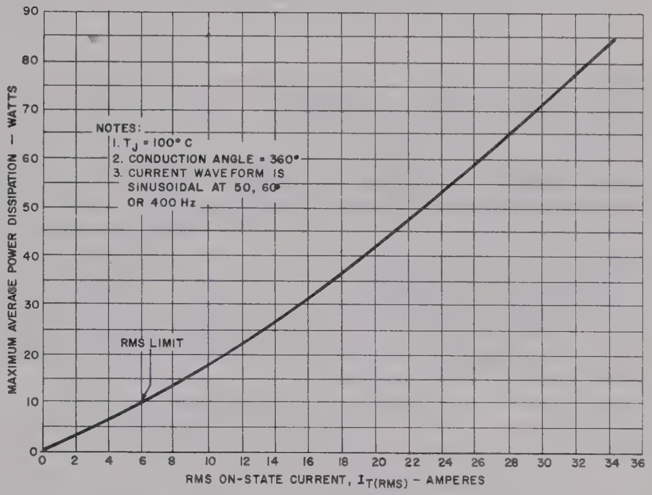
1. Waveform of Commutating dv/dt



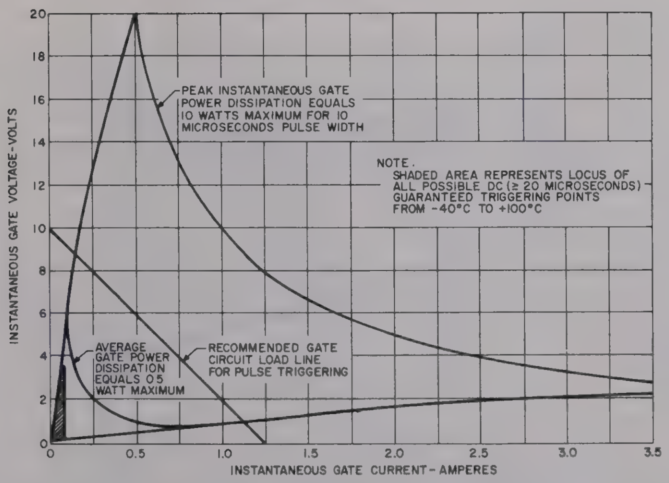
2. Maximum On-State Voltage vs. On-State Current



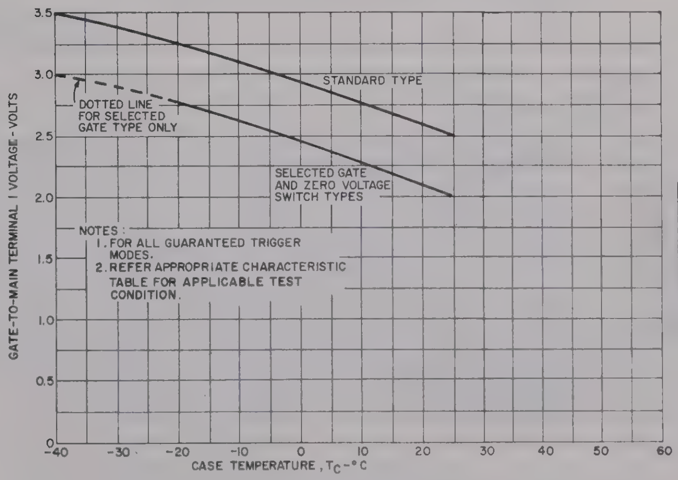
3. Maximum Average Power Dissipation vs. RMS On-State Current



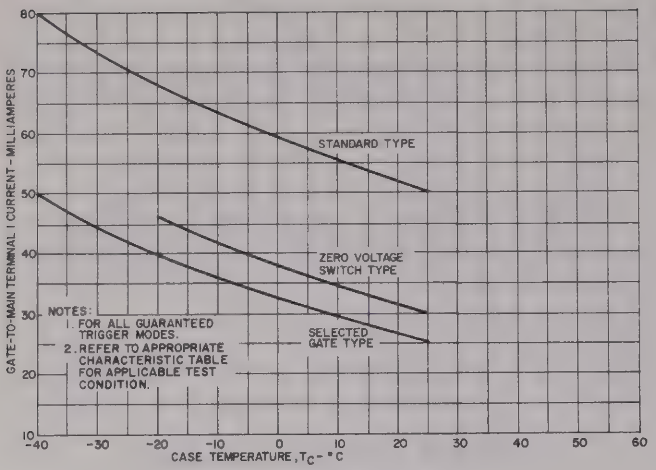
4. Maximum Average Power Dissipation vs. RMS On-State Current (High Level)



5. Gate Characteristics and Ratings

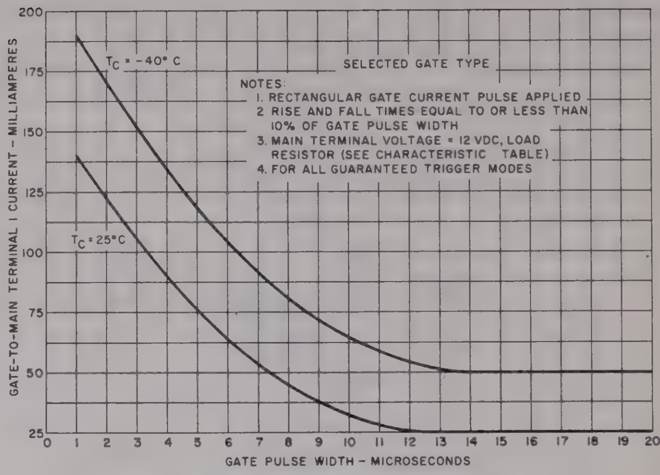


6. Maximum DC Gate Trigger Voltage vs. Case Temperature



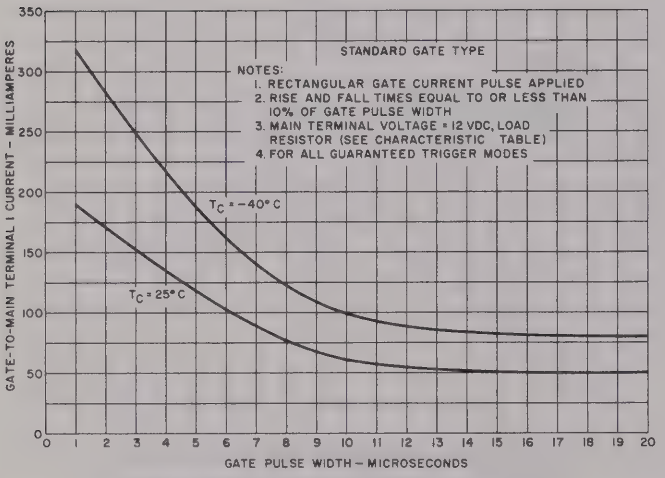
NOTES:
1. FOR ALL GUARANTEED TRIGGER MODES.
2. REFER TO APPROPRIATE CHARACTERISTIC TABLE FOR APPLICABLE TEST CONDITION.

7. Maximum DC Gate Trigger Current vs. Case Temperature



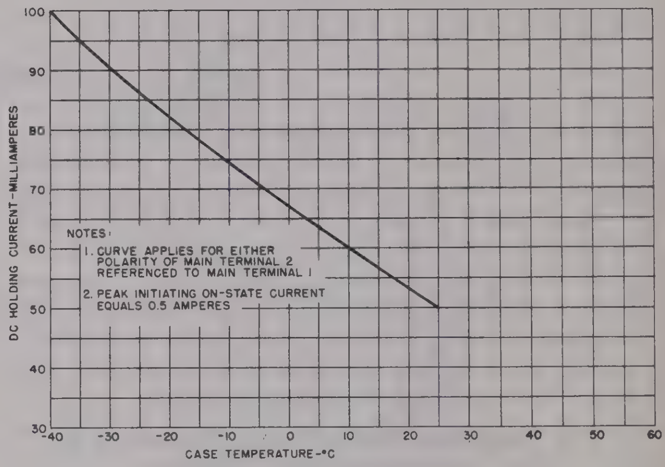
NOTES:
1. RECTANGULAR GATE CURRENT PULSE APPLIED
2. RISE AND FALL TIMES EQUAL TO OR LESS THAN 10% OF GATE PULSE WIDTH
3. MAIN TERMINAL VOLTAGE = 12 VDC, LOAD RESISTOR (SEE CHARACTERISTIC TABLE)
4. FOR ALL GUARANTEED TRIGGER MODES

8. Maximum Gate Trigger Current vs. Gate Pulse Width (Selected Gate Type)



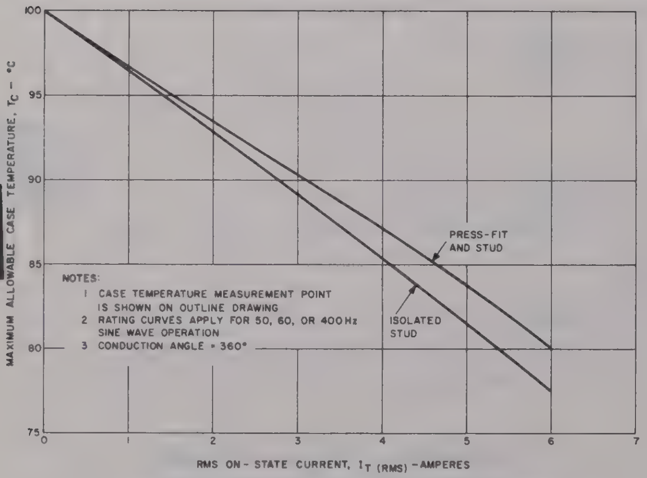
NOTES:
1. RECTANGULAR GATE CURRENT PULSE APPLIED
2. RISE AND FALL TIMES EQUAL TO OR LESS THAN 10% OF GATE PULSE WIDTH
3. MAIN TERMINAL VOLTAGE = 12 VDC, LOAD RESISTOR (SEE CHARACTERISTIC TABLE)
4. FOR ALL GUARANTEED TRIGGER MODES

9. Maximum Gate Trigger Current vs. Gate Pulse Width (Standard Gate Type)



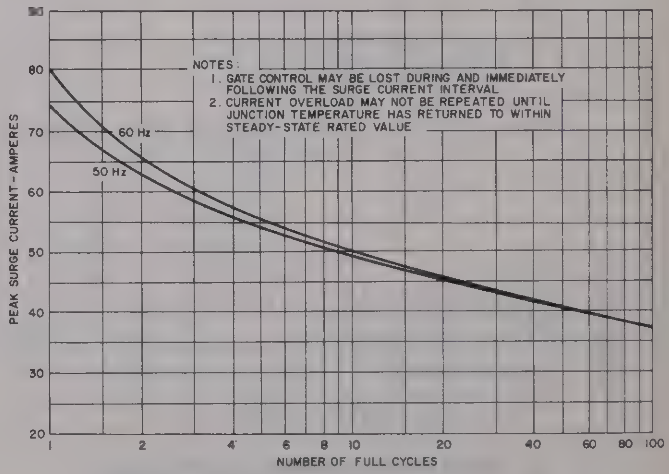
NOTES:
1. CURVE APPLIES FOR EITHER POLARITY OF MAIN TERMINAL 2 REFERENCED TO MAIN TERMINAL 1
2. PEAK INITIATING ON-STATE CURRENT EQUALS 0.5 AMPERES

10. Maximum DC Holding Current vs. Case Temperature



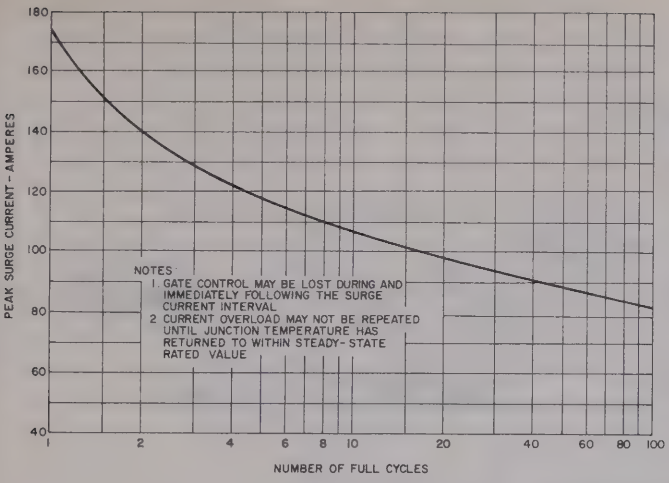
NOTES:
1. CASE TEMPERATURE MEASUREMENT POINT IS SHOWN ON OUTLINE DRAWING
2. RATING CURVES APPLY FOR 50, 60, OR 400 Hz SINE WAVE OPERATION
3. CONDUCTION ANGLE = 360°

11. Maximum Allowable Case Temperature vs. RMS On-State Current



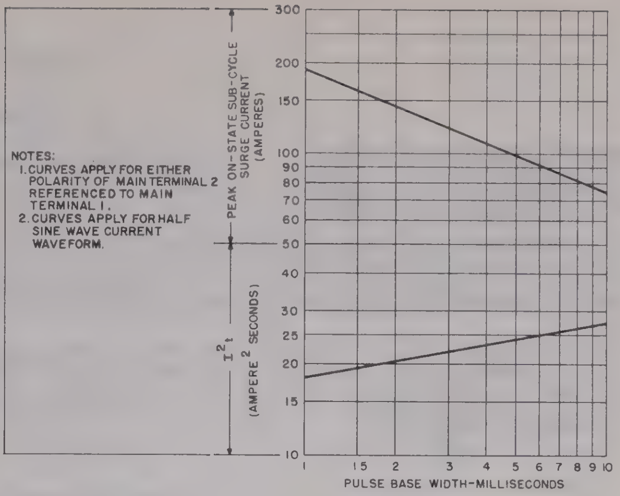
NOTES:
1. GATE CONTROL MAY BE LOST DURING AND IMMEDIATELY FOLLOWING THE SURGE CURRENT INTERVAL
2. CURRENT OVERLOAD MAY NOT BE REPEATED UNTIL JUNCTION TEMPERATURE HAS RETURNED TO WITHIN STEADY-STATE RATED VALUE

12. Maximum Allowable Full Cycle Surge Current Following Rated Load Conditions



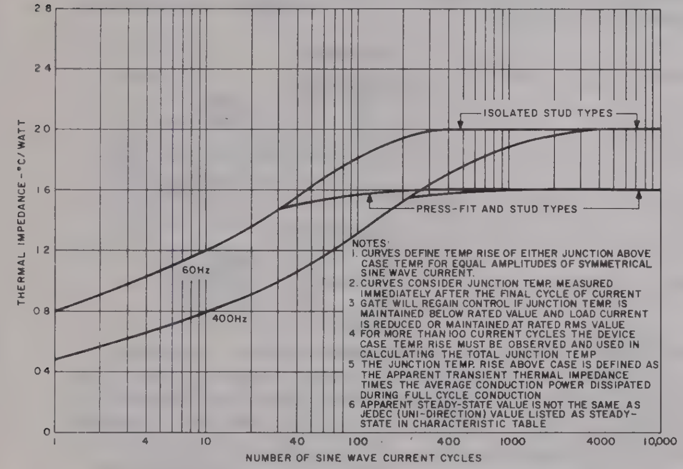
NOTES
1. GATE CONTROL MAY BE LOST DURING AND IMMEDIATELY FOLLOWING THE SURGE CURRENT INTERVAL
2. CURRENT OVERLOAD MAY NOT BE REPEATED UNTIL JUNCTION TEMPERATURE HAS RETURNED TO WITHIN STEADY-STATE RATED VALUE

13. Maximum Allowable Full Cycle Surge Current Following Rated Load Conditions (400 Hz)



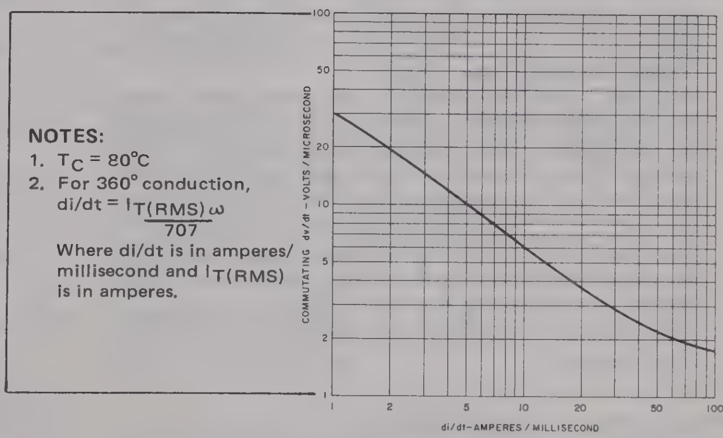
NOTES:
1. CURVES APPLY FOR EITHER POLARITY OF MAIN TERMINAL 2 REFERENCED TO MAIN TERMINAL 1.
2. CURVES APPLY FOR HALF SINE WAVE CURRENT WAVEFORM.

14. Sub-Cycle Surge and I^2t Ratings Following Rated Load Conditions



NOTES:
1. CURVES DEFINE TEMP RISE OF EITHER JUNCTION ABOVE CASE TEMP. FOR EQUAL AMPLITUDES OF SYMMETRICAL SINE WAVE CURRENT.
2. CURVES CONSIDER JUNCTION TEMP. MEASURED IMMEDIATELY AFTER THE FINAL CYCLE OF CURRENT
3 GATE WILL REGAIN CONTROL IF JUNCTION TEMP. IS MAINTAINED BELOW RATED VALUE AND LOAD CURRENT IS REDUCED OR MAINTAINED AT RATED RMS VALUE
4 FOR MORE THAN 100 CURRENT CYCLES THE DEVICE CASE TEMP. RISE MUST BE OBSERVED AND USED IN CALCULATING THE TOTAL JUNCTION TEMP
5 THE JUNCTION TEMP. RISE ABOVE CASE IS DEFINED AS THE APPARENT TRANSIENT THERMAL IMPEDANCE TIMES THE AVERAGE CONDUCTION POWER DISSIPATED DURING FULL CYCLE CONDUCTION
6 APPARENT STEADY-STATE VALUE IS NOT THE SAME AS JEDEC (UNI-DIRECTION) VALUE LISTED AS STEADY-STATE IN CHARACTERISTIC TABLE

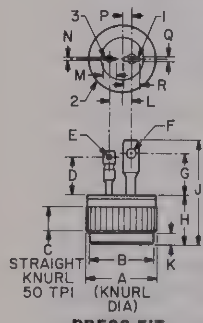
15. Maximum Apparent Transient Thermal Impedance



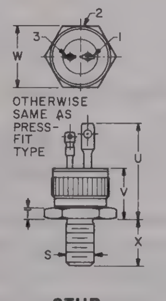
NOTES:
1. $T_C = 80°C$
2. For 360° conduction,
$$di/dt = \frac{I_{T(RMS)}\,\omega}{707}$$
Where di/dt is in amperes/millisecond and $I_{T(RMS)}$ is in amperes.

16. Typical Rate of Removal of Current (di/dt) Effect Upon Commutating dv/dt

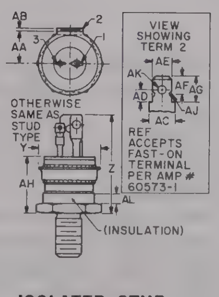
OUTLINE DRAWINGS



PRESS-FIT



STUD

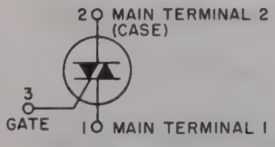

AB
2
3
1
AA
VIEW SHOWING TERM 2
AE
AK
AF
AG
AD
AJ
AC
REF ACCEPTS FAST-ON TERMINAL PER AMP # 60573-1
OTHERWISE SAME AS STUD TYPE
Y
Z
AH
AL
(INSULATION)

ISOLATED STUD

SYM	DECIMAL (INCHES) MIN.	DECIMAL (INCHES) MAX	METRIC (MM) MIN.	METRIC (MM) MAX.
A	.501	.505	12.73	12.83
B	.467	.475	11.86	12.07
C	.177 REF.		4.50 REF.	
D	.260	.301	6.60	7.65
E	.035	.045	.89	1.14
F	.065	.075	1.65	1.41
G		.350		8.89
H	.340	.376	8.64	9.55
J		.782		19.86
K	.083	.097	2.11	2.46
L	.130	.180	3.30	4.57
M	.085	.115	2.16	2.92

SYM	DECIMAL (INCHES) MIN.	DECIMAL (INCHES) MAX.	METRIC (MM) MIN.	METRIC (MM) MAX.
N	.016	.023	.41	.58
P	.065 REF.		1.65 REF.	
Q	.028	.035	.71	.89
R	.110	.135	2.79	3.43
S	1/4-28 UNF2A		1/4-28 UNF2A	
T	.086	.098	2.18	2.49
U		.865		21.79
V		.475		12.07
W	.552	.562	14.02	14.27
X	.432	.442	10.97	11.23
Y	.580	.610	14.73	15.49

SYM	DECIMAL (INCHES) MIN.	DECIMAL (INCHES) MAX.	METRIC (MM) MIN.	METRIC (MM) MAX.
Z		.975		24.77
AA	.290	.330	7.37	8.38
AB	.017	.024	.43	.61
AC	.235	.265	5.97	6.73
AD	.115	.121	2.29	3.07
AE	.186	.189	4.72	4.80
AF	.170 REF.		4.32 REF	
AG	.245	.255	6.22	6.48
AH		.585		14.86
AJ	.025	R-REF.	.64	R-REF.
AK	.065	.070	1.65	1.78
AL	.100	.110	2.54	2.79

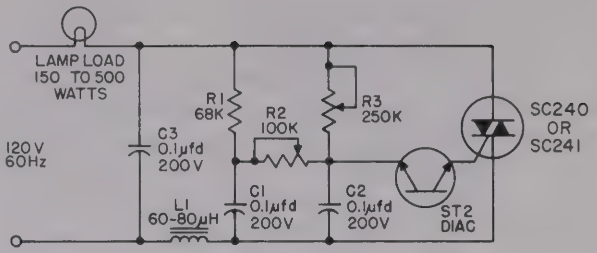


TERMINAL ARRANGEMENT

NOTES: (1)Case temperature is measured at the center of any hex flat or press-fit base.
(2)One ext. tooth lock washer and one nut (both steel, cad. plated) supplied with each stud and isolated stud unit.
(3)Insulation hardware for stud device consisting of terminal, 2 mica washers and one nylon bushing available at extra cost upon request.

TYPICAL CIRCUIT

Triacs are especially useful in lamp dimming because of their ability to conduct in both directions. The circuit shown here is one of the more popular circuits used. The R-C time constants provide a phase-shifted AC signal to the Diac. When the voltage on C2 exceeds the breakover voltage of the ST2 Diac, the Diac switches to the on-state and triggers the Triac. If R2 is adjusted so that the Diac is just below the triggering point when R3 is at the maximum setting, R3 will provide a smooth continuous control from 5% to over 95% of full power to the lamp load.
Capacitor C3 and inductor L1 form a low-pass filter to substantially reduce the radio frequency interference which can be generated in phase control circuits. For further discussion of this circuit as well as many others, please refer to application notes listed below.



MOUNTING CONSIDERATIONS*

Installation of Press-Fit Device in Heat Sink

When press fitting a Triac into a heatsink, the following specifications and recommendations apply:

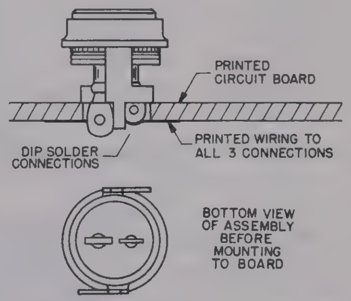
1. Heatsink materials may be copper, aluminum, or steel. For maximum heat transfer and minimum corrosion problems, copper is recommended. The heatsink thickness, or amount of heatsink wall, in contact with the Triac should be 1/8 inch.
2. The hole diameter into which the Triac is pressed must be 0.4975 ± .001 inch. A slight chamfer on the hole should be used. This hole may be punched in a flat plate and reamed, or extruded and sized in sheet metal.
3. The entire knurled section of the Triac should be in contact with the heatsink to insure maximum heat transfer. The Triac must not be inserted into a heatsink deeper than the knurl height.
4. The Triac insertion force must not exceed 800 pounds. If the insertion force approaches this value before complete insertion, either the Triac is misaligned with the hole or the Triac-to-hole interference is excessive. The insertion force must be uniformly applied to the top face (terminal end) of the Triac within an annular ring which has an inside diameter of not less than 0.370 inch and not larger than 0.390 inch; the outside diameter of the insertion force must not be less than 0.500 inch.
5. The thermal resistance between the Triac case and a copper heatsink will not exceed 0.5°C/W, if the Triac is inserted in the manner described.

Soldering of Press-Fit Package to Heat Sink

The press-fit package may be soldered directly to a heatsink using 60/40 (Pb-Sn) solder at a temperature of about 200°C.

Attachment of Press-Fit Device to Printed Circuit Board

For certain light load applications, the Triac can be inverted and, using a special brass bracket (A7149451), dip-soldered into a printed circuit board. The feet on the bracket act both as a mechanical support and Main Terminal 2 (case) electrical connection. For Triacs preassembled into the bracket, add –X24 to the type number, for example, SC241BX24.



Attachment of the Stud & Isolated Stud Device To a Heat Sink

These devices require certain precautions in order to insure good thermal transfer. The chassis hole must be drilled and deburred, and should be between .005 and .015 inches larger than the stud outside diameter. The use of a Torque wrench is highly recommended and must be used within the torque limits indicated on page 2. A good grade of silicone grease will minimize contact thermal resistance.

---

*A more detailed discussion may be found in the General Electric SCR Manual, 4th Edition (1967), Chapter 17, "Cooling the Power Semiconductor."

OTHER TRIAC AND APPLICATION INFORMATION AVAILABLE FROM GENERAL ELECTRIC

Publication Number	Specification Sheets	
175.19	SC35/36	(3 Amp)
175.26	SC45/46	(10 Amp)
175.27	SC50/51	(15 Amp)
175.21	SC60/61	(25 Amp)
175.15	SC141/146	(6, 10 Amp in plastic package)
175.25	SC40/41	(6 Amp)
175.17	SC245/246	(10 Amp)
175.18	SC250/251	(15 Amp)
	Reliability Reports	
95.29	Glassivated Triac Reliability Report	

Publication Number	Application Notes
200.32	A Variety of Mounting Techniques for Press Fit Devices
200.35	Using the Triac for Control of AC Power
200.45	Temperature Controls Incorporating Zero Voltage Switching
200.51	Better Room Conditioning Via Solid State Controls
200.53	Solid State Incandescent Lighting Controls
201.19	RF Filter Considerations for Triac & SCR Circuits
201.20	Proportional Zero Voltage Switching Temperature Control
201.22	Low Power Zero Voltage Switching Using the PA424
200.58	Solid State Electric Heating Controls

Also, individual specifications are listed in publication number 450.52 —Semiconductor Specifications Index. All of these referred to may be ordered by publication number from General Electric Company, Distribution Services, Bldg. 6-208, Schenectady, New York 12305.

TRIAC

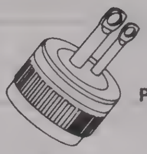
Silicon AC Switch

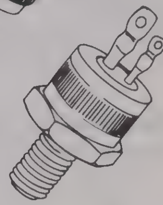
SC245
SC246

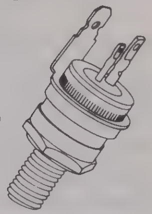
10A RMS **Up to 500 Volts**

Variations

Mechanical	Electrical
Press-Fit	Zero Voltage Switch Type
Stud	Selected Gate Type
Isolated Stud	400 Hertz Type


PRESS-FIT


STUD


ISOLATED STUD

The triac is a silicon AC switch which may be gate triggered from an OFF state to an ON state for either polarity of applied voltage.

The SC240 series of glassivated triacs incorporates General Electric's new POWER–GLAS process that improves upon normal passivation techniques. It provides for an intimate void-free bond between the silicon chip and the stress-matched glass coating. The resulting stable low level leakage current significantly improves performance and reliability.

Features:

- Glassivated silicon chip for maximum reliability.
- Improved commutating dv/dt (4V/μs. min.)
- 100A Peak One Full Cycle Surge Rating (60 Hz)
- 1000 watt load (120V line)
- 2000 watt load (240V line)
- Inherent immunity from transient voltage damage (can be broken over safely in either direction)
- Press-Fit, Stud, and Isolated Stud Packages available.
- Standard Electrical Variations available:

  (1) Selected for use with the General Electric PA424 Zero Voltage Switch

  (2) Selected for 25mA Maximum Gate Trigger Current in all four modes.

  (3) Selected for Operation at 400 Hz.

TYPICAL TRIAC APPLICATIONS

GENERAL FUNCTIONS

TYPES OF EQUIPMENT	Heat Control	Motor Speed Control	Light Control	Solid State Contactors and Relays	Power Regulation
Photographic Dev. Equip.	X		X		X
Process Control	X	X	X	X	X
Reproduction Equipment	X	X	X	X	X
Bio-Medical	X	X	X	X	X
Air Conditioners		X			
Blenders, Mixers		X			
Computer Tape Decks		X			
Fans		X			
Hand Tools		X			
Machine Tools/Misc. Mfg.		X		X	
Sewing Machines		X			
Laundry		X		X	
Farm Equipment	X	X	X	X	
Light Dimmers			X		
Photographic Equipment	X		X	X	
Outdoor Signs			X	X	
Clutches/Brakes				X	
Industrial Timers				X	
Traffic Signal Control			X	X	
Vending Machines	X			X	
Aircraft	X	X	X	X	X
Computer Power Supplies				X	X
Home Entertainment	X	X	X	X	X

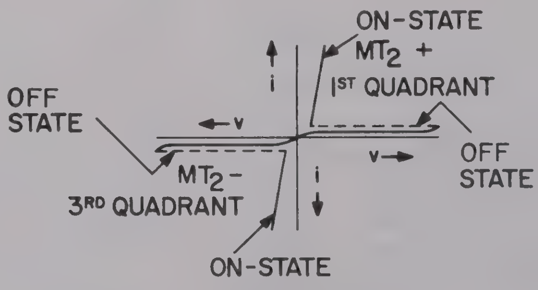
FOR TRIAC TRIGGERS SEE PAGE 153

MAXIMUM ALLOWABLE RATINGS—ALL TYPES

PACKAGE	ELECTRICAL TYPE				Repetitive Peak Off-State Voltage V_{DRM}(1) $T_C = -40°C$ to $+100°C$
	Standard Type	Zero Voltage Switch	Selected Gate	400 Hz Operation	
PRESS-FIT	SC246B	SC246B12	SC246B13	SC246B14	200 Volts
STUD	SC245B	SC245B12	SC245B13	SC245B14	
ISOLATED STUD	SC245B2	SC245B22	SC245B23	SC245B24	
PRESS-FIT	SC246D	SC246D12	SC246D13	SC246B14	400 Volts
STUD	SC245D	SC245D12	SC245D13	SC245D14	
ISOLATED STUD	SC245D2	SC245D22	SC245D23	SC245D24	
PRESS-FIT	SC246E	SC246E12	SC246E13	SC246E14	500 Volts
STUD	SC245E	SC245E12	SC245E13	SC245E14	
ISOLATED STUD	SC245E2	SC245E22	SC245E23	SC245E24	

RMS On-State Current, $I_{T(RMS)}$(4)	10 Amperes
Peak One Full Cycle Surge (non-rep) On-State Current, I_{TSM} (50 Hz)	90 Amperes
(60 Hz)	100 Amperes
(400 Hz)	187 Amperes
I^2t (for fusing), for time at(2) 1.0 millisecond	20 Ampere^2 seconds (See Chart 14)
8.3 millisecond	41.5
Peak Gate Power Dissipation, P_{GM}(3)	10 Watts for 10 microseconds (See Chart 5)
Average Gate Power Dissipation, $P_{G(AV)}$	0.5 Watts
Peak Gate Current, I_{GM}(3)	See Chart 5
Peak Gate Voltage, V_{GM}(3)	See Chart 5
Critical Rate-of-Rise of On-State Current, di/dt(2)(5)	
Breakover voltage triggered operation	10 Amperes per microsecond
Storage Temperature, T_{STG}	−40°C to +125°C
Operating Temperature, T_J	−40°C to +100°C
Stud Torque—(STUD & ISOLATED STUD TYPES)	25 Lb-in (29 Kg-cm)
Insertion Pressure—(PRESS-FIT TYPE)	800 lbs (364 Kg)
Isolation Breakdown Voltage Between Any Terminal and Stud (ISOLATED STUD TYPE)(6)	1800 Volts RMS

NOTES:
1. Ratings apply for zero gate voltage only. Ratings apply for either polarity of main terminal 2 voltage referenced to main terminal 1.
2. Ratings apply for either polarity of main terminal 2 referenced to main terminal 1.
3. Ratings apply for either polarity of gate terminal referenced to main terminal 1.
4. At case reference point temperature of 78.5°C (74°C isolated stud type) maximum and 360° conduction.
5. di/dt rating is established in accordance with JEDEC suggested standard No. 7, Section 5.1.2.4. off-state (blocking) voltage capability may be temporarily lost immediately after each current pulse for duration less than the period of the applied repetition rate. The pulse repetition rate for this test is 400 Hz. The duration of the JEDEC di/dt test condition is 5.0 seconds (minimum).
6. Rating applies for 50, 60 and 400 Hz sinusoidal waveform.



TYPICAL E-I CHARACTERISTICS

WARNING

Isolated stud products described in this specification sheet should be handled with care. The ceramic portion of these thyristors contains BERYLLIUM OXIDE as a major ingredient.

Do not crush, grind, or abrade these portions of the thyristors because the dust resulting from such action may be hazardous if inhaled.

TABLE I—STANDARD TYPE CHARACTERISTICS

Type	Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions			Reference Note
All types	Peak Off-State current	I_{DRM}				mA	V_{DRM} = Maximum Allowable Peak Off-State Voltage Gate Open Circuited			1
			–	–	0.1		T_C = +25°C			
			–	–	0.5		T_C = +100°C			
All types	Peak-On-State Voltage	V_{TM}	–	–	1.65	Volts	T_C = +25°C, I_{TM} = 14 A peak, 1 millisecond wide pulse, Duty cycle $\leqq 2\%$			1
All types	Critical Rate of Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt	–	50	–	Volts/μsec	T_C = +100°C, Rated V_{DRM} Gate Open Circuited, Exponential Waveform			1
All except 400 Hertz Type (Refer to Table IV)	Critical Rate of Rise of Commutating Off-State Voltage (Commutating dv/dt)	dv/dt(c)	4.0	–	–	Volts/μsec	T_C = +78.5°C (74°C for isolated stud type), $I_{T(RMS)}$ = Rated Max. Allowable RMS On-State Current, V_{DRM} = Rated Maximum Allowable Peak Off-State Voltage, Gate Open Circuited, Commutating di/dt = 5.4 A/msec			1
All except selected gate type (Refer to Table III)	D.C. Gate Trigger Current	I_{GT}				mAdc	V_D = 12 Vdc			2
							Trigger Mode	R_L	T_C	
			–	–	50		MT2+ Gate+	100 ohms	+25°C	
			–	–	50		MT2– Gate–	100 ohms		
			–	–	50		MT2+ Gate–	50 ohms		
			–	–	80		MT2+ Gate+	50 ohms	–40°C	
			–	–	80		MT2– Gate–	50 ohms		
			–	–	80		MT2+ Gate–	25 ohms		
All except selected gate type (Refer to Table III)	D.C. Gate Trigger Voltage	V_{GT}				Vdc	V_D = 12 Vdc			2
							Trigger Mode	R_L	T_C	
			–	–	2.5		MT2+ Gate+	100 ohms	+25°C	
			–	–	2.5		MT2– Gate–	100 ohms		
			–	–	2.5		MT2+ Gate–	50 ohms		
			–	–	3.5		MT2+ Gate+	50 ohms	–40°C	
			–	–	3.5		MT2– Gate–	50 ohms		
			–	–	3.5		MT2+ Gate–	25 ohms		
			0.20	–	–		MT2+ Gate+ MT2– Gate– MT2+ Gate– MT2– Gate+	1000 ohms	+100°C	2, 3
All types	Holding Current	I_H				mAdc	Main Terminal Source Voltage = 24 Vdc, Peak initiating on-state current = 0.5A, 0.1 milliseconds to 10 milliseconds wide pulse Gate trigger source = 7 V, 20 ohms			1
			–	–	50		T_C = +25°C			
			–	–	100		T_C = –40°C			
All types	Latching Current	I_L				mAdc	Main Terminal Source Voltage = 24 Vdc, Gate trigger source = 15 V, 100 ohms, 50 μsec pulse width, 5 μsec rise and fall times max			2
							Trigger Mode		T_C	
			–	–	100		MT2+ Gate+		+25°C	
			–	–	100		MT2– Gate–			
			–	–	200		MT2+ Gate–			
			–	–	200		MT2+ Gate+		–40°C	
			–	–	200		MT2– Gate–			
			–	–	400		MT2+ Gate–			
All types	Steady-State Thermal Resistance	$R_{\theta JA}$	–	–	45	°C/Watt	Junction to Ambient			4
Press-fit & Stud type		$R_{\theta JC}$	–	–	2.0		Junction to Case			
Isolated stud type			–	–	2.3					

NOTES:

1. Values apply for either polarity of main terminal 2 characteristics referenced to main terminal 1.
2. Main terminal 1 is the reference terminal for main terminal 2 and gate terminal.
3. With V_D equal to maximum allowable off-state voltage.
4. Junction to case values tested in accordance with JEDEC Semi-conductor device registration #JC-22 (RDF-2), VA, Note 6, which states, "Thermal characteristics are to be measured with the device operating in only one direction. The values registered are to be the limiting value for either direction." The junction to ambient value is under worst case conditions, i.e., with #22 copper wire used for electrical contact to the terminals and natural convection.

TABLE II–ZERO VOLTAGE SWITCH TYPE (FOR USE WITH PA424 ZERO VOLTAGE SWITCH)

NOTE: ALL STANDARD CHARACTERISTICS APPLY EXCEPT AS INDICATED

CHARACTERISTICS									Reference Note
Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions			
Pulse Gate Trigger Current	I_{GT}				mAdc	V_D = 3 Vdc, Gate Pulse width = 50 μsec			1
						Trigger Mode	R_L	T_C	
		–	–	30		MT2– Gate– MT2+ Gate–	20 ohms	+25°C	
		–	–	46		MT2– Gate– MT2+ Gate–	14 ohms	–20°C	
Pulse Gate Trigger Voltage	V_{GT}				Volts	V_D = 3 Vdc, Gate Pulse width = 50 μsec			1
						Trigger Mode	R_L	T_C	
		–	–	2.0		MT2– Gate– MT2+ Gate–	20 ohms	+25°C	
		–	–	2.75		MT2– Gate– MT2+ Gate–	14 ohms	–20°C	
Latching Current	I_L				mAdc	Main Terminal Source Voltage = 3 Vdc, Gate trigger source = PA424			1
						Trigger Mode		T_C	
		–	–	115		MT2– Gate– MT2+ Gate–		+25°C	
		–	120	–		MT2– Gate– MT2+ Gate–		–20°C	

TABLE III–SELECTED GATE TYPE

NOTE: ALL STANDARD CHARACTERISTICS APPLY EXCEPT AS INDICATED

CHARACTERISTICS									Reference Note
Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions			
D.C. Gate Trigger Current	I_{GT}				mAdc	V_D = 12 Vdc			1
						Trigger Mode	R_L	T_C	
		–	–	25		MT2+ Gate+	100 ohms	+25°C	
		–	–	25		MT2– Gate–	100 ohms		
		–	–	25		MT2+ Gate–	50 ohms		
		–	–	25		MT2– Gate+	50 ohms		
		–	–	50		MT2+ Gate+	50 ohms	–40°C	
		–	–	50		MT2– Gate–	50 ohms		
		–	–	50		MT2+ Gate–	25 ohms		
		–	–	50		MT2– Gate+	25 ohms		
D.C. Gate Trigger Voltage	V_{GT}				Vdc	V_D = 12 Vdc			1
						Trigger Mode	R_L	T_C	
		–	–	2.0		MT2+ Gate+	100 ohms	+25°C	
		–	–	2.0		MT2– Gate–	100 ohms		
		–	–	2.0		MT2+ Gate–	50 ohms		
		–	–	2.0		MT2– Gate+	50 ohms		
		–	–	3.0		MT2+ Gate+	50 ohms	–40°C	
		–	–	3.0		MT2– Gate–	50 ohms		
		–	–	3.0		MT2+ Gate–	25 ohms		
		–	–	3.0		MT2– Gate+	25 ohms		

TABLE IV–400 HZ OPERATION TYPE

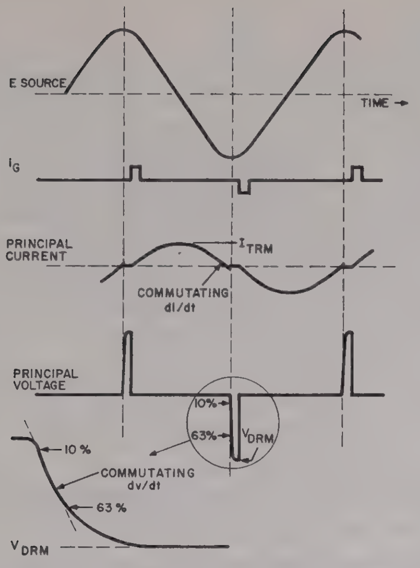
NOTE: ALL STANDARD CHARACTERISTICS APPLY EXCEPT AS INDICATED

CHARACTERISTICS							Reference Note
Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions	
Critical Rate of Rise of Commutating Off-State Voltage (Commutating dv/dt)	dv/dt(c)	4.0	–	–	Volts/μsec	T_C = +78.5°C (+74°C for isolated stud type), $I_{T(RMS)}$ = Rated Max. Allowable RMS On-State Current V_{DRM} = Rated Maximum Allowable Peak Off-State Voltage Gate Open Circuited Commutating di/dt = 36 A/msec	2

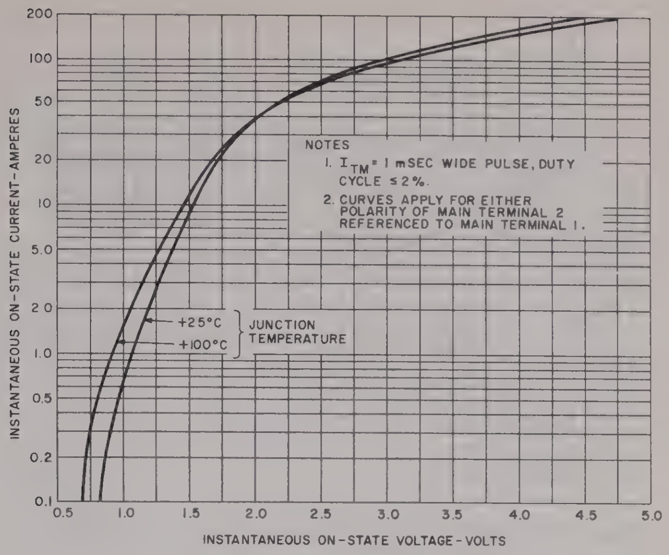
NOTES

1 Main terminal 1 is the reference terminal for main terminal 2 and gate terminal.

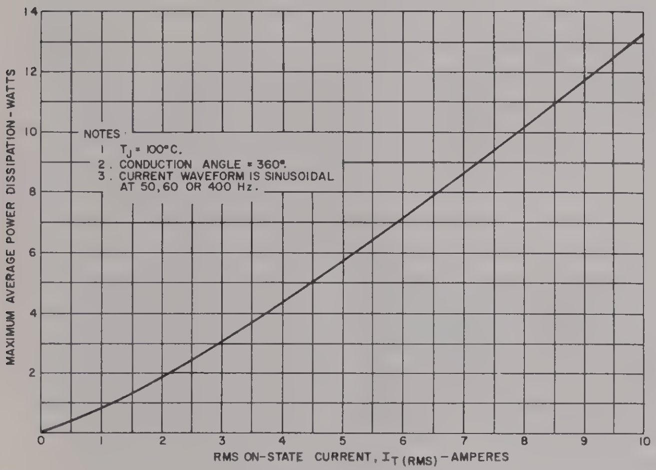
2 Values apply for either polarity of main terminal 2 characteristic referenced to main terminal 1.


E SOURCE
TIME
I_G
PRINCIPAL CURRENT
I_{TRM}
COMMUTATING dI/dt
PRINCIPAL VOLTAGE
10%
63%
V_{DRM}
10 %
COMMUTATING dv/dt
63 %
V_{DRM}

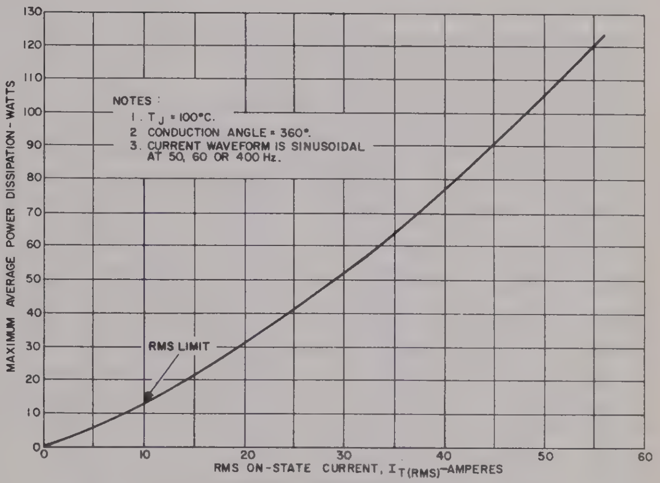
1. Waveform of Commutating dv/dt



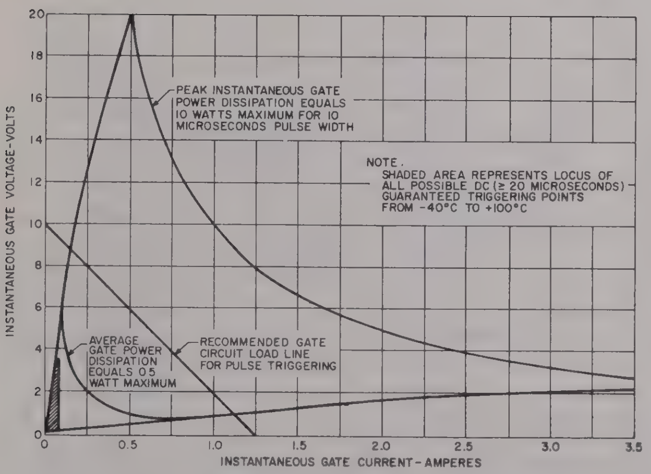
2. Maximum On-State Voltage vs. On-State Current



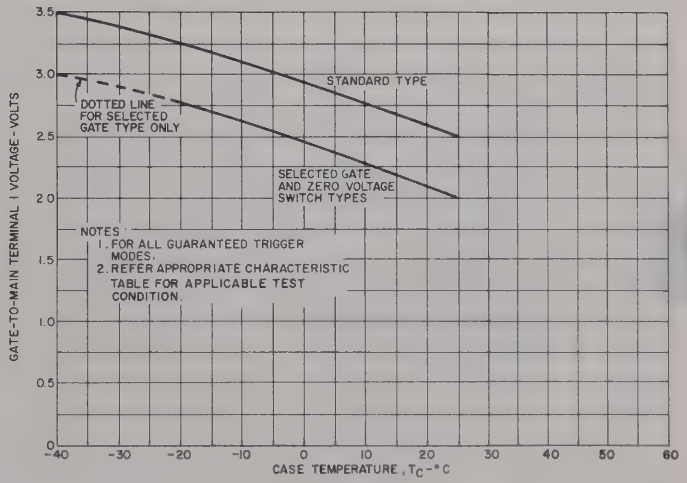
3. Maximum Average Power Dissipation vs. RMS On-State Current



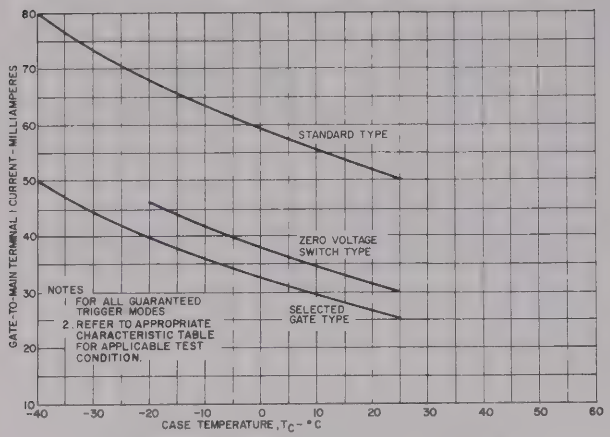
4. Maximum Average Power Dissipation vs. RMS On-State Current (High Level)



5. Gate Characteristics and Ratings

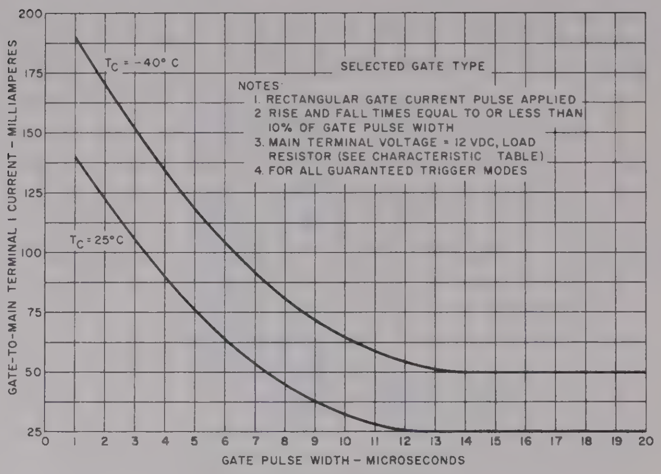


6. Maximum DC Gate Trigger Voltage vs. Case Temperature



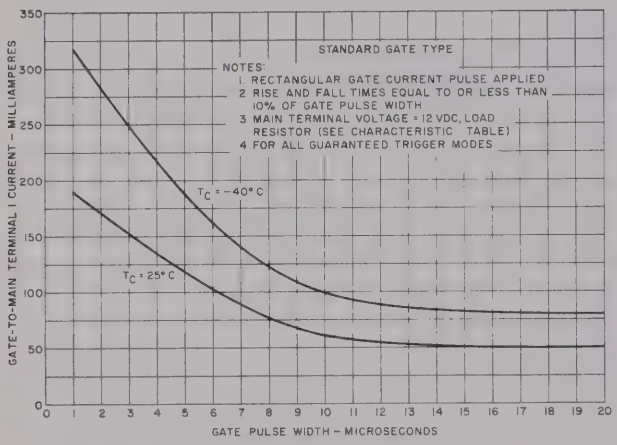
NOTES
1. FOR ALL GUARANTEED TRIGGER MODES
2. REFER TO APPROPRIATE CHARACTERISTIC TABLE FOR APPLICABLE TEST CONDITION.

7. Maximum DC Gate Trigger Current vs. Case Temperature



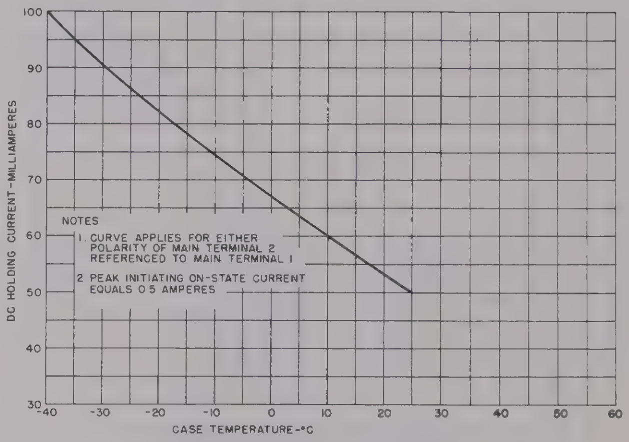
NOTES:
1. RECTANGULAR GATE CURRENT PULSE APPLIED
2. RISE AND FALL TIMES EQUAL TO OR LESS THAN 10% OF GATE PULSE WIDTH
3. MAIN TERMINAL VOLTAGE = 12 VDC, LOAD RESISTOR (SEE CHARACTERISTIC TABLE)
4. FOR ALL GUARANTEED TRIGGER MODES

8. Maximum Gate Trigger Current vs. Gate Pulse Width (Selected Gate Type)



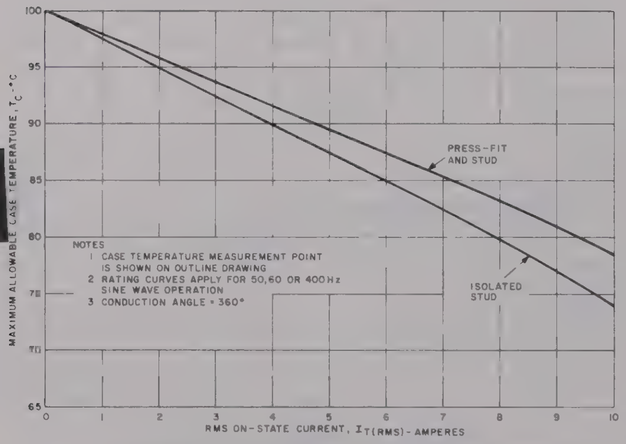
NOTES:
1. RECTANGULAR GATE CURRENT PULSE APPLIED
2. RISE AND FALL TIMES EQUAL TO OR LESS THAN 10% OF GATE PULSE WIDTH
3. MAIN TERMINAL VOLTAGE = 12 VDC, LOAD RESISTOR (SEE CHARACTERISTIC TABLE)
4. FOR ALL GUARANTEED TRIGGER MODES

9. Maximum Gate Trigger Current vs. Gate Pulse Width (Standard Gate Type)



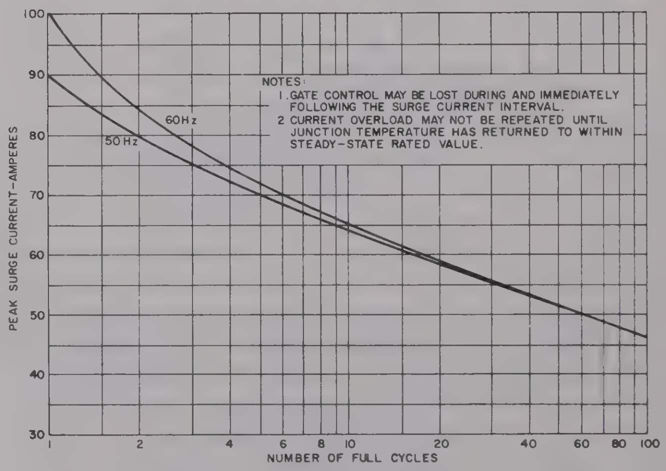
NOTES
1. CURVE APPLIES FOR EITHER POLARITY OF MAIN TERMINAL 2 REFERENCED TO MAIN TERMINAL 1
2. PEAK INITIATING ON-STATE CURRENT EQUALS 0.5 AMPERES

10. Maximum DC Holding Current vs. Case Temperature



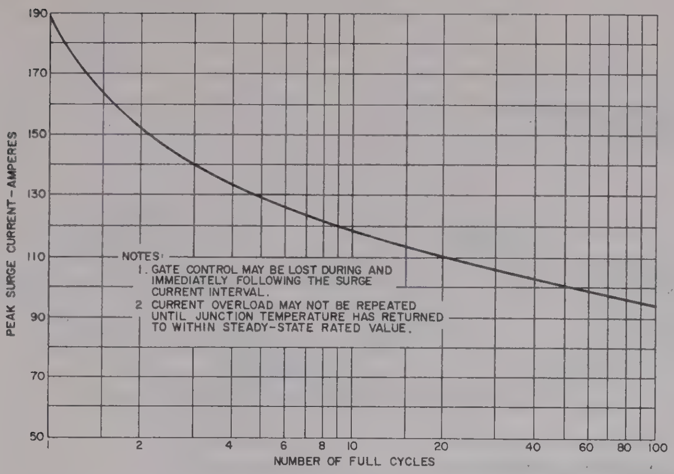
NOTES
1. CASE TEMPERATURE MEASUREMENT POINT IS SHOWN ON OUTLINE DRAWING
2. RATING CURVES APPLY FOR 50,60 OR 400 Hz SINE WAVE OPERATION
3. CONDUCTION ANGLE = 360°

11. Maximum Allowable Case Temperature vs. RMS On-State Current



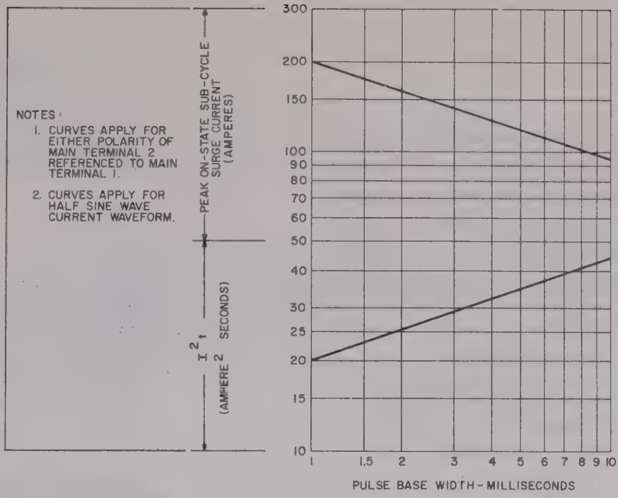
NOTES:
1. GATE CONTROL MAY BE LOST DURING AND IMMEDIATELY FOLLOWING THE SURGE CURRENT INTERVAL.
2. CURRENT OVERLOAD MAY NOT BE REPEATED UNTIL JUNCTION TEMPERATURE HAS RETURNED TO WITHIN STEADY-STATE RATED VALUE.

12. Maximum Allowable Full Cycle Surge Current Following Rated Load Conditions



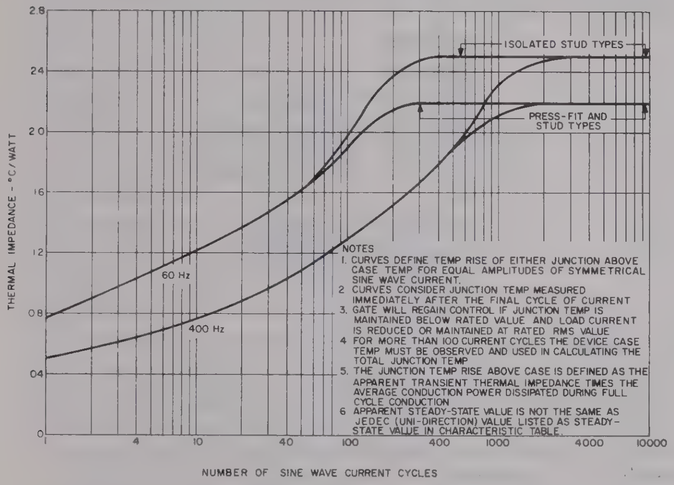
NOTES:
1. GATE CONTROL MAY BE LOST DURING AND IMMEDIATELY FOLLOWING THE SURGE CURRENT INTERVAL.
2. CURRENT OVERLOAD MAY NOT BE REPEATED UNTIL JUNCTION TEMPERATURE HAS RETURNED TO WITHIN STEADY-STATE RATED VALUE.

13. Maximum Allowable Full Cycle Surge Current Following Rated Load Conditions (400 Hz)



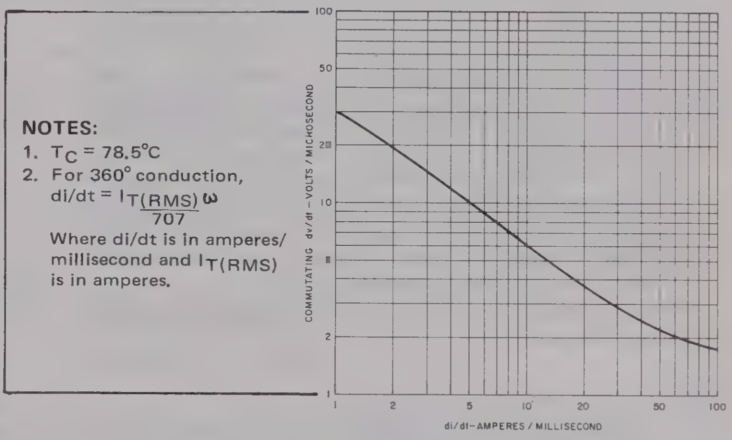
NOTES:
1. CURVES APPLY FOR EITHER POLARITY OF MAIN TERMINAL 2 REFERENCED TO MAIN TERMINAL 1.
2. CURVES APPLY FOR HALF SINE WAVE CURRENT WAVEFORM.

14. Sub-Cycle Surge and I^2t Ratings Following Rated Load Conditions



NOTES
1. CURVES DEFINE TEMP RISE OF EITHER JUNCTION ABOVE CASE TEMP FOR EQUAL AMPLITUDES OF SYMMETRICAL SINE WAVE CURRENT.
2. CURVES CONSIDER JUNCTION TEMP MEASURED IMMEDIATELY AFTER THE FINAL CYCLE OF CURRENT
3. GATE WILL REGAIN CONTROL IF JUNCTION TEMP IS MAINTAINED BELOW RATED VALUE AND LOAD CURRENT IS REDUCED OR MAINTAINED AT RATED RMS VALUE
4. FOR MORE THAN 100 CURRENT CYCLES THE DEVICE CASE TEMP MUST BE OBSERVED AND USED IN CALCULATING THE TOTAL JUNCTION TEMP
5. THE JUNCTION TEMP RISE ABOVE CASE IS DEFINED AS THE APPARENT TRANSIENT THERMAL IMPEDANCE TIMES THE AVERAGE CONDUCTION POWER DISSIPATED DURING FULL CYCLE CONDUCTION
6. APPARENT STEADY-STATE VALUE IS NOT THE SAME AS JEDEC (UNI-DIRECTION) VALUE LISTED AS STEADY-STATE VALUE IN CHARACTERISTIC TABLE.

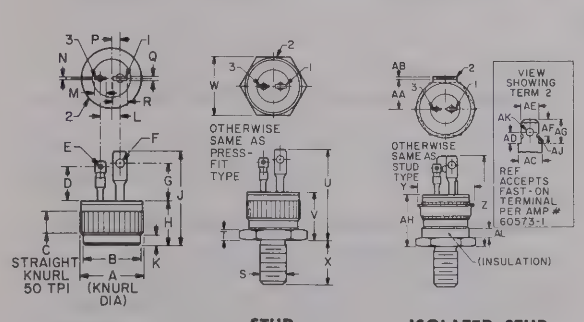
15. Maximum Apparent Transient Thermal Impedance



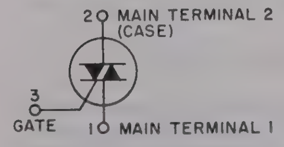
NOTES:
1. $T_C = 78.5°C$
2. For 360° conduction, $di/dt = \frac{I_{T(RMS)}\,\omega}{707}$
Where di/dt is in amperes/millisecond and $I_{T(RMS)}$ is in amperes.

16. Typical Rate of Removal of Current (di/dt) Effect Upon Commutating dv/dt

OUTLINE DRAWINGS



PRESS-FIT **STUD** **ISOLATED STUD**



TERMINAL ARRANGEMENT

SYM	DECIMAL (INCHES)		METRIC (MM)	
	MIN.	MAX.	MIN.	MAX.
A	.501	.505	12.73	12.83
B	.467	.475	11.86	12.07
C	.177 REF.		4.50 REF.	
D	.260	.301	6.60	7.65
E	035	.045	.89	1.14
F	.065	.075	1.65	1.41
G		.350		8.89
H	.340	.376	8.64	9.55
J		.782		19.86
K	.083	.097	2.11	2.46
L	.130	.180	3.30	4.57
M	.085	.115	2.16	2.92

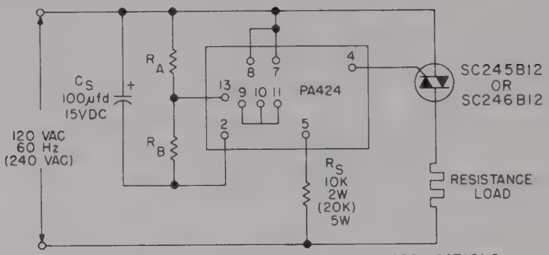
SYM	DECIMAL (INCHES)		METRIC (MM)	
	MIN.	MAX.	MIN.	MAX.
N	.016	.023	.41	.58
P	.065 REF.		1.65 REF.	
Q	.028	.035	.71	.89
R	.110	.135	2.79	3.43
S	1/4-28 UNF2A		1/4-28 UNF2A	
T	.086	.098	2.18	2.49
U		.865		21.79
V		.475		12.07
W	.552	.562	14.02	14.27
X	.432	.442	10.97	11.23
Y	.580	.610	14.73	15.49

SYM	DECIMAL (INCHES)		METRIC (MM)	
	MIN.	MAX.	MIN.	MAX.
Z		.975		24.77
AA	.290	.330	7.37	8.38
AB	.017	.024	.43	.61
AC	.235	.265	5.97	6.73
AD	.115	.121	2.29	3.07
AE	.186	.189	4.72	4.80
AF	.170 REF.		4.32 REF	
AG	.245	.255	6.22	6.48
AH		.585		14.86
AJ	.025	R-REF.	.64	R-REF
AK	.065	.070	1.65	1.78
AL	.100	.110	2.54	2.79

NOTES: (1)Case temperature is measured at the center of any hex flat or press-fit base.
(2)One ext. tooth lock washer and one nut (both steel, cad. plated) supplied with each stud and isolated stud unit.
(3)Insulation hardware for stud device consisting of terminal, 2 mica washers and one nlyon bushing available at extra cost upon request.

TYPICAL CIRCUIT

When the SC245 or SC246 is used with General Electric's PA424 zero voltage switch integrated circuit, an all solid-state electric temperature control results if a thermistor is used in the input of the PA424. With the proper thermistor, this circuit has the capability of controlling temperature to ±0.2°F. This application and many others, is covered in greater detail in the PA424 specification sheet (Pub. No. 85.21).



R_A = THERMISTOR FOR TEMPERATURE CONTROL APPLICATIONS

MOUNTING CONSIDERATIONS*

Installation of Press-Fit Device in Heat Sink

When press fitting a Triac into a heatsink, the following specifications and recommendations apply:

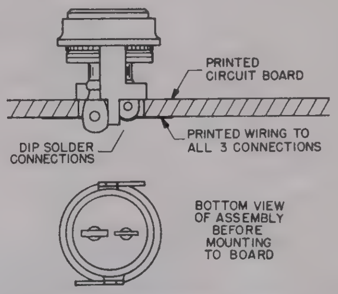
1. Heatsink materials may be copper, aluminum, or steel. For maximum heat transfer and minimum corrosion problems, copper is recommended. The heatsink thickness, or amount of heatsink wall, in contact with the Triac should be 1/8 inch.
2. The hole diameter into which the Triac is pressed must be 0.4975 ± .001 inch. A slight chamfer on the hole should be used. This hole may be punched in a flat plate and reamed, or extruded and sized in sheet metal.
3. The entire knurled section of the Triac should be in contact with the heatsink to insure maximum heat transfer. The Triac must not be inserted into a heatsink deeper than the knurl height.
4. The Triac insertion force must not exceed 800 pounds. If the insertion force approaches this value before complete insertion, either the Triac is misaligned with the hole or the Triac-to-hole interference is excessive. The insertion force must be uniformly applied to the top face (terminal end) of the Triac within an annular ring which has an inside diameter of not less than 0.370 inch and not larger than 0.390 inch; the outside diameter of the insertion force must not be less than 0.500 inch.
5. The thermal resistance between the Triac case and a copper heatsink will not exceed 0.5°C/W, if the Triac is inserted in the manner described.

Soldering of Press-Fit Package to Heat Sink

The press-fit package may be soldered directly to a heatsink using 60/40 (Pb-Sn) solder at a temperature of about 200°C.

Attachment of Press-Fit Device to Printed Circuit Board

For certain light load applications, the Triac can be inverted and, using a special brass bracket (A7149451), dip-soldered into a printed circuit board. The feet on the bracket act both as a mechanical support and Main Terminal 2 (case) electrical connection. For Triacs preassembled into the bracket, add –X24 to the type number, for example, SC246BX24.



PRINTED CIRCUIT BOARD
PRINTED WIRING TO ALL 3 CONNECTIONS
DIP SOLDER CONNECTIONS
BOTTOM VIEW OF ASSEMBLY BEFORE MOUNTING TO BOARD

Attachment of the Stud & Isolated Stud Device To a Heat Sink

These devices require certain precautions in order to insure good thermal transfer. The chassis hole must be drilled and deburred, and should be between .005 and .015 inches larger than the stud outside diameter. The use of a Torque wrench is highly recommended and must be used within the torque limits indicated on page 2. A good grade of silicone grease will minimize contact thermal resistance.

*A more detailed discussion may be found in the General Electric SCR Manual, 4th Edition (1967), Chapter 17, "Cooling the Power Semiconductor."

OTHER TRIAC AND APPLICATION INFORMATION AVAILABLE FROM GENERAL ELECTRIC

Publication Number	Specification Sheets	
85.21	PA424	(Zero Voltage Switch)
175.19	SC35/36	(3 Amp)
175.25	SC40/41	(6 Amp)
175.27	SC50/51	(15 Amp)
175.21	SC60/61	(25 Amp)
175.15	SC141/146	(6, 10 Amp in plastic package)
175.26	SC45/46	(10 Amp)
175.16	SC240/241	(6 Amp)
175.18	SC250/251	(15 Amp)
	Reliability Reports	
95.29	Glassivated Triac Reliability Report	

Publication Number	Application Notes
200.32	A Variety of Mounting Techniques for Press Fit Devices
200.35	Using the Triac for Control of AC Power
200.45	Temperature Controls Incorporating Zero Voltage Switching
200.51	Better Room Conditioning Via Solid State Controls
200.53	Solid State Incandescent Lighting Controls
201.19	RF Filter Considerations for Triac & SCR Circuits
201.20	Proportional Zero Voltage Switching Temperature Control
201.22	Low Power Zero Voltage Switching Using the PA424
200.58	Solid State Electric Heating Controls

Also, individual specifications are listed in publication number 450.52 —Semiconductor Specifications Index. All of these referred to may be ordered by publication number from General Electric Company, Distribution Services, Bldg. 6-208, Schenectady, New York 12305.

TRIAC

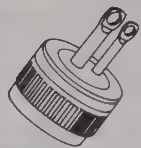
Silicon AC Switch

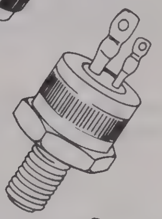
SC250
SC251

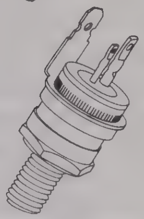
15A RMS **Up to 500 Volts**

Variations

Mechanical	Electrical
Press-Fit	Zero Voltage Switch Type
Stud	Selected Gate Type
Isolated Stud	400 Hertz Type







The triac is a silicon AC switch which may be gate triggered from an OFF state to an ON state for either polarity of applied voltage.

The SC240 series of glassivated triacs incorporates General Electric's new POWER–GLAS process that improves upon normal passivation techniques. It provides for an intimate void-free bond between the silicon chip and the stress-matched glass coating. The resulting stable low level leakage current significantly improves performance and reliability.

Features:

- Glassivated silicon chip for maximum reliability.
- Improved commutating dv/dt (4V/vs. min.)
- 100A Peak One Full Cycle Surge Rating (60 Hz)
- 1200 watt load (120V line)
- 2400 watt load (240V line)
- Inherent immunity from transient voltage damage (can be broken over safely in either direction).
- Press-Fit, Stud, and Isolated Stud Packages available.
- Standard Electrical Variations available:
  - (1) Selected for Use with the General Electric PA424 Zero Voltage Switch.
  - (2) Selected for 25mA Maximum Gate Trigger Current in all four modes.
  - (3) Selected for Operation at 400 Hz.

TYPICAL TRIAC APPLICATIONS

GENERAL FUNCTIONS

TYPES OF EQUIPMENT	Heat Control	Motor Speed Control	Light Control	Solid State Contactors and Relays	Power Regulation
Photographic Dev. Equip.	X		X		X
Process Control	X	X	X	X	X
Reproduction Equipment	X	X	X	X	X
Bio-Medical	X	X	X	X	X
Air Conditioners		X		X	
Blenders, Mixers		X			
Computer Tape Decks		X			
Fans		X			
Hand Tools		X			
Machine Tools/Misc. Mfg.		X		X	
Sewing Machines		X			
Laundry	X	X		X	
Farm Equipment	X	X	X	X	
Light Dimmers			X		
Photographic Equipment	X		X	X	
Outdoor Signs			X	X	
Clutches/Brakes				X	
Industrial Timers				X	
Traffic Signal Control			X	X	
Vending Machines	X			X	
Aircraft	X	X	X	X	X
Computer Power Supplies				X	X
Home Entertainment	X	X	X	X	X

FOR TRIAC TRIGGERS SEE PAGE 153

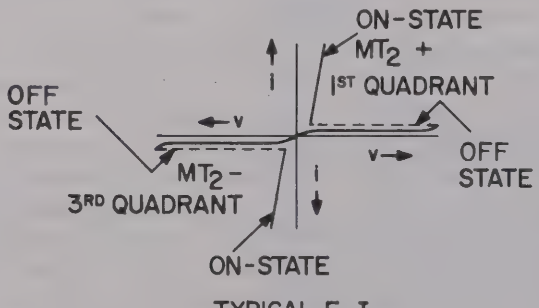
MAXIMUM ALLOWABLE RATINGS—ALL TYPES

PACKAGE	ELECTRICAL TYPE				Repetitive Peak Off-State Voltage V_{DRM}(1) $T_C = -40°C$ to $+115°C$
	Standard Type	Zero Voltage Switch	Selected Gate	400 Hz Operation	
PRESS-FIT	SC251B	SC251B12	SC251B13	SC251B14	200 Volts
STUD	SC250B	SC250B12	SC250B13	SC250B14	
ISOLATED STUD	SC250B2	SC250B22	SC250B23	SC250B24	
PRESS-FIT	SC251D	SC251D12	SC251D13	SC251D14	400 Volts
STUD	SC250D	SC250D12	SC250D13	SC250D14	
ISOLATED STUD	SC250D2	SC250D22	SC250D23	SC250D24	
PRESS-FIT	SC251E	SC251E12	SC251E13	SC251E14	500 Volts
STUD	SC250E	SC250E12	SC250E13	SC250E14	
ISOLATED STUD	SC250E2	SC250E22	SC250E23	SC250E24	

RMS On-State Current, $I_{T(RMS)}$ (4)	10 Amperes
Peak One Full Cycle Surge (non-rep) On-State Current, I_{TSM} (50 Hz)	90 Amperes
(60 Hz)	100 Amperes
(400 Hz)	187 Amperes
I^2t (for fusing), for time at (2) 1.0 millisecond	20 Ampere² seconds
8.3 millisecond	41.5 (See Chart 14)
Peak Gate Power Dissipation, P_{GM} (3)	10 Watts for 10 microseconds (See Chart 5)
Average Gate Power Dissipation, $P_{G(AV)}$	0.5 Watts
Peak Gate Current, I_{GM} (3)	See Chart 5
Peak Gate Voltage, V_{GM} (3)	See Chart 5
Critical Rate-of-Rise of On-State Current, di/dt (2)(5)	
Breakover voltage triggered operation	10 Amperes per microsecond
Storage Temperature, T_{STG}	−40°C to +125°C
Operating Temperature, T_J	−40°C to +115°C
Stud Torque—**(STUD & ISOLATED STUD TYPES)**	25 Lb-in (29 Kg-cm)
Insertion Pressure—**(PRESS-FIT TYPE)**	800 lbs (364 Kg)
Isolation Breakdown Voltage Between Any Terminal and Stud **(ISOLATED STUD TYPE)** (6)	1800 Volts RMS

NOTES:

1. Ratings apply for zero gate voltage only. Ratings apply for either polarity of main terminal 2 voltage referenced to main terminal 1.
2. Ratings apply for either polarity of main terminal 2 referenced to main terminal 1.
3. Ratings apply for either polarity of gate terminal referenced to main terminal 1.
4. At case reference point temperature of 84°C (78°C isolated stud type) maximum and 360° conduction.
5. di/dt rating is established in accordance with JEDEC suggested standard No. 7, Section 5.1.2.4. off-state (blocking) voltage capability may be temporarily lost immediately after each current pulse for duration less than the period of the applied repetition rate. The pulse repetition rate for this test is 400 Hz. The duration of the JEDEC di/dt test condition is 5.0 seconds (minimum).
6. Rating applies for 50, 60 and 400 Hz sinusoidal waveform.



TYPICAL E-I CHARACTERISTICS

WARNING

Isolated stud products described in this specification sheet should be handled with care. The ceramic portion of these thyristors contains BERYLLIUM OXIDE as a major ingredient.

Do not crush, grind, or abrade these portions of the thyristors because the dust resulting from such action may be hazardous if inhaled.

TABLE I—STANDARD TYPE CHARACTERISTICS

Type	Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions			Reference Note
All types	Peak Off-State current	I_{DRM}				mA	V_{DRM} = Maximum Allowable Peak Off-State Voltage Gate Open Circuited			1
			–	–	0.1		T_C = +25°C			
			–	–	0.5		T_C = +115°C			
All types	Peak-On-State Voltage	V_{TM}	–	–	1.65	Volts	T_C = +25°C, I_{TM} = 21 A peak. 1 millisecond wide pulse, Duty cycle ≦ 2%			1
All types	Critical Rate of Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt	–	50	–	Volts/μsec	T_C = +115°C, Rated V_{DRM} Gate Open Circuited, Exponential Waveform			1
All except 400 Hertz Type (Refer to Table IV)	Critical Rate of Rise of Commutating Off-State Voltage (Commutating dv/dt)	dv/dt(c)	4.0	–	–	Volts/μsec	T_C = +84°C (+78°C for isolated stud type), $I_{T(RMS)}$ = Rated Max. Allowable RMS On-State Current, V_{DRM} = Rated Maximum Allowable Peak Off-State Voltage, Gate Open Circuited, Commutating di/dt = 8 A/msec			1
All except selected gate type (Refer to Table III)	D.C. Gate Trigger Current	I_{GT}				mAdc	V_D = 12 Vdc			2
							Trigger Mode	R_L	T_C	
			–	–	50		MT2+ Gate+	100 ohms	+25°C	
			–	–	50		MT2– Gate–	100 ohms		
			–	–	50		MT2+ Gate–	50 ohms		
			–	–	80		MT2+ Gate+	50 ohms	–40°C	
			–	–	80		MT2– Gate–	50 ohms		
			–	–	80		MT2+ Gate–	25 ohms		
All except selected gate type (Refer to Table III)	D.C. Gate Trigger Voltage	V_{GT}				Vdc	V_D = 12 Vdc			2
							Trigger Mode	R_L	T_C	
			–	–	2.5		MT2+ Gate+	100 ohms	+25°C	
			–	–	2.5		MT2– Gate–	100 ohms		
			–	–	2.5		MT2+ Gate–	50 ohms		
			–	–	3.5		MT2+ Gate+	50 ohms	–40°C	
			–	–	3.5		MT2– Gate–	50 ohms		
			–	–	3.5		MT2+ Gate–	25 ohms		
			0.20	–	–		MT2+ Gate+ MT2– Gate– MT2+ Gate– MT2– Gate+	1000 ohms	+115°C	2, 3
All types	Holding Current	I_H				mAdc	Main Terminal Source Voltage = 24 Vdc, Peak initiating on-state current = 0.5A, 0.1 milliseconds to 10 milliseconds wide pulse Gate trigger source = 7 V, 20 ohms			1
			–	–	50		T_C = +25°C			
			–	–	100		T_C = –40°C			
All types	Latching Current	I_L				mAdc	Main Terminal Source Voltage = 24 Vdc, Gate trigger source = 15 V, 100 ohms, 50 μsec pulse width, 5 μsec rise and fall times max			2
							Trigger Mode		T_C	
			–	–	100		MT2+ Gate+		+25°C	
			–	–	100		MT2– Gate–			
			–	–	200		MT2+ Gate–			
			–	–	200		MT2+ Gate+		–40°C	
			–	–	200		MT2– Gate–			
			–	–	400		MT2+ Gate–			
All types	Steady-State Thermal Resistance	$R_{\theta JA}$	–	–	45	°C/Watt	Junction to Ambient			4
Press-fit & Stud type		$R_{\theta JC}$	–	–	2.0		Junction to Case			
Isolated stud type			–	–	2.3					

NOTES:

1. Values apply for either polarity of main terminal 2 characteristics referenced to main terminal 1.
2. Main terminal 1 is the reference terminal for main terminal 2 and gate terminal.
3. With V_D equal to maximum allowable off-state voltage.
4. Junction to case values tested in accordance with JEDEC Semi-conductor device registration #JC-22 (RDF-2), VA, Note 6, which states, "Thermal characteristics are to be measured with the device operating in only one direction. The values registered are to be the limiting value for either direction." The junction to ambient value is under worst case conditions, i.e., with # 22 copper wire used for electrical contact to the terminals and natural convection.

TABLE II—ZERO VOLTAGE SWITCH TYPE (FOR USE WITH PA424 ZERO VOLTAGE SWITCH)

NOTE: ALL STANDARD CHARACTERISTICS APPLY EXCEPT AS INDICATED

CHARACTERISTICS									Reference Note
Test	**Symbol**	**Min.**	**Typ.**	**Max.**	**Units**	**Test Conditions**			
Pulse Gate Trigger Current	I_{GT}				mAdc	V_D = 3 Vdc, Gate Pulse width = 50 μsec			1
						Trigger Mode	R_L	T_C	
		–	–	30		MT2– Gate– MT2+ Gate–	20 ohms	+25°C	
		–	–	46		MT2– Gate– MT2+ Gate–	14 ohms	−20°C	
Pulse Gate Trigger Voltage	V_{GT}				Volts	V_D = 3 Vdc, Gate Pulse width = 50 μsec			1
						Trigger Mode	R_L	T_C	
		–	–	2.0		MT2– Gate– MT2+ Gate–	20 ohms	+25°C	
		–	–	2.75		MT2– Gate– MT2+ Gate–	14 ohms	−20°C	
Latching Current	I_L				mAdc	Main Terminal Source Voltage = 3 Vdc, Gate trigger source = PA424			1
						Trigger Mode		T_C	
		–	–	115		MT2– Gate– MT2+ Gate–		+25°C	
		–	120	–		MT2– Gate– MT2+ Gate–		−20°C	

TABLE III—SELECTED GATE TYPE

NOTE: ALL STANDARD CHARACTERISTICS APPLY EXCEPT AS INDICATED

CHARACTERISTICS									Reference Note
Test	**Symbol**	**Min.**	**Typ.**	**Max.**	**Units**	**Test Conditions**			
D.C. Gate Trigger Current	I_{GT}				mAdc	V_D = 12 Vdc			1
						Trigger Mode	R_L	T_C	
		–	–	25		MT2+ Gate+	100 ohms	+25°C	
		–	–	25		MT2– Gate–	100 ohms		
		–	–	25		MT2+ Gate–	50 ohms		
		–	–	25		MT2– Gate+	50 ohms		
		–	–	50		MT2+ Gate+	50 ohms	−40°C	
		–	–	50		MT2– Gate–	50 ohms		
		–	–	50		MT2+ Gate–	25 ohms		
		–	–	50		MT2– Gate+	25 ohms		
D.C. Gate Trigger Voltage	V_{GT}				Vdc	V_D = 12 Vdc			1
						Trigger Mode	R_L	T_C	
		–	–	2.0		MT2+ Gate+	100 ohms	+25°C	
		–	–	2.0		MT2– Gate–	100 ohms		
		–	–	2.0		MT2+ Gate–	50 ohms		
		–	–	2.0		MT2– Gate+	50 ohms		
		–	–	3.0		MT2+ Gate+	50 ohms	−40°C	
		–	–	3.0		MT2– Gate–	50 ohms		
		–	–	3.0		MT2+ Gate–	25 ohms		
		–	–	3.0		MT2– Gate+	25 ohms		

TABLE IV—400 HZ OPERATION TYPE

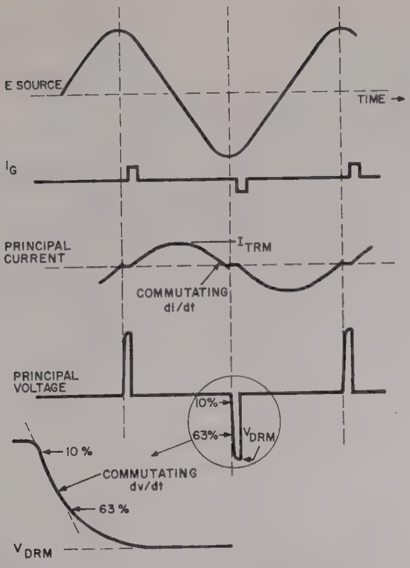
NOTE: ALL STANDARD CHARACTERISTICS APPLY EXCEPT AS INDICATED

CHARACTERISTICS							Reference Note
Test	**Symbol**	**Min.**	**Typ.**	**Max.**	**Units**	**Test Conditions**	
Critical Rate of Rise of Commutating Off-State Voltage (Commutating dv/dt)	dv/dt(c)	4.0	–	–	Volts/μsec	T_C = +84°C (+78°C for isolated stud type), $I_{T(RMS)}$ = Rated Max. Allowable RMS On-State Current V_{DRM} = Rated Maximum Allowable Peak off-state Voltage Gate Open Circuited Commutating di/dt = 54 A/msec	2

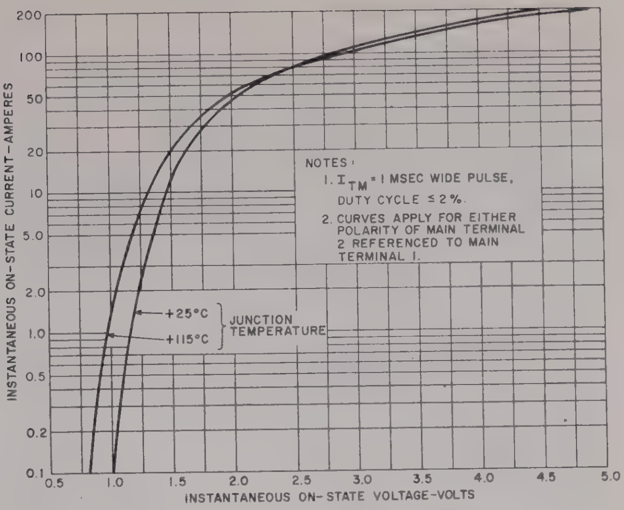
NOTES

1 Main terminal 1 is the reference terminal for main terminal 2 and gate terminal.

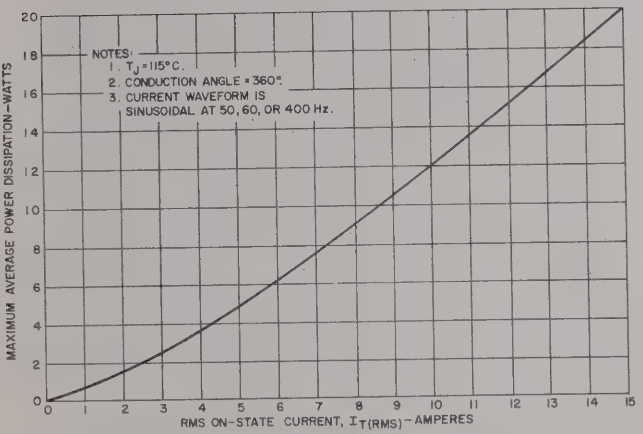
2 Values apply for either polarity of main terminal 2 characteristic referenced to main terminal 1.


E SOURCE
TIME →
I_G
PRINCIPAL CURRENT
I_{TRM}
COMMUTATING di/dt
PRINCIPAL VOLTAGE
10%
63%
V_{DRM}
10 %
COMMUTATING dv/dt
63 %
V_{DRM}

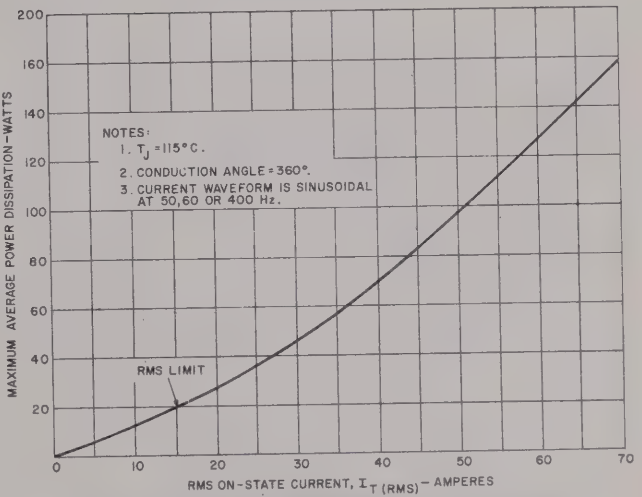
1. Waveform of Commutating dv/dt



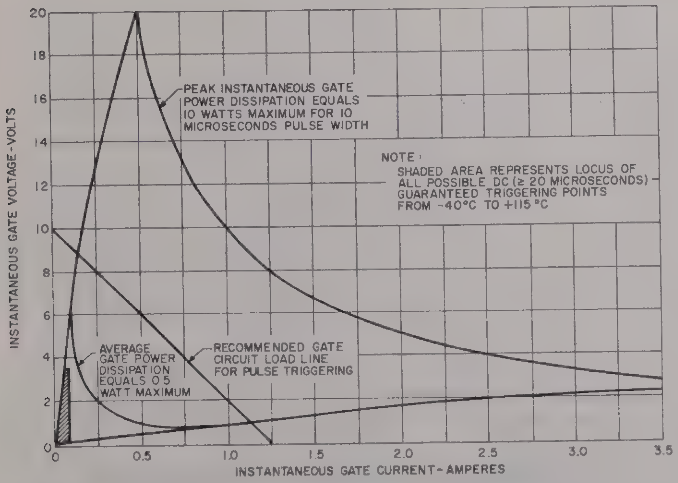
2. Maximum On-State Voltage vs. On-State Current



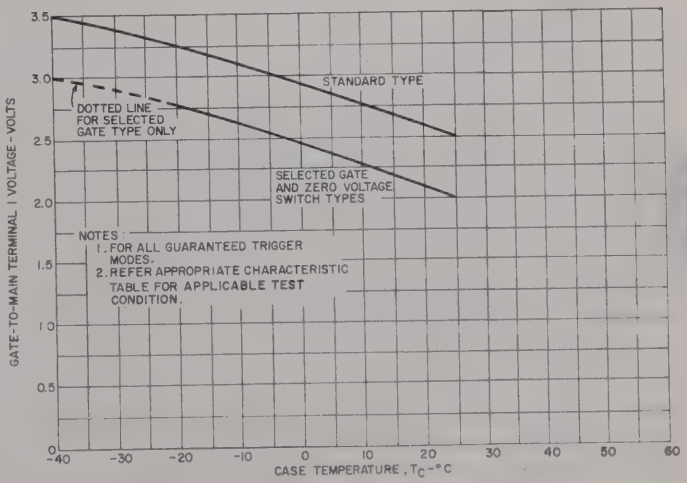
3. Maximum Average Power Dissipation vs. RMS On-State Current



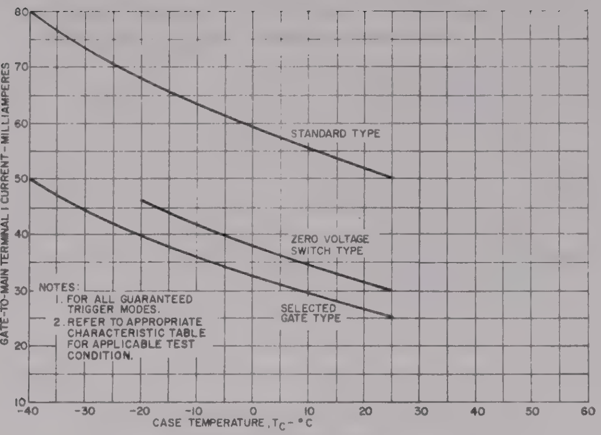
4. Maximum Average Power Dissipation vs. RMS On-State Current (High Level)



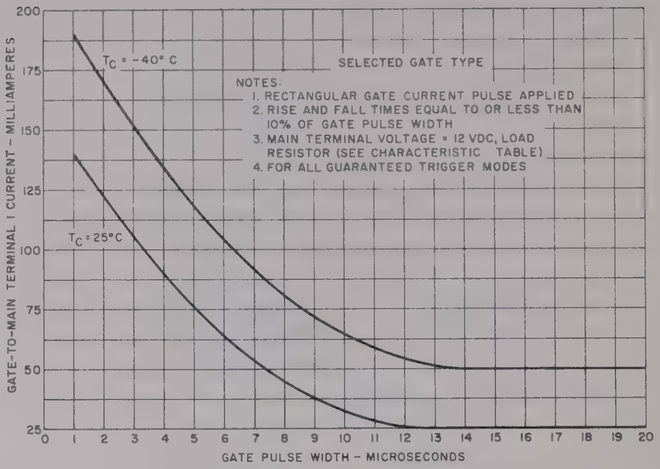
5. Gate Characteristics and Ratings



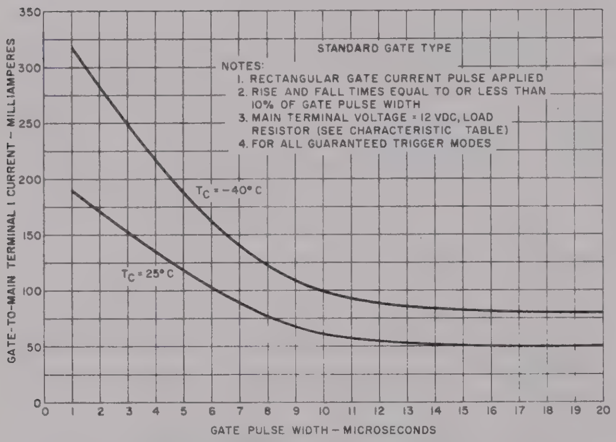
6. Maximum DC Gate Trigger Voltage vs. Case Temperature



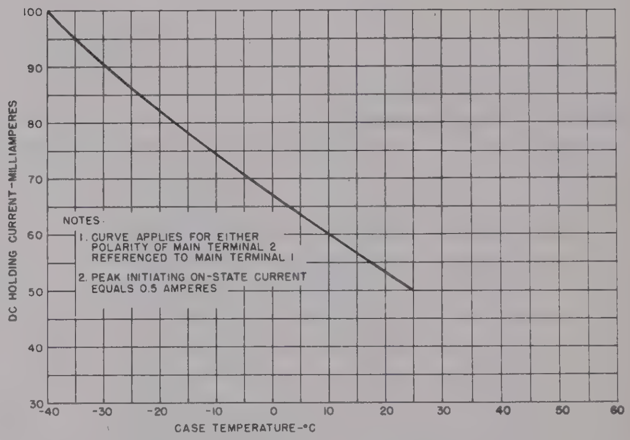
7. Maximum DC Gate Trigger Current vs. Case Temperature



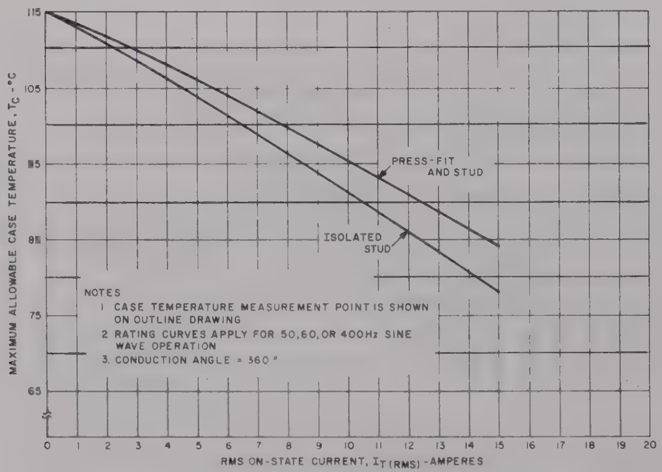
8. Maximum Gate Trigger Current vs. Gate Pulse Width (Selected Gate Type)



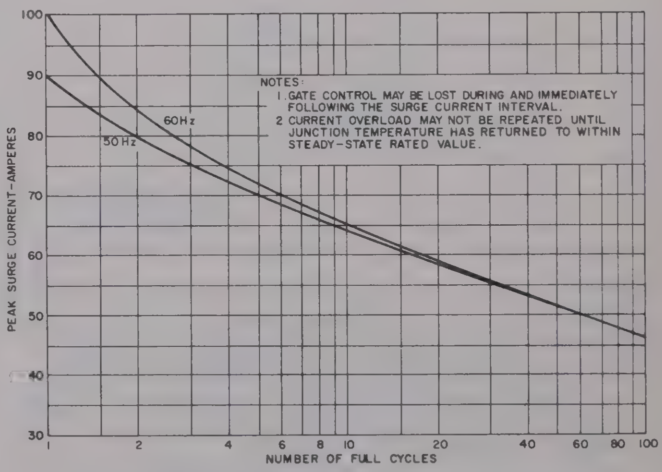
9. Maximum Gate Trigger Current vs. Gate Pulse Width (Standard Gate Type)



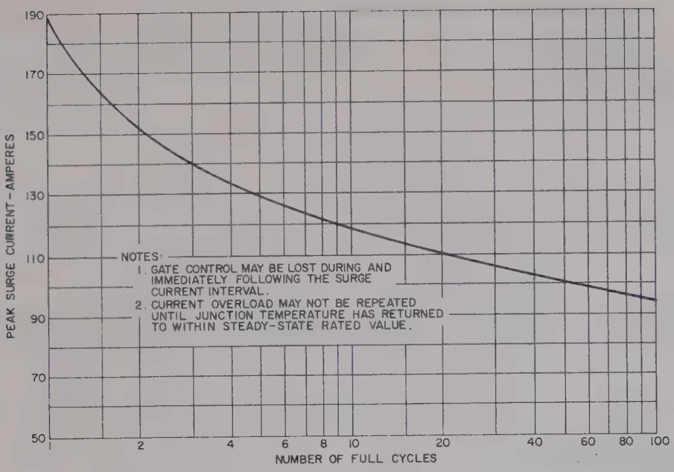
10. Maximum DC Holding Current vs. Case Temperature



11. Maximum Allowable Case Temperature vs. RMS On-State Current

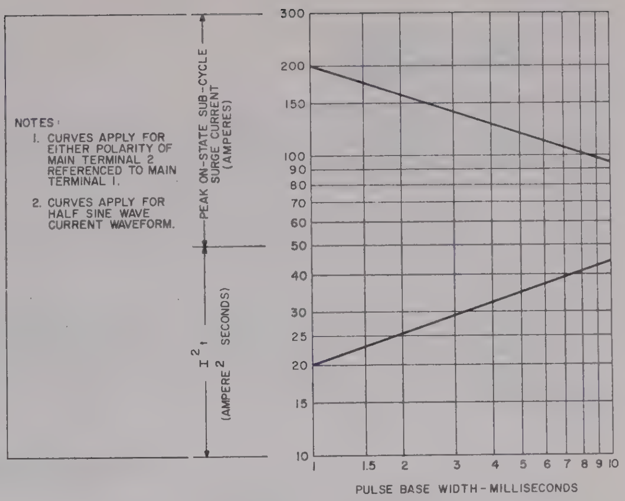


12. Maximum Allowable Full Cycle Surge Current Following Rated Load Conditions



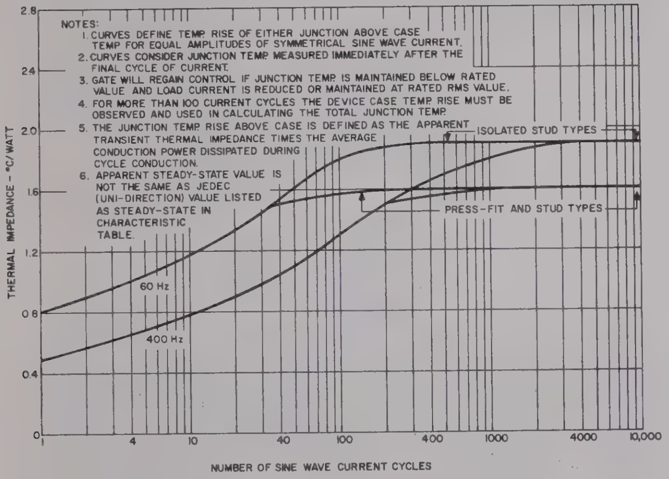
NOTES:
1. GATE CONTROL MAY BE LOST DURING AND IMMEDIATELY FOLLOWING THE SURGE CURRENT INTERVAL.
2. CURRENT OVERLOAD MAY NOT BE REPEATED UNTIL JUNCTION TEMPERATURE HAS RETURNED TO WITHIN STEADY-STATE RATED VALUE.

13. Maximum Allowable Full Cycle Surge Current Following Rated Load Conditions (400 Hz)



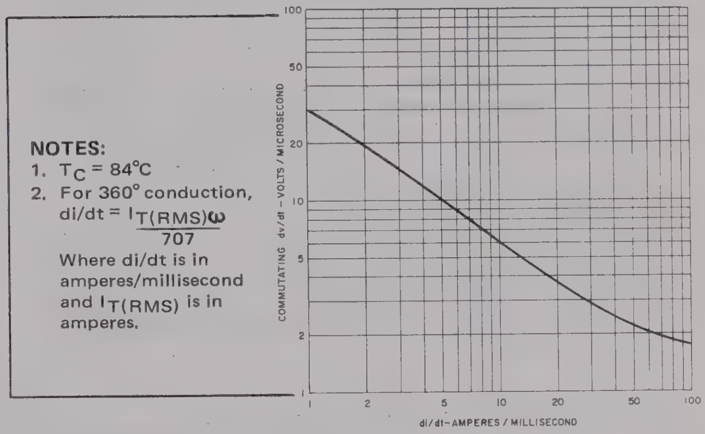
NOTES:
1. CURVES APPLY FOR EITHER POLARITY OF MAIN TERMINAL 2 REFERENCED TO MAIN TERMINAL 1.
2. CURVES APPLY FOR HALF SINE WAVE CURRENT WAVEFORM.

14. Sub-Cycle Surge and I^2t Ratings Following Rated Load Conditions



NOTES:
1. CURVES DEFINE TEMP. RISE OF EITHER JUNCTION ABOVE CASE TEMP FOR EQUAL AMPLITUDES OF SYMMETRICAL SINE WAVE CURRENT.
2. CURVES CONSIDER JUNCTION TEMP. MEASURED IMMEDIATELY AFTER THE FINAL CYCLE OF CURRENT.
3. GATE WILL REGAIN CONTROL IF JUNCTION TEMP. IS MAINTAINED BELOW RATED VALUE AND LOAD CURRENT IS REDUCED OR MAINTAINED AT RATED RMS VALUE.
4. FOR MORE THAN 100 CURRENT CYCLES THE DEVICE CASE TEMP. RISE MUST BE OBSERVED AND USED IN CALCULATING THE TOTAL JUNCTION TEMP.
5. THE JUNCTION TEMP. RISE ABOVE CASE IS DEFINED AS THE APPARENT TRANSIENT THERMAL IMPEDANCE TIMES THE AVERAGE CONDUCTION POWER DISSIPATED DURING CYCLE CONDUCTION.
6. APPARENT STEADY-STATE VALUE IS NOT THE SAME AS JEDEC (UNI-DIRECTION) VALUE LISTED AS STEADY-STATE IN CHARACTERISTIC TABLE.

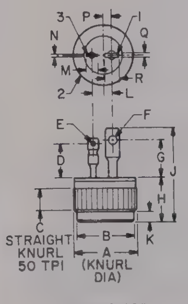
15. Maximum Apparent Transient Thermal Impedance



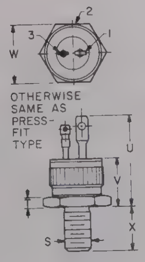
NOTES:
1. $T_C = 84°C$
2. For 360° conduction, $di/dt = \frac{I_{T(RMS)}\omega}{707}$
Where di/dt is in amperes/millisecond and $I_{T(RMS)}$ is in amperes.

16. Typical Rate of Removal of Current (di/dt) Effect Upon Commutating dv/dt

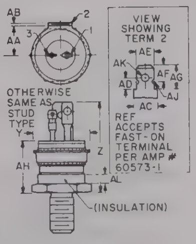
OUTLINE DRAWINGS



PRESS-FIT



STUD

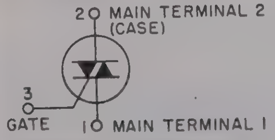

AB
2
3
1
AA
VIEW SHOWING TERM 2
AE
AK
AF
AG
AD
AJ
AC
REF ACCEPTS FAST-ON TERMINAL PER AMP # 60573-1
OTHERWISE SAME AS STUD TYPE
Y
Z
AH
AL
(INSULATION)

ISOLATED STUD

SYM	DECIMAL (INCHES) MIN.	DECIMAL (INCHES) MAX.	METRIC (MM) MIN.	METRIC (MM) MAX.
A	.501	.505	12.73	12.83
B	.467	.475	11.86	12.07
C	.177 REF.		4.50 REF.	
D	.260	.301	6.60	7.65
E	.035	.045	.89	1.14
F	.065	.075	1.65	1.41
G		.350		8.89
H	.340	.376	8.64	9.55
J		.782		19.86
K	.083	.097	2.11	2.46
L	.130	.180	3.30	4.57
M	.085	.115	2.16	2.92

SYM	DECIMAL (INCHES) MIN.	DECIMAL (INCHES) MAX.	METRIC (MM) MIN.	METRIC (MM) MAX.
N	.016	.023	.41	.58
P	.065 REF.		1.65 REF.	
Q	.028	.035	.71	.89
R	.110	.135	2.79	3.43
S	1/4-28 UNF2A		1/4-28 UNF2A	
T	.086	.098	2.18	2.49
U		.865		21.79
V		.475		12.07
W	.552	.562	14.02	14.27
X	.432	.442	10.97	11.23
Y	.580	.610	14.73	15.49

SYM	DECIMAL (INCHES) MIN.	DECIMAL (INCHES) MAX.	METRIC (MM) MIN.	METRIC (MM) MAX.
Z		.975		24.77
AA	290	.330	7.37	8.38
AB	.017	.024	.43	.61
AC	.235	.265	5.97	6.73
AD	.115	.121	2.29	3.07
AE	.186	.189	4.72	4.80
AF	.170 REF.		4.32 REF	
AG	.245	.255	6.22	6.48
AH		.585		14.86
AJ	.025	R-REF.	.64	R-REF.
AK	.065	.070	1.65	1.78
AL	.100	.110	2.54	2.79



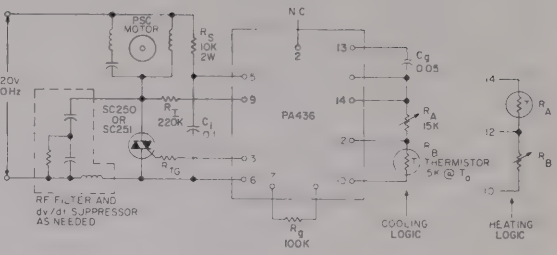
TERMINAL ARRANGEMENT

NOTES: (1)Case temperature is measured at the center of any hex flat or press-fit base.
(2)One ext. tooth lock washer and one nut (both steel, cad. plated) supplied with each stud and isolated stud unit.
(3)Insulation hardware for stud device consisting of terminal, 2 mica washers and one nlyon bushing available at extra cost upon request.

TYPICAL CIRCUIT

The circuit shown here is for controlling speed for a permanent-split capacitor fan motor in response to temperature. For a cooling fan application, R_B is a thermister having about 5000 ohms resistance at the desired operating temperature. R_A is made variable in order to select the temperature set-point for the control. When temperature increases, fan speed will increase to provide a greater cooling effect. In a heating application, such as a fan-and-coil room heater, the functions of R_A and R_B are reversed so that an increase in temperature will decrease fan speed to provide less heating effect.

This circuit will control the motor over the full range from zero to 100% speed; and usually requires a motor with ball bearings. When sleeve bearings are used, it is generally desirable to limit the minimum speed in order to properly maintain bearing lubrication. A low-speed limit may also be wanted in order to maintain a minimum level of air circulation.



MOUNTING CONSIDERATIONS*

Installation of Press-Fit Device in Heat Sink

When press fitting a Triac into a heatsink, the following specifications and recommendations apply:

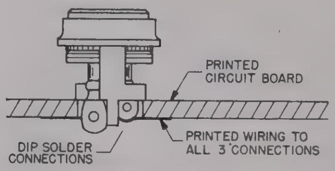
1. Heatsink materials may be copper, aluminum, or steel. For maximum heat transfer and minimum corrosion problems, copper is recommended. The heatsink thickness, or amount of heatsink wall, in contact with the Triac should be 1/8 inch.
2. The hole diameter into which the Triac is pressed must be 0.4975 ± .001 inch. A slight chamfer on the hole should be used. This hole may be punched in a flat plate and reamed, or extruded and sized in sheet metal.
3. The entire knurled section of the Triac should be in contact with the heatsink to insure maximum heat transfer. The Triac must not be inserted into a heatsink deeper than the knurl height.
4. The Triac insertion force must not exceed 800 pounds. If the insertion force approaches this value before complete insertion, either the Triac is misaligned with the hole or the Triac-to-hole interference is excessive. The insertion force must be uniformly applied to the top face (terminal end) of the Triac within an annular ring which has an inside diameter of not less than 0.370 inch and not larger than 0.390 inch; the outside diameter of the insertion force must not be less than 0.500 inch.
5. The thermal resistance between the Triac case and a copper heatsink will not exceed 0.5°C/W, if the Triac is inserted in the manner described.

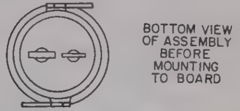
Soldering of Press-Fit Package to Heat Sink

The press-fit package may be soldered directly to a heatsink using 60/40 (Pb-Sn) solder at a temperature of about 200°C.

Attachment of Press-Fit Device to Printed Circuit Board

For certain light load applications, the Triac can be inverted and, using a special brass bracket (A7149451), dip-soldered into a printed circuit board. The feet on the bracket act both as a mechanical support and Main Terminal 2 (case) electrical connection. For Triacs preassembled into the bracket, add −X24 to the type number, for example, SC251BX24.





Attachment of the Stud & Isolated Stud Device To a Heat Sink

These devices require certain precautions in order to insure good thermal transfer. The chassis hole must be drilled and deburred, and should be between .005 and .015 inches larger than the stud outside diameter. The use of a Torque wrench is highly recommended and must be used within the torque limits indicated on page 2. A good grade of silicone grease will minimize contact thermal resistance.

---

*A more detailed discussion may be found in the General Electric SCR Manual, 4th Edition (1967), Chapter 17, "Cooling the Power Semiconductor."

OTHER TRIAC AND APPLICATION INFORMATION AVAILABLE FROM GENERAL ELECTRIC

Publication Number		
	Specification Sheets	
85.31	**PA436**	(Phase Control Integrated Circuit)
175.19	**SC35/36**	(3 Amp)
175.25	**SC40/41**	(6 Amp)
175.26	**SC45/46**	(10 Amp)
175.21	**SC60/61**	(25 Amp)
175.15	**SC141/146**	(6, 10 Amp in plastic package)
175.27	**SC50/51**	(15 Amp)
175.16	**SC240/241**	(6 Amp)
175.17	**SC245/246**	(10 Amp)
	Reliability Reports	
95.25	Glassivated Triac Reliability Report	

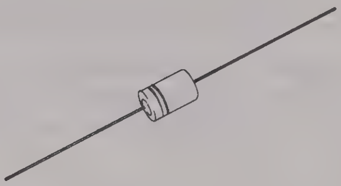
Publication Number	
	Application Notes
200.32	A Variety of Mounting Techniques for Press Fit Devices
200.35	Using the Triac for Control of AC Power
200.45	Temperature Controls Incorporating Zero Voltage Switching
200.51	Better Room Conditioning Via Solid State Controls
200.53	Solid State Incandescent Lighting Controls
201.19	RF Filter Considerations for Triac & SCR Circuits
201.20	Proportional Zero Voltage Switching Temperature Control
201.22	Low Power Zero Voltage Switching Using the PA424
200.58	Solid State Electric Heating Controls

Also, individual specifications are listed in publication number 450.52 —Semiconductor Specifications Index. All of these referred to may be ordered by publication number from General Electric Company, Distribution Services, Bldg. 6-208, Schenectady, New York 12305.

Silicon Diodes

SSD708

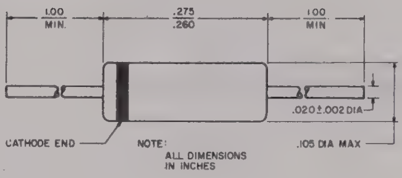
The General Electric type SSD708 is a very low leakage diode for general application. This diode incorporates an oxide passivated planar structure built in a high resistivity epitaxial layer grown on a low resistivity silicon substrate. This structure makes possible a diode having high conductance, low leakage, and low capacitance, combined with improved uniformity and reliability. Type SSD708 is housed in a standard glass diode DO-7 package.



absolute maximum ratings: (25°C) (unless otherwise specified)

Current	
Average Rectified	75 mA
Forward Steady-State DC	50 mA
Recurrent Peak Forward	225 mA
Peak Forward Surge (1.0 μsec pulse)	2000 mA
Power	
Dissipation (25°C)*	250 mW
Temperature	
Operating	−65 to +175°C
Storage	−65 to +200°C

*Derate 1.43 mW/°C above 25°C based on $T_J = 200$°C.



electrical characteristics: (25°C) (unless otherwise specified)

		Min.	Max.	
Forward Voltage	V_F			
$I_F = 10\ \mu A$		0.520	0.620	Volt
$I_F = 100\ \mu A$		0.610	0.700	Volt
$I_F = 1.0$ mA		0.700	0.790	Volt
$I_F = 10$ mA		0.790	0.890	Volt
$I_F = 50$ mA		0.875	1.000	Volt
$I_F = 100$ mA (Note 1)		0.930	1.100	Volt
Reverse Current	I_R			
$V_R = 20$ Volts			20	pA
$V_R = 20$ Volts, $T_A = 150$°C			100	nA
Breakdown Voltage	B_V			
$I_R = 5\ \mu A$		40		Volts
Capacitance	C_O			
$V_R = 0$ Volts (Note 2)			4	pF

Notes: 1. Pulsed measurement (pulse width $\leq 300\ \mu$sec, Duty Cycle $\leq 2\%$)
2. Capacitance as measured on Boonton Model 75A, capacitance bridge at a signal level of 50 mV and a frequency of 1MHz.

Silicon Diode

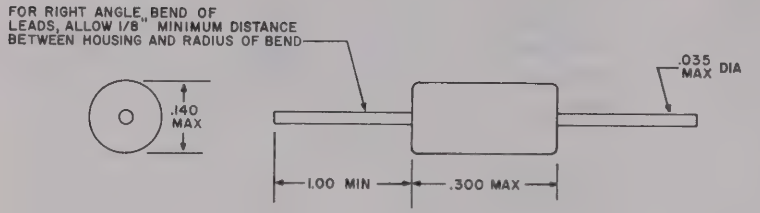
ST2

AC SWITCH

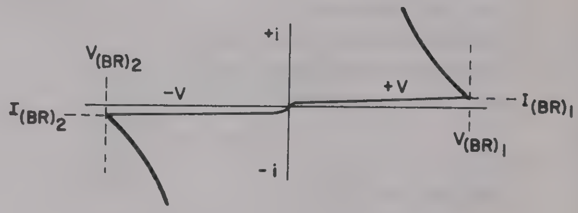
The DIAC is diffused silicon bi-directinal trigger diode which may be used to trigger the G-E TRIAC or Silicon Controlled Rectifiers. This device has a three-layer structure having negative resistance switching characteristics for both directions of applied voltage.

The DIAC is a diffused silicon bi-directional trigger diode which may be used to trigger the G-E TRIAC or Silicon Controlled Rectifiers. This device has a three-layer structure having negative resistance switching characteristics for both directions of applied voltage.

OUTLINE DRAWING


FOR RIGHT ANGLE BEND OF LEADS, ALLOW 1/8" MINIMUM DISTANCE BETWEEN HOUSING AND RADIUS OF BEND
.035 MAX DIA
.140 MAX
1.00 MIN
.300 MAX

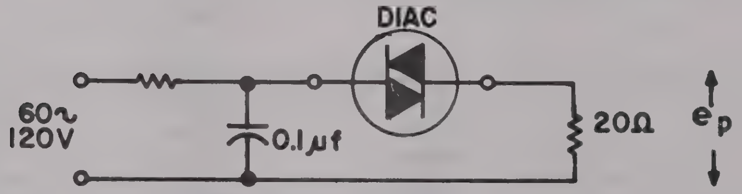
VOLT - AMPERE CHARACTERISTICS



RATINGS at 50°C Ambient

Peak Current (10 μsec duration, 120 cycle repetition rate)	I_p	±2	Amperes Max.
Peak Output Voltage *	e_p	±3	Volts Min.

* CIRCUIT FOR PEAK OUTPUT VOLTAGE TEST



CHARACTERISTICS at 25°C Ambient

Test	Symbols	Min.	Typ.	Max.	Units
Breakover Voltage	$V_{(BR)_1}$ and $V_{(BR)_2}$	28	32	36	Volts
Breakover Voltage Temp. Coefficient		--	0.1	---	%/°C
Breakover Currents	$I_{(BR)_1}$ and $I_{(BR)_2}$	-- --	--- ---	200	μamp
Breakover Voltage Symmetry	<——— $V_{(BR)_1} = V_{(BR)_2} \pm 10\% \; V_{(BR)_2}$ ———>				

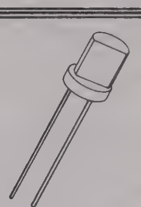
It should be recognized that the General Electric ST2 is a developmental device and that Ratings and Characteristics listed above are typical of the device at the time this specification sheet is issued. The General Electric Company reserves the right to make any changes in specifications which in the Company's opinion are required to improve the device or make it more adaptable.

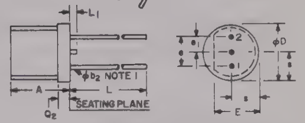
Silicon
Asymmetrical AC Trigger

ST4

The ST4 is an asymmetrical AC trigger integrated circuit for use in triac phase controls. This device greatly reduces the snap-on effects that are present in symmetrical trigger circuits and minimizes control circuit hysteresis. This performance is possible with a single RC time constant, whereas a symmetrical circuit of comparable performance would require at least three additional passive components.

The ST4 is available in a two leaded TO98 type in-line epoxy package.





SYMBOL	INCHES		MILLIMETERS	
	MIN	MAX.	MIN	MAX
A	.170	265	4 32	6 73
ϕb_2	.016	019	406	.483
ϕD	165	205	4 19	5 21
E	.110	.155	2 79	3.94
e	.095	.105	2.41	2.67
e_1	045	055	1 14	1 40
L	500		12 70	
Q_2	055	075	1 40	1.90
s	.080	.115	2.03	2 92
L_1	031	094	794	2 38

NOTE 1: LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN 070 AND 250 FROM THE SEATING PLANE BETWEEN 250 AND END OF LEAD A MAX OF .021 IS HELD

FEATURES

- Reduces Circuit Complexity (Minimum Parts Count)
- Hysteresis–Free Control
- Low Switching Current (80μA)
- Wide Range of Control
- Low Cost Packaging

PERFORMANCE

A typical triac phase-control circuit is shown in figure 1 along with the symmetrical trigger characteristics.

Its main disadvantage is the snap-on hysteresis exhibited in figure 2.

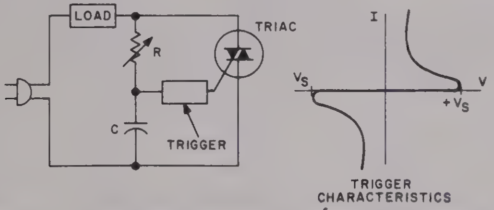


Figure 1. Typical triac phase-control circuit with hysteresis.

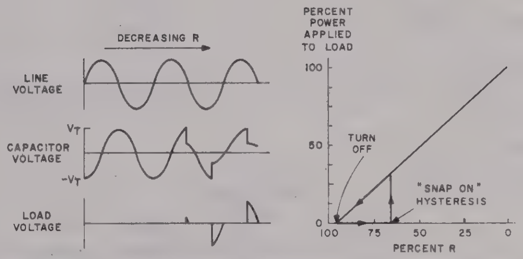


Figure 2. Typical waveforms illustrating hysteresis effect.

Using a lamp dimmer as an example, the light "snaps on" to moderate brightness, although a gradual increase in brightness is both expected and desired. During each half-cycle of AC voltage, the capacitor C is charged through the resistor R and while the trigger is not firing, the capacitor voltage lags line voltage by approximately 90°. However, once the trigger device fires, the capacitor voltage drops as it is discharged into the triac gate. During the next half-cycle, the capacitor voltage will now exceed the breakover voltage sooner since it started charging from a lower voltage. This action results in a large step in the transfer function of figure 2. This snap-on effect can be eliminated with additional circuit components, usually 2 resistors and a capacitor.

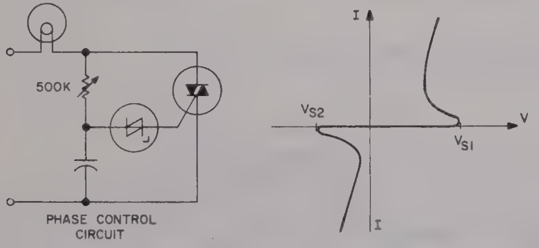


Figure 3. Typical triac phase-control circuit with an asymmetrical switch.

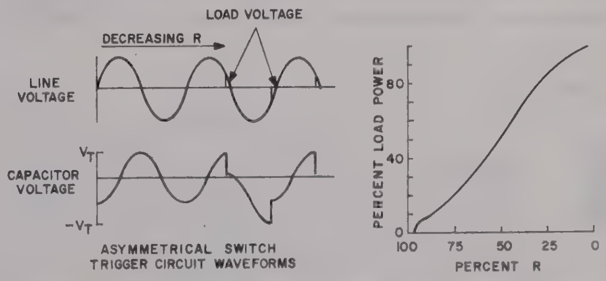


Figure 4. Hysteresis-free, cost-optimized, circuit performance.

A superior and more economical way to eliminate this hysteresis is to use the ST4 trigger device. The ST4 is constructed such that when the device triggers for the first time, the triggering voltage on the next half-cycle is equal to the original breakover voltage plus the voltage decrease due to the capacitor discharge into the triac gate. This allows the capacitor voltage to maintain the same time relationship with line voltage and thus the same firing angle. These concepts are shown graphically in figures 3 and 4.

Further discussion of hysteresis, device operation, and light dimming can be found in:

1. *GE SCR Manual,* chapters 7 & 9. **2.** 200.35 *Using the Triac for the Control of AC Power.* **3.** 200.53 *Solid State Incandescent Lighting Control.*

absolute maximum ratings: (25℃)

CURRENT

I_{21} Continuous	200 ma
I_{21} Pulsed (PW = 2μs, Duty Cycle ≤ 10%)	500 ma
I_{12} Pulsed (PW = 2μs, Duty Cycle ≤ 10%)	175 ma

POWER

Total Average*	350 mW

*Derate power 3.5 mW/℃ above 25℃

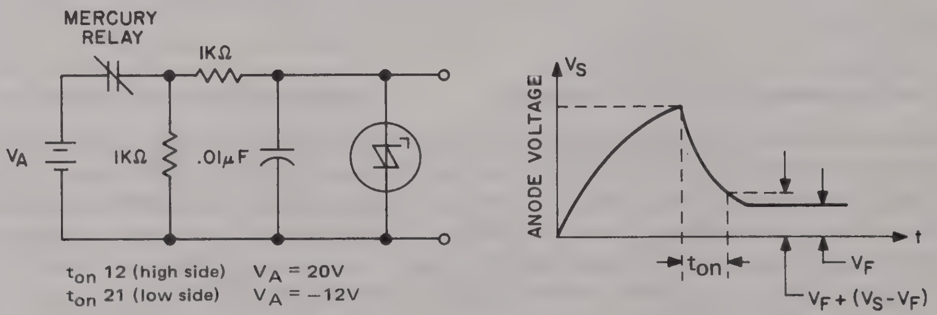
TEMPERATURE

Operating junction temperature range	−55℃ to +125℃
Storage temperature range	−55℃ to +150℃
Lead temperature (during soldering) at distance ≥ 1/16 ins. (1.59 mm) from case for 10 sec. max.	260℃

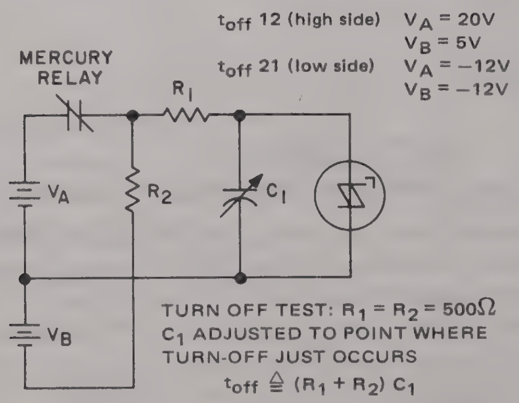
electrical characteristics: (25℃)

Test	Symbol	Min.	Max.	Units	Test Conditions
Switching Voltage	V_{S1}	14	18	Volts	
	V_{S2}	7	9	Volts	
Switching Current	I_{S1}, I_{S2}	–	80	μA	
	I_{S1}, I_{S2}	–	160	μA	$T_A = -55$℃
Voltage Drop	V_{F1}	7	10	Volts	$I_{12} = 100$ mA
	V_{F2}	–	1.6	Volts	$I_{21} = 100$ mA
Off-State Current	I_{12}	–	100	nA	$V_{12} = 10$ Volts
	I_{21}	–	100	nA	$V_{21} = 5$ Volts
Switching Voltage Temperature Coefficient	T.C.	–	.05	%/°C	$T_J = -55$°C to +125℃
Turn-on Time	t_{on}	--	1	μsec	See Circuit 1
Turn-off Time	t_{off}	–	30	μsec	See Circuit 2
Output Pulse	V_o	3.5	–	Volts	See Circuit 3

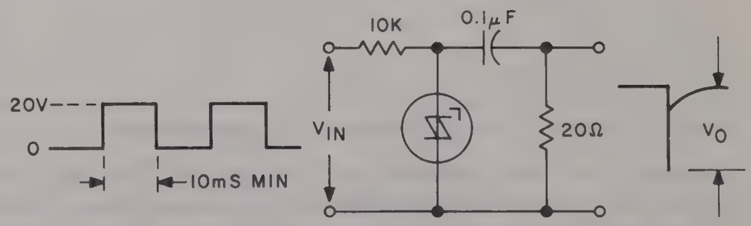
Circuit 1
Turn-on Time, t_{on}

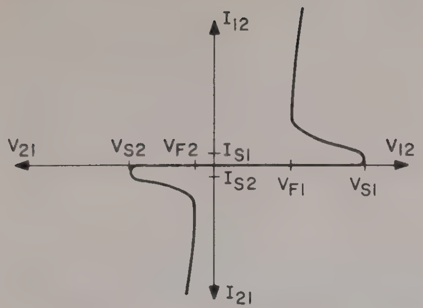

MERCURY RELAY
IKΩ
VA
IKΩ
.01μF
ton 12 (high side) VA = 20V
ton 21 (low side) VA = −12V
VS
ANODE VOLTAGE
t
ton
VF
VF + (VS−VF)

Circuit 2
Turn-off Time, t_{off}


toff 12 (high side) VA = 20V
VB = 5V
toff 21 (low side) VA = −12V
VB = −12V
MERCURY RELAY
R1
VA
R2
C1
VB
TURN OFF TEST: R1 = R2 = 500Ω
C1 ADJUSTED TO POINT WHERE
TURN-OFF JUST OCCURS
toff ≙ (R1 + R2) C1

Circuit 3
Peak Pulse Amplitude, V_o (Both Directions)


20V
0
10mS MIN
VIN
10K
0.1μF
20Ω
VO



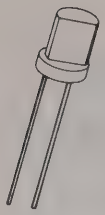


FIGURE 5. ST4 ELECTRICAL CHARACTERISTICS

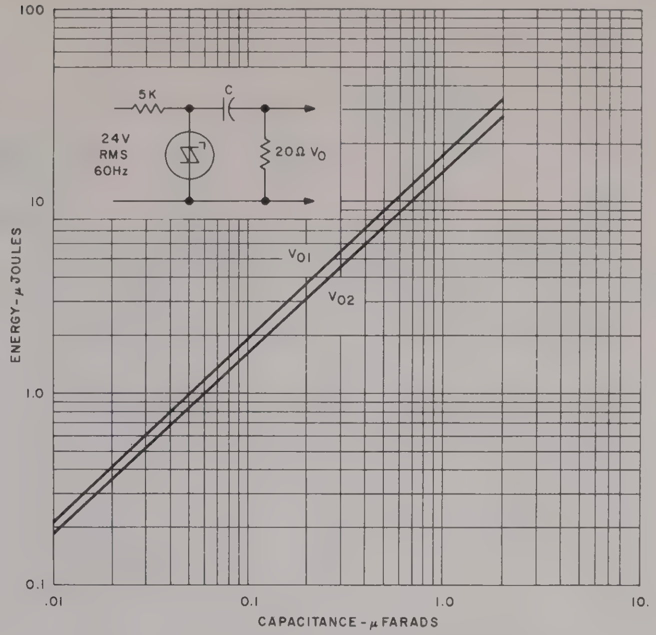


FIGURE 6. CAPACITIVE DISCHARGE ENERGY (PER PULSE) VS. CAPACITANCE (TYPICAL)

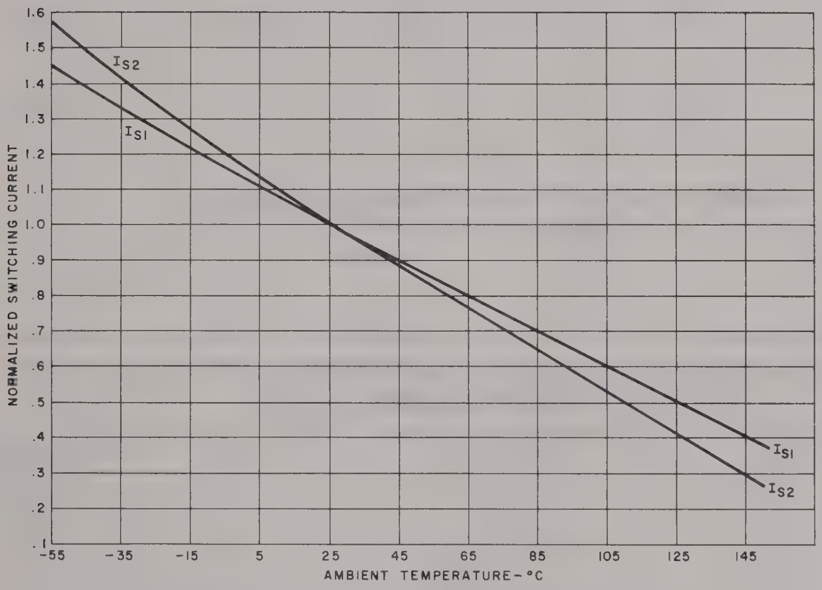


FIGURE 7. SWITCHING CURRENT VARIATION WITH TEMPERATURE (TYPICAL)

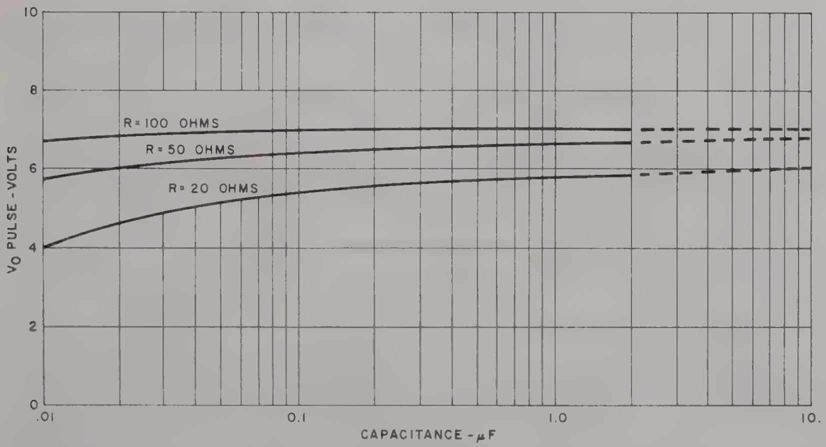


FIGURE 8. OUTPUT PULSE (EITHER DIRECTION) AS A FUNCTION OF LOAD RESISTANCE AND CHARGING CAPACITANCE (TYPICAL)

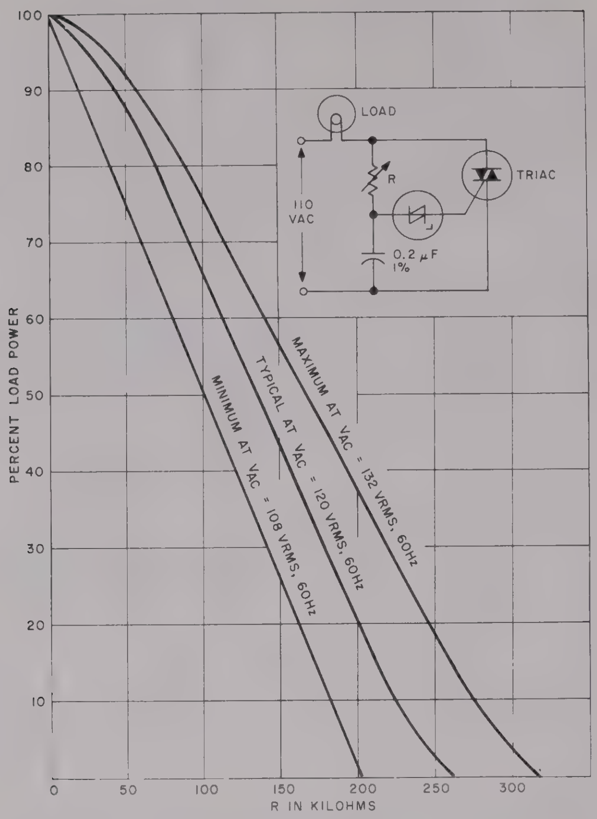


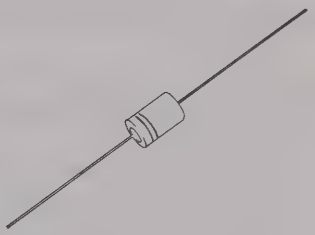
FIGURE 9. OUTPUT POWER TO LOAD VS. CONTROL RESISTOR VALUE (25°C)

USE THE ST4 ASYMMETRICAL AC TRIGGER WITH A TRIAC SELECTED FROM GE'S COMPREHENSIVE LINE.		
Current Rating	**GE Type**	**Specification Sheet No.**
3A	SC35/36	175.24
6A	SC40/41	175.25
6A	SC240/241	175.16
6/10A	SC141/146	175.15
10A	SC45/46	175.26
10A	SC245/246	175.17
15A	SC50/51	175.27
15A	SC250/251	175.18
25A	SC60/61	175.21

Silicon
Diodes
STABISTORS

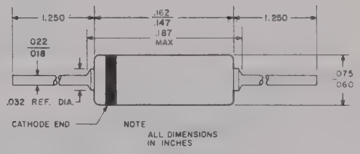
• to wear or

These low-cost General Electric Stabistors are multi-pellet diodes which have a tightly controlled conductance at $I_F = 10mA$. They consist of 2, 3, or 4 planar passivated epitaxial diode pellets in series, mounted in a subminiature double-heatsink package. The STB567, STB568, and STB569 are examples of such diodes with 2, 3, and 4 pellets respectively. These diodes can be used as low voltage regulator diodes or to maintain a bias on the output transistor of push-pull amplifiers. Multi-Pellet Stabistors maintain LINEAR temperature response (in millivolts per degree C) over the ambient temperature range of −55°C to +175°C. Nominal change in voltage for the STB567, STB568, and STB569 is 4mV, 6mV, and 8mV respectively for each degree C change in ambient temperature.

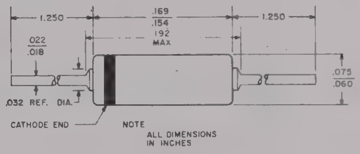


absolute maximum ratings: (25°C) (unless otherwise specified)

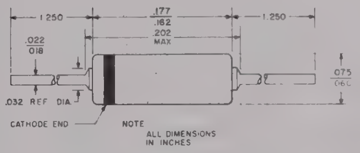
Voltage		
Reverse (continuous)	12	volts
Power		
Dissipation	400	mW
(Derate: 2.67 mW/°C for Ambient Temperature above 25°C)		
Temperature		
Operating	−65 to +175	°C
Storage	−65 to +200	°C
Lead (1/16 ± 1/32 inch from case for 10 sec)	300	°C


1.250
.162
.147
.187
MAX
1.250
022
018
.075
060
.032 REF. DIA.
CATHODE END
NOTE
ALL DIMENSIONS
IN INCHES

STB567


1.250
.169
.154
192
MAX
1.250
022
.018
.075
.060
.032 REF. DIA.
CATHODE END
NOTE
ALL DIMENSIONS
IN INCHES

STB568


1.250
.177
.162
.202
MAX
1.250
.022
018
075
060
.032 REF DIA.
CATHODE END
NOTE
ALL DIMENSIONS
IN INCHES

STB569

NOTES

1. ALL DIMENSIONS ARE IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

electrical characteristics: (25°C) (unless otherwise specified)

	STB567		STB568		STB569		
	Min.	Max.	Min.	Max.	Min.	Max.	
Forward Voltage*							
$I_F = 10mA$	1.31	1.61	2.09	2.31	2.72	3.01	Volts
Breakdown Voltage							
$I_R = 5\mu A$	12		12		12		Volts

***Forward Voltage Tolerances:**

STB567	1.46 ± 10%
STB568	2.20 ± 5%
STB569	2.87 ± 5%

TB567,8,9

Press Pak
Mounting Clamp

SERIES 1000

the Series 1000, Press Pak, Mounting Clamp
ɔling of the ½" GE Press Pak's.

of this clamp:

- *Hardened Steel pivot* insuring *constant pressure* in rugged applications over long periods.
- One-piece phenolic insulator gives added 1/2" creep distance.
- Use of special *Force Indicator Gauge eliminates* need for torque wrenches, inaccurate "flex" gauges, and *guesswork.*
- Various bolt lengths available to accommodate most mounting situations.
- No loose parts to complicate assembly.
- Stiffening *brace* to reinforce heat sink available upon request.
- Single-side cooling terminal available upon request.
- Positive, non-binding swivel action.

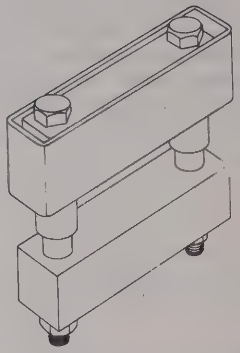
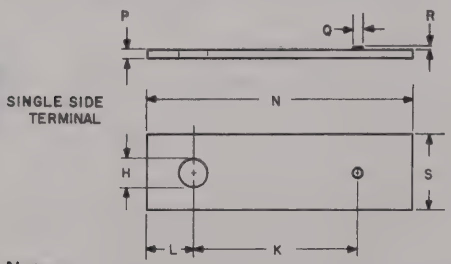
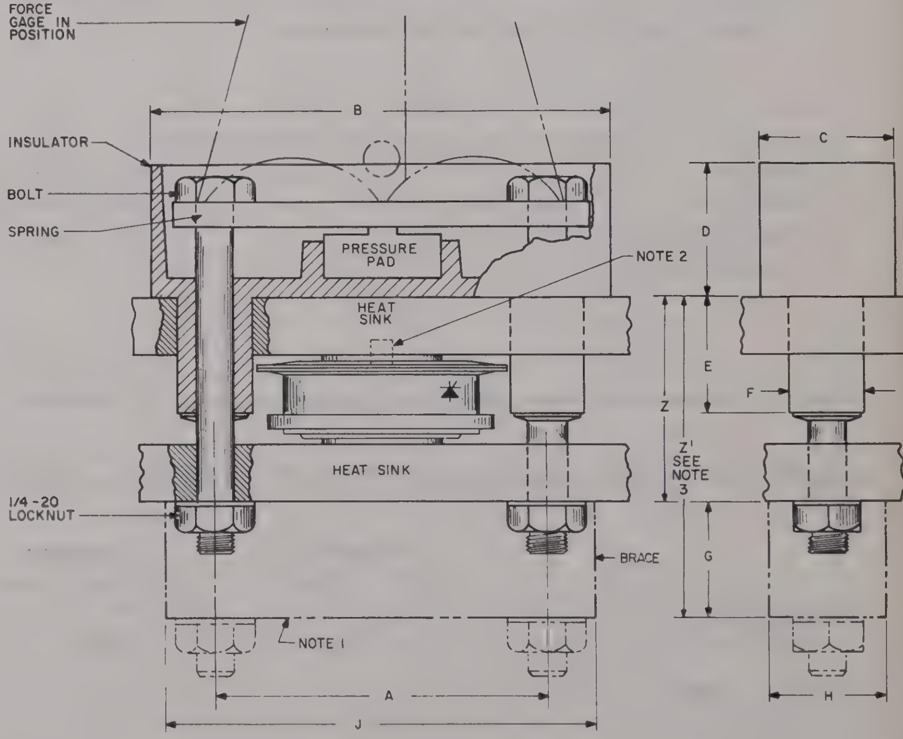


TABLE I DIMENSIONS

	INCHES		MM	
DIM.	MIN.	MAX.	MIN.	MAX.
A	2.115	2.135	53.72	54.23
B	2.935	2.965	74.54	75.31
C	.865	.885	21.97	22.48
D	.825	.855	20.95	21.72
E	.730	.770	18.54	19.56
F	.460	.480	11.68	12.19
G	.735	.765	18.66	19.43
H	.735	.765	18.66	19.43
J	2.710	2.790	68.83	70.87
K	2.177	2.197	55.30	55.79
L	.605	.645	15.37	16.37
M	.380	.392	9.66	9.95
N	3.480	3.520	88.40	89.40
P	.090	.095	2.29	2.40
Q	.125	.135	3.18	3.42
R	.025	.035	.64	.88
S	.980	1.020	24.90	25.90



OUTLINE DRAWING



Notes:

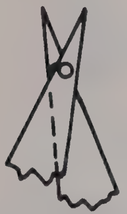
1. The back up brace should be used when the mounting web of the heatsink is not sufficiently thick to prevent the heatsink from bending when the clamp is tightened. Extruded aluminum heatsinks with mounting webs less than 1/4 require this brace.
2. The semiconductor device to be mounted must be positively located in the center of the clamp. A 1/8 diameter by 1/4 long grooved or spring pin is recommended for locating the device. Use a #30 drill (.1285 diameter) for the hole in the heatsink.
3. When using brace add 3/4" to required "Z" dimension to accommodate brace thickness.
4. Minimum heatsink web thickness should be 5/16" to insure positive pressure.

MOUNTING PROCEDURE

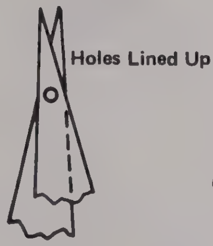
With the semiconductor positively located in place on the heatsink(s) (refer to Note 1 of Table I), place the clamp in position with the bolts through the holes in the heatsink(s), and proceed as follows:

1. Refer to Device Specification Sheet for Preparation of Mounting Surface.
2. Tighten the nuts evenly until finger tight.
3. Tighten each bolt ½ turn, using a 7/16 socket wrench on the bolt heads.
4. Place the Force Indicator Gauge firmly against the springs, as shown on the Outline Drawing, so that both ends and the middle are in solid contact with the springs. The holes of the gauge will then indicate the spring deflection, or force; correct mounting force is indicated when the holes coincide.

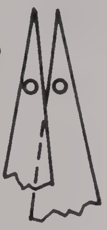
Examples:



Less then rated force. Tighten nuts alternately ¼ turn at a time until points coincide.



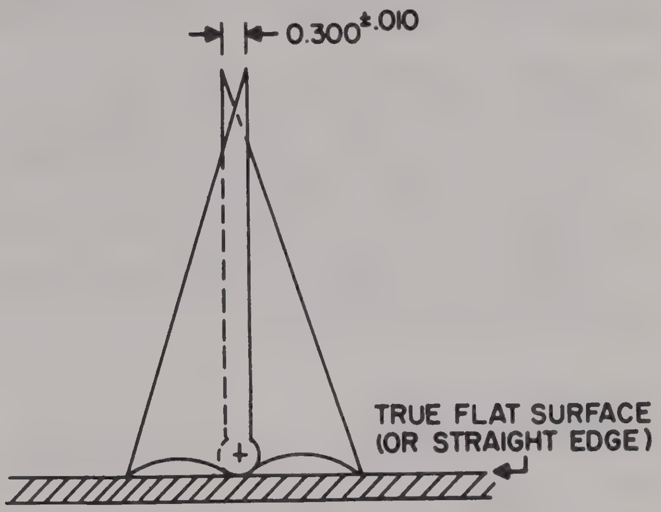
Correct force.



Excessive force. Loosen nuts and start over. *NEVER* try to adjust spring force by backing off the nuts, spring friction will produce false readings. Always start at Step 1.

To Calibrate Force Gauge:

If the gauge is suspected of being out of calibration due to wear or damage, check it on a flat surface as shown below.



If the points are not 0.300 ± .010 apart, calibrate the gauge by filing the bottom contact points.

ORDERING INSTRUCTIONS

In order to select the proper clamp for a given application, it is necessary to know three mounting parameters:

- The correct force necessary to mount the semiconductor device.
- The length of the bolts necessary to span dimension "Z".
- The capability of the sink to withstand the mounting force without bending (refer to Note 1 of Table I)

Knowing these parameters, the proper clamp may be selected from Table II.

TABLE II – CLAMP SELECTION CHART

GE Device Type[4]	# Springs	Recommended Mounting Force (lbs)	Clamp Force (lbs.)	Allowable "Z"[1] Dimension (inches)	Bolt Length (inches)	Order Number[2,3]
C350, C354 C355, C358 C380, C385 A390, A396	1	700-900	700-900	.800-1.175	2.00	HW1000G101
				.900-1.425	2.25	HW1000G102
				1.150-1.675	2.50	HW1000G103
				1.250-1.925	2.75	HW1000G104
				1.500-2.175	3.00	HW1000G105

Phenolic temperature beyond 125°C and spring temperature above 110°C is not permissible.

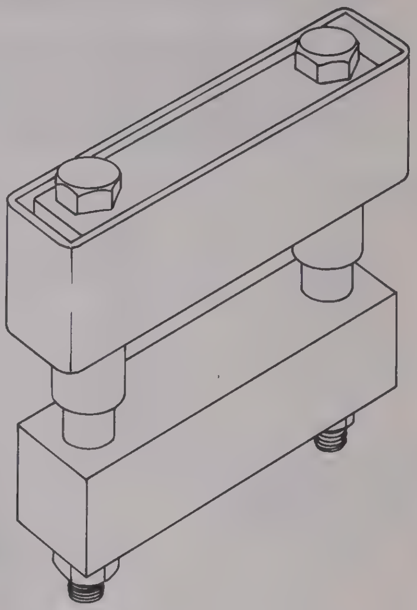
Minimum heatsink web thickness should be 5/16" to insure positive pressure.

1. Refer to Outline Drawing and to Note 3 of Table I for determination of "Z" dimension.
2. If a brace is required, add suffix "B" to the order number, e.g. HW1000G101B.
3. If a terminal is required (used with single side cooling), add the letter "T" to the order number, e.g. HW1000G101BT.
4. All group numbers or bolt lengths can be used with any device types.

Press Pak
Mounting Clamp

SERIES 2500

The General Electric Company now offers the Series 2500, Press Pak, mounting clamp designed to facilitate single-, or double-side cooling of all GE Press Pak's.

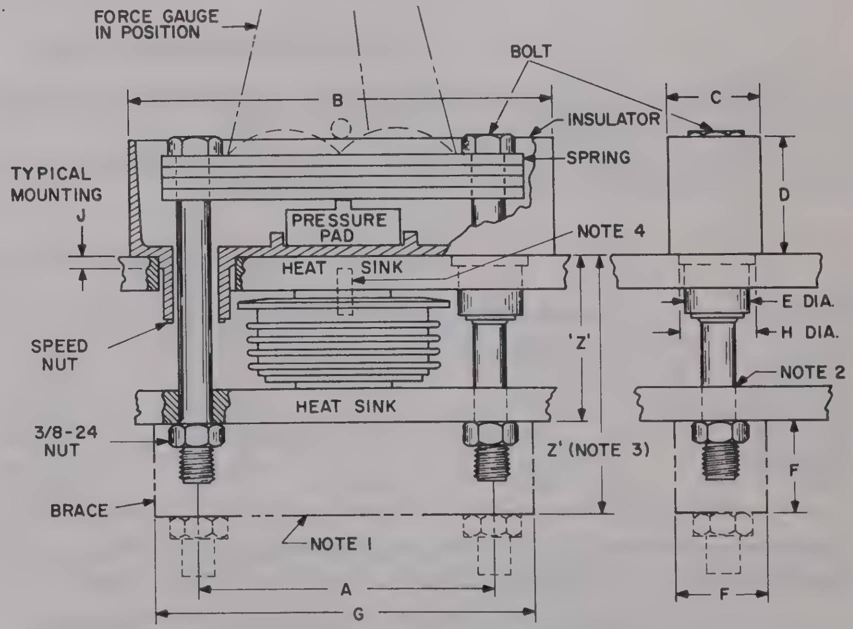


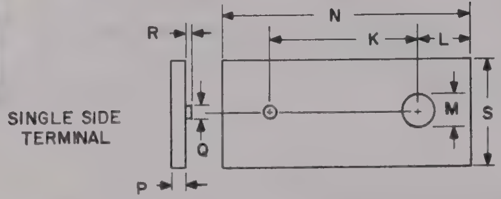
Special features of this clamp:

- Metal pivot insuring constant pressure in rugged applications over long periods.
- One-piece phenolic insulator gives 1" nominal creep distance.
- Use of special *Force Indicator Gauge* eliminates need for torque wrenches, inaccurate "flex" gauges, and *guesswork*.
- Various bolt lengths available to accommodate most mounting situations.
- No loose parts to complicate assembly.
- Stiffening *brace* to reinforce heat sink *available upon request*.
- *Single-side cooling terminal available upon request*.
- Positive, non-binding swivel action.

OUTLINE DRAWING

DIM.	INCHES MIN.	INCHES MAX.	MM MIN.	MM MAX.
A	3.095	3.105	78.6	79.0
B	——	4.520	——	114.5
C	——	1.000	——	25.4
D	1.230	1.270	31.2	32.2
E	.680	.700	17.28	17.77
F	——	1.000	——	25.4
G	3.940	4.060	100.0	103.1
H	.850	.860	21.60	21.83
J	.110	.140	2.80	3.55
K	2.177	2.197	55.30	55.79
L	.605	.645	15.37	16.37
M	.380	.392	9.66	9.95
N	3.480	3.520	88.40	89.40
P	.090	.095	2.29	2.40
Q	.125	.135	3.18	3.42
R	.025	.035	.64	.88
S	1.230	1.270	31.25	32.25





SINGLE SIDE TERMINAL

NOTES:

1. The backup brace should be used when the mounting web of the heatsink is not sufficiently thick to prevent the heatsink from bending when the clamp is tightened. Extruded aluminum heatsinks with mounting webs less then 3/8" thick require this brace in order to withstand the full 2500 lbs. mounting force. Refer to MOUNTING PROCEDURE for complete mounting instructions.
2. Drill clearance holes in lower heatsink for a 3/8 - 24 bolt.
3. When a brace is used, the "Z" dimension includes the one inch thickness of the brace. Refer to Table II for selection of the proper bolt length.
4. The semiconductor device to be mounted must be positively located in the center of the clamp. A 1/8" diameter by 1/4" long grooved or spring pin is recommended for locating the device. Use a #30 drill (0.1285" dia.) for the hole in the heatsink.

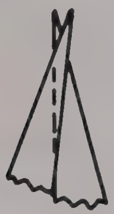
SERIES 2500

MOUNTING PROCEDURE

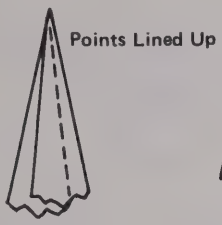
With the semiconductor positively located in place on the heatsink(s) (refer to Note 4 of Table 1), place the clamp in position with the bolts through the holes in the heatsink(s), and proceed as follows:

1. Refer to Device Specification Sheet for Preparation of Mounting Surface.
2. Tighten the nuts evenly until finger tight.
3. Tighten bolts 2½ turns each, using a 9/16 socket wrench on the bolt heads.
4. Place the Force Indicator Gauge firmly against the springs, as shown on the Outline Drawing, so that both ends and the middle are in solid contact with the springs. The upper points of the gauge will then indicate the spring deflection, or force; correct mounting force is indicated when the points coincide.

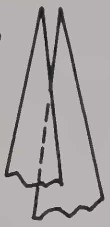
Examples:



Less than rated force. Tighten nuts alternately 1/4 turn at a time until points coincide.



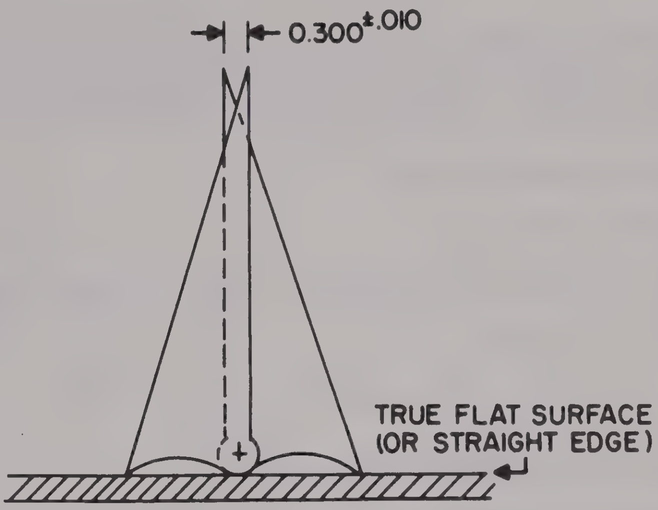
Correct force.



Excessive force. Loosen nuts and start over. *NEVER* try to adjust spring force by backing off the nuts, spring friction will produce false readings. Always start at Step. 1.

To Calibrate Force Gauge:

If the gauge is suspected of being out of calibration due to wear or damage, check it on a flat surface as shown below.



If the points are not 0.300 ± .010 apart, calibrate the gauge by filing the bottom contact points.

ORDERING INSTRUCTIONS

In order to select the proper clamp for a given application, it is necessary to know three mounting parameters:

- The correct force necessary to mount the semiconductor device.
- The length of the bolts necessary to span dimension "Z".
- The capability of the sink to withstand the mounting force without bending (refer to Note 1 of Table I).

Knowing these parameters, the proper clamp may be selected from Table II.

TABLE II – CLAMP SELECTION CHART

GE Device Type[4]	Recommended Mounting Force (lbs)	Clamp Force (lbs)	Allowable "Z"[1] Dimension (inches)	Bolt Length (inches)	Order Number[2,3]
C387, C388	2000-2500	2200-2400	1.375-2.125	3.50	HW2500G77
C397, C398			1.875-2.625	4.00	HW2500G78
C395			2.375-3.125	4.50	HW2500G79
C500 Family			3.375-4.125	5.50	HW2500G82
A500 Family			5.375-6.125	7.50	HW2500G83

Phenolic temperature beyond 125°C and spring temperature above 110°C is not permissable.

1. Refer to Outline Drawing and to Note 3 of Table I for determination of "Z" dimension.
2. If a brace is required, add suffix "B" to the order number, e.g. HW2500G72B.
3. If a terminal is required (used with a single side cooling), add the letter "T" to the order number, e.g. HW2500G72BT.
4. All group numbers or bolt lengths can be used with any device types.

Germanium
Tunnel Diodes

TYPE
TD-9

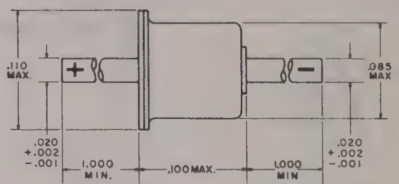
The General Electric TD-9 is a Germanium Tunnel Diode offering a peak current of 500 μa. This device, which makes use of the quantum mechanical tunneling phenomenon to obtain a negative conductance characteristic, is designed for converter, small signal, low level switching and logic applications. This device is housed in General Electrics new hermetically sealed subminiature axial package.

ABSOLUTE MAXIMUM RATINGS

Forward Current* I_F	2.5 ma
Reverse Current* I_R	5 ma
Storage Temperature T_{STG}	$-55^\circ C$ to $+100^\circ C$
Lead Temperature	
1/16" ± 1/32" from case for 10 sec	$260^\circ C$

* Derate maximum currents 1%/°C above 25°C

AXIAL DIODE OUTLINE

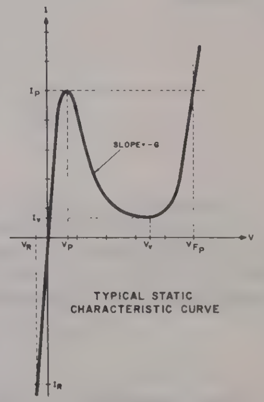


ALL DIMENSIONS IN INCHES.
DIMENSIONS ARE REFERENCE UNLESS TOLERANCED.

ELECTRICAL CHARACTERISTICS: (25°C)

Static Characteristics:

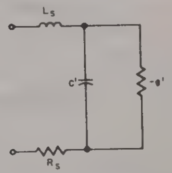
		Min	Typ	Max	Units
Peak Point Current	I_P	450	500	550	μa
Valley Point Current	I_V		60	100	μa
Peak Point Voltage	V_P		65		mv
Valley Point Voltage	V_V		350		mv
Forward Voltage (I_F=I_P Typ)	V_{FP}		500		mv
Reverse Voltage (I_R=I_P Typ)	V_{RP}		20	40	mv



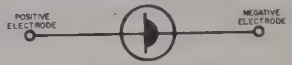
TYPICAL STATIC
CHARACTERISTIC CURVE

Dynamic Characteristics:

		Min	Typ	Max	Units
Total Series Inductance	L_S		0.5		nh
Total Series Resistance	R_S		2.5	6.0	ohm
Valley Point Capacitance	C		2.5	5.0	pf
Max. Terminal Neg. Cond.	-G		4		$x10^{-3}$mho
Resistive Cutoff Freq.	f_{ro}		2.5		kmc
Self Resonant Freq.	f_{ro}		4.5		kmc
Frequency of Oscillation	f_{osc}		4.5		kmc



EQUIVALENT CIRCUIT
(BIASED IN NEGATIVE
CONDUCTANCE REGION)



TUNNEL DIODE SYMBOL

$$fro = \frac{|g'|}{2\pi C'}\sqrt{\frac{1}{Rs\,|g'|} - 1}$$

$$fxo = \frac{1}{2}\sqrt{\frac{1}{LsC'} - \left(\frac{|g'|}{C}\right)^2}$$

$$fosc = \frac{1}{2\pi}\sqrt{\frac{1}{LsC} - \left(\frac{Rt}{L-}\right)^2}$$

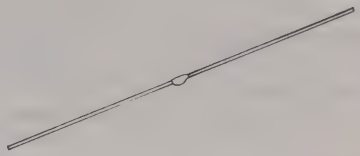
Germanium Diodes

P N

TD251,2,4,5,6,A

TD253,A,B

The General Electric Types TD-251,A through TD-256,A series of tunnel diodes are extremely fast, P-Type germanium devices with peak currents of 2.2, 4.7, 10, 22, 50 and 100 ma. Among the unique features offered by these tunnel diodes are high I_P/I_V ratios and C/I_P ratios as low as 0.025 pf/ma. They are intended for use in pulse generators, threshold detectors, memory and logic circuits. Specially selected units offering tighter control over parameters are also available. These devices are fabricated with General Electric's new sandwich pellet and are housed in a subminiature epoxy package. A special microwave package can be furnished which offers a series inductance of 0.1 nh.



absolute maximum ratings: (25°C)

	TD-251 TD-251A	TD-252 TD-252A	TD-253 TD-253A TD-253B	TD-254 TD-254A	TD-255 TD-255A	TD-256 TD-256A	
Continuous Forward DC Current*	2.2	5	10	11	25	50	ma
Maximum Power Dissipation	1.5	3.5	7	7.5	18	35	mw
Operating and Storage Temperature	←		—55 to +75			→	°C
Lead Temperature 1/16″ ± 1/32″ from case for 10 seconds	←		230			→	°C

*Derate maximum forward current 1% per °C for ambients in excess of 25°C.

electrical characteristics: (25°C)

	COLOR DOT	BROWN TD-251			BROWN/GRAY TD-251A			RED TD-252			RED/GRAY TD-252A			
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Peak Point Current	I_P	2.0	2.2	2.4	2.0	2.2	2.4	4.2	4.7	5.2	4.2	4.7	5.2	ma
Valley Point Current	I_V		.20	.31		.22	.31		.45	.60		.45	.60	ma
Peak Point Voltage	V_P		70			80	110		80			90	120	mv
Valley Point Voltage	V_V		390			390			390			400		mv
Forward Voltage ($I_F = I_P$)	V_{FP}	500	540	650	500	580	650	500	560	650	500	575	650	mv
($I_F = .25\ I_P$)	V_{FS}	420	500		420	500		435	510		435	530		mv
Total Series Inductance	L_S		1.5			1.5			1.5			1.5		nh
Total Series Resistance	R_S		5			7			3.5			4.0		ohms
Valley Point Terminal Capacitance	C_V		1.8	3.0		0.65	1.0		2.8	6.0		0.65	1.0	pf
Rise Time	t_r**		430			160			320			74		Psec

**Switching speed with constant current drive, $t_r \approx \frac{V_{FP} - V_P}{I_P - I_V} C_V$

TD251,2,4,5,6,A TD253,A,B

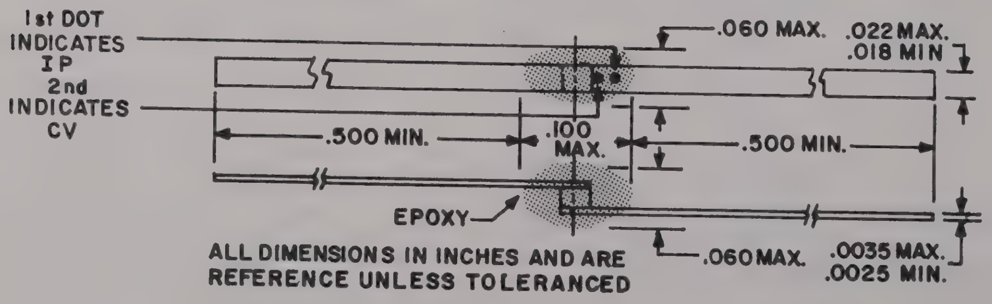
electrical characteristics: (25°C)

		ORANGE TD-253			ORANGE/GRAY TD-253A			ORANGE/WHITE TD-253B			YELLOW TD-254			YELLOW/GRAY TD-254A			
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Peak Point Current	I_P	9.0	10	11	9.0	10	11	9.0	10	11	20	22	24	20	22	24	ma
Valley Point Current	I_V		0.9	1.4		0.9	1.4		0.9	1.4		2.7	3.8		2.7	3.8	ma
Peak Point Voltage	V_P		75			80			90	120		90			100	120	mv
Valley Point Voltage	V_V		400			410			420			425			425		mv
Forward Voltage																	
($I_F = I_P$)	V_{FP}	500	560	650	520	570	650	550	600	650		600		550	600	650	mv
($I_F = .25\ I_P$)	V_{FS}	450	510		450	530		450	540			520		460	540		mv
Total Series Inductance	L_S		1.5			1.5			1.5			1.5			1.5		nh
Total Series Resistance	R_S		1.7			2.0			2.5			1.8			2.0		ohms
Valley Point Terminal Capacitance	C_V		6.5	9.0		3.5	5.0		1.2	2.0		7.0	18		2.5	4.0	pf
Rise Time	t_r**		350			190			68			185			64		Psec

electrical characteristics: (25°C)

		GREEN TD-255			GREEN/GRAY TD-255A			BLUE TD-256			BLUE/GRAY TD-256A			
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Peak Point Current	I_P	45	50	55	45	50	55	90	100	110	90	100	110	ma
Valley Point Current	I_V		6.0	8.5		6.0	8.5		12.0	17.5		12.0	17.5	ma
Peak Point Voltage	V_P		110			130			150			180		mv
Valley Point Voltage	V_V		425			425			450			450		mv
Forward Voltage														
($I_F = I_P$)	V_{FP}		625			640			650			660		mv
($I_F = .25\ I_P$)	V_{FS}		530		480	550			530		500	550		mv
Total Series Inductance	L_S		1.5			1.5			1.5			1.5		nh
Total Series Resistance	R_S		1.4			1.5			1.1			1.2		ohms
Valley Point Terminal Capacitance	C_V		8.5	25		3.0	5.0		10.0	35		4.0	6.0	pf
Rise Time	t_r**		100			35			57			22		Psec

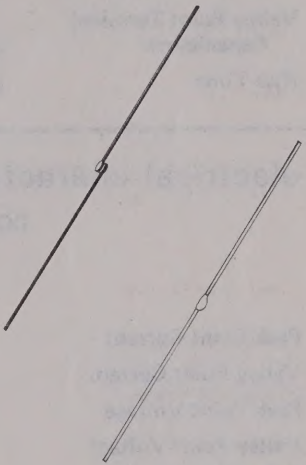
DIMENSIONS WITHIN JEDEC OUTLINE DO-18


1st DOT
INDICATES
IP
2nd
INDICATES
CV
.060 MAX.
.022 MAX.
.018 MIN
.500 MIN.
.100
MAX.
.500 MIN.
EPOXY
.060MAX.
.0035 MAX.
.0025 MIN.
ALL DIMENSIONS IN INCHES AND ARE
REFERENCE UNLESS TOLERANCED

Germanium
Diodes

TYPE	
TD261,A	TD271,A
TD262,A	TD272,A
TD263,A,B	TD273,A,B
TD264,A	TD274,A
TD265,A	TD275,A
TD266,A	TD276,A

The General Electric TD261,A through TD266A series of tunnel diodes are extremely fast, P-Type germanium devices with peak currents of 2.2, 4.7, 10, 22, 50 and 100 ma. Among the unusual features offered by these tunnel diodes are high I_P/I_V ratios and C/Ip ratios as low as 0.025 pf/ma. New manufacturing techniques provide a high temperature tunnel diode capable of 100°C storage and operation resulting in high reliability performance. Types TD271,A through TD276,A are built in a special microwave package which has electrical characteristics of the TD260 line with a series inductance of .15 mh. Specially selected units offering parameter variations or tighter control are also available.



absolute maximum ratings: (25°C)

	TD261 TD261A TD271 TD271A	TD262 TD262A TD272 TD272A	TD263 TD263A TD263B TD273 TD273A TD273B	TD264 TD264A TD274 TD274A	TD265 TD265A TD275 TD275A	TD266 TD266A TD276 TD276A	
Maximum Power Dissipation	1.5	3.5	7	7.5	18	35	mw
Operating and Storage Temperature	←		–55 to +100°C			→	°C
Lead Temperature 1/16" ± 1/32" from case for 10 seconds	←		230			→	°C

*Derate maximum forward current 1% per °C for ambients in excess of 25°C.

electrical characteristics: (25°C)

COLOR DOT**		BROWN TD261 TD271			BROWN/GRAY TD261A TD271A			RED TD262 TD272			RED/GRAY TD262A TD272A			
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Peak Point Current	I_P	2.0	2.2	2.4	2.0	2.2	2.4	4.2	4.7	5.2	4.2	4.7	5.2	ma
Valley Point Current	I_V		.20	.31		.22	.31		.45	.60		.45	.60	ma
Peak Point Voltage	V_P		70	100		80	110		80	110		90	120	mv
Valley Point Voltage	V_V		390			390			390			400		mv
Forward Voltage														
($I_F = I_P$)	V_{FP}*	500	540	650	500	580	650	500	560	650	500	575	650	mv
($I_F = .25\ I_P$)	V_{FS}	420	500		420	500		435	510		435	530		mv
Total Series Inductance														
TD260	L_S		1.5			1.5			1.5			1.5		nh
TD270	L_S		.15			.15			.15			.15		nh
Total Series Resistance	R_S		5			7			3.5			4.0		ohms
Valley Point Terminal Capacitance	C_V		1.8	3.0		0.65	1.0		2.8	6.0		0.65	1.0	pf
Rise Time	t_r***		430			160			320			74		Psec

*Max V_{FP} on TD270 devices is 675 mv

**TD270 series marked with white cathode dot only

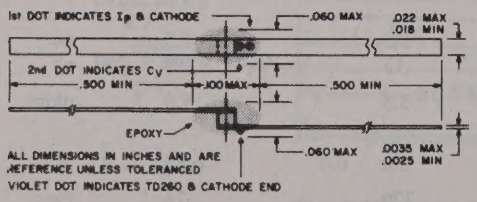
***Switching speed with constant current drive, $t_r \approx \frac{V_{FP} - V_P}{I_P - I_V} C_V$

electrical characteristics: (25°C)

COLOR DOT**		ORANGE			ORANGE/GRAY			ORANGE/ WHITE			YELLOW			YELLOW/GRAY			
		TD263 TD273			TD263A TD273A			TD263B TD273B			TD264 TD274			TD264A TD274A			
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Peak Point Current	I_P	9.0	10	11	9.0	10	11	9.0	10	11	20	22	24	20	22	24	ma
Valley Point Current	I_V		0.9	1.4		0.9	1.4		0.9	1.4		2.7	3.1		2.7	3.1	ma
Peak Point Voltage	V_P		75	100		80	110		90	120		90	115		100	130	mv
Valley Point Voltage	V_V		400			410			420			425			425		mv
Forward Voltage																	
($I_F = I_P$)	V_{FP}*	500	560	650	520	570	650	550	600	670	500	580	650	550	610	680	mv
($I_F = .25\ I_P$)	V_{FS}	450	510		450	530		450	540			520		460	540		mv
Total Series Inductance																	
TD260	L_S		1.5			1.5			1.5			1.5			1.5		nh
TD270	L_S		.15			.15			.15			.15			.15		nh
Total Series Resistance	R_S		1.7			2.0			2.5			1.8			2.0		ohms
Valley Point Terminal Capacitance	C_V		6.5	9.0		3.5	5.0		1.2	2.0		7.0	18		2.5	4.0	pf
Rise Time	t_r***		350			190			68			185			64		Psec

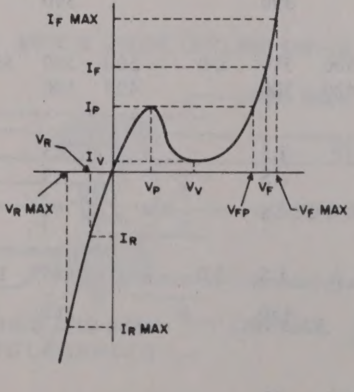
electrical characteristics: (25°C)

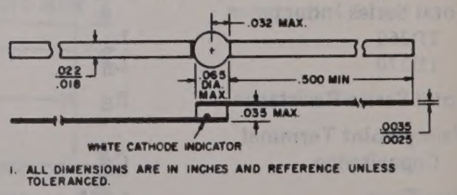
COLOR DOT**		GREEN			GREEN/GRAY			BLUE			BLUE/GRAY			
		TD265 TD275			TD265A TD275A			TD266 TD276			TD266A TD276A			
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Peak Point Current	I_P	45	50	55	45	50	55	90	100	110	90	100	110	ma
Valley Point Current	I_V		6.0	8.5		6.0	8.5		12.0	17.5		12.0	17.5	ma
Peak Point Voltage	V_P		110	180		130	200		150	210		180	260	mv
Valley Point Voltage	V_V		425			425			450			450		mv
Forward Voltage														
($I_F = I_P$)	V_{FP}	520	625	700	550	640	750	520	650	720	550	680	800	mv
($I_F = .25\ I_P$)	V_{FS}		530		480	550			530		500	550		mv
Total Series Inductance														
TD260	L_S		1.5			1.5			1.5			1.5		nh
TD270	L_S		.15			.15			.15			.15		nh
Total Series Resistance	R_S		1.4			1.5			1.1			1.2		ohms
Valley Point Terminal Capacitance	C_V		8.5	25		3.0	5.0		10.0	35		4.0	6.0	pf
Rise Time	t_r***		100			35			57			22		Psec



DIMENSIONS WITHIN JEDEC OUTLINE DO-18
1st DOT INDICATES Ip & CATHODE
.060 MAX
.022 MAX
.018 MIN
2nd DOT INDICATES Cv
.500 MIN
.100 MAX
.500 MIN
EPOXY
.060 MAX
.0035 MAX
.0025 MIN
ALL DIMENSIONS IN INCHES AND ARE REFERENCE UNLESS TOLERANCED
VIOLET DOT INDICATES TD260 & CATHODE END

TD260 SERIES





DIMENSIONS WITHIN JEDEC OUTLINE DO-20
.032 MAX.
.022
.018
.065 DIA. MAX.
.500 MIN
.035 MAX.
.0035
.0025
WHITE CATHODE INDICATOR
1. ALL DIMENSIONS ARE IN INCHES AND REFERENCE UNLESS TOLERANCED.

TD270 SERIES

SEMICONDUCTOR PRODUCTS DEPARTMENT
GENERAL ELECTRIC
ELECTRONICS PARK, SYRACUSE, N. Y. 13201

451.90

PRINTED IN U.S.A.